Roadside rights-of-way as pollinator habitat: a literature review

Final Report to the Maine Department of Transportation

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SUMMARY

Pollination of crops and naturally-occurring flowering plants is a critical ecosystem service provided by managed and unmanaged animal pollinators. Insects are the most studied pollinators, particularly managed honey bees, unmanaged wild bees, and butterflies. Bees and butterflies thrive in early-successional habitat featuring grasses, exposed soil, wildflowers, and shrubs, which is consistently found within transportation and utility rights-of-way (ROW). However, intensive management of ROW can reduce the amount of high-quality pollinator habitat; such practices include frequent mowing, broadcast herbicide use, and planting non-native cool season grasses. Here, we review peer-reviewed academic and non-peer reviewed gray literature describing ROW management practices and their effects on pollinator populations, focusing on applications of these practices in landscapes similar to those found in Maine and the northeast United States; that is, landscapes that are heavily forested and interspersed with agriculture, developed areas, and wetlands. The literature consistently recommends these management practices to provide pollinator habitat in ROW and promote plant and pollinator diversity and abundance:

1) Reduce mowing frequency and time mowing to pollinator activity.

2) Target herbicide applications to undesirable plant species using backpack sprayers.

3) Plant native seeds, seedlings, or shrubs, leaving some exposed soil for nesting.

We considered threats to plants and pollinators associated with ROW, including traffic volume and mortality, noise, light, and air pollution, and habitat fragmentation. The literature suggests that these threats vary widely across road sizes, types, and landscape context, and the overall negative impacts do not outweigh the potential benefits of promoting pollinator habitat in ROW.

Landscape context also influences the composition of ROW plant and pollinator communities. In Maine, agriculture and grassland in the surrounding generally reduced bumble bee and butterfly abundance in Priority 1 ROW sites.

Many state Departments of Transportation have incorporated integrative vegetation management (IVM) principles into ROW management, and we summarize a number of case studies here. Restoration projects in high-visibility areas are common; further, these can lead to public support for additional pollinator habitat enhancement. Implementing new management practices can be difficult, therefore we discuss strategies to aid in successful adoption, including gathering public support, collaborations between public and private agencies, and innovative funding opportunities. While assessing vegetation management impacts on bee and butterfly communities in ROW is a rapidly expanding area of research, there are still many gaps in current knowledge. We conclude this report by addressing these gaps and provide suggestions for further study.

ACRONYMS

BMP: Best management practice, used to describe recommended management strategies.

CCAA: Candidate Conservation Agreement with Assurances, a voluntary conservation agreement between the U.S. Fish and Wildlife Service and one or more public or private parties that provides non-federal landowners incentives for participation through assurances that limit future conservation obligations.

DOT: Department of Transportation, a government agency that is devoted to transportation. DOTs exist at federal, state, and local levels.

FHWA: U.S. Federal Highway Administration, a division of the U.S. DOT that specializes in highway transportation.

IVM: Integrated vegetation management, a management scheme that aims to manage vegetation and the environment by balancing the benefits of cost, control, environmental quality, public health, and regulatory compliance.

IRVM: Integrated roadside vegetation management, an IVM scheme applied specifically to land associated with roadsides (Brandt et al. 2015).

PICO: An approach to outlining the scope of a literature search by defining Population, Intervention, Comparators, and Outcome criteria to develop an effective search strategy and collect the most relevant literature (Villemey et al. 2018).

ROW: Right-of-way, a type of easement granted or reserved over the land for transportation purposes, including maintenance and vegetation management.

USFWS: U.S. Fish and Wildlife Service, an agency of the US federal government within the US Department of the Interior dedicated to the management of fish, wildlife, and natural habitats.

TABLES AND FIGURES

1. Introduction

1.1. Pollinator services, biology, and conservation

Insect pollination is necessary for the reproduction of nearly 90% of flowering plants and two-thirds of crop plants globally (Klein et al. 2007, Ollerton et al. 2011). Crop pollination services contribute $34 billion to the United States economy annually (Jordan et al. 2021). Managed honey bee (*Apis mellifera*) hives provide much of this service, though unmanaged pollinators, including wild bees, butterflies, wasps, moths, and flies, are also significant contributors. Of these, most research has studied wild bees; much less is known about crop pollination by non-bee unmanaged pollinators (Rader et al. 2020). In the case of specialty crops grown in Maine and the northeastern United States, such as lowbush blueberries, cranberries, apples, and squash, wild bees can be more effective crop pollinators than honey bees (Garibaldi et al. 2013, Asare et al. 2017). Though honey bees can establish wild colonies and forage for food, beekeepers provide food and shelter for them, and the USDA classifies them as livestock (vanEngelsdorp and Meixner 2010). However, wild bees and other unmanaged insect pollinators require naturally-occurring food and shelter.

Maine is home to at least 278 wild bee species in six families of the order Hymenoptera, and at least 118 butterfly species in five taxonomic families within the insect order Lepidoptera, (Webster and deMaynadier 2005, Dibble et al. 2017). Both bees and butterflies, with some exceptions, are adults for a single growing season, during which they spend most of their energy on reproduction. Bees will establish nests, lay eggs, and provision those eggs with pollen and nectar to provide nourishment for the larval stage upon hatching. Bees and many butterflies overwinter as larvae or pupae and emerge the next spring as reproducing adults. A notable exception is the monarch butterfly (*Danaus plexippus*), which migrates south for the winter and overwinters as an adult. The following spring, overwintered adults migrate back north, laying eggs and producing multiple new generations of butterflies; these later generations reach the furthest north, reproduce, and the final generation of the season enters into reproductive diapause preceding the southward migration (Oberhauser and Solensky 2004). Bees consume pollen, and bees and many butterflies consume nectar from flowering plants. Flowering plants provide food and shelter for butterfly eggs and caterpillars. Wild bees nest either underground in exposed sandy soil or in cavities created by hollow twigs or rotting logs. Access to resources for both bees and butterflies is constrained by their maximum flight limits: wild bees typically fly 0.5 mi or less, while butterflies can fly up to 1.25 miles to find food (Greenleaf et al. 2007, Davis et al. 2007).

Pollinator habitat has been in steady decline for decades (Potts et al. 2010). This decline, along with increasing pesticide use, parasites, and pathogens, has contributed to drastic declines in insect pollinator populations (Goulson et al. 2015), including the regal fritillary (*Speyeria idalia*) and the rusty patched bumble bee (*Bombus affinis*), both of which were historically present in Maine. Maine currently has five state threatened and five state endangered insect pollinator species, and many others that are listed as species of Special Concern (Appendix A, this report; Maine State Wildlife Plan 2015). Recent surveys, including the Maine Butterfly Survey and Maine Bumble Bee Atlas, have updated or established baseline data on insect pollinator species distribution and relative abundance throughout the state (Webster and deMaynadier 2005, Bickerman-Martens et al. 2017).

1.2. Pollinator habitat along roadside rights-of-way

Roadside rights-of-way (ROW) are generally managed as early-successional habitat dominated by grasses, often featuring weedy flowering species. Roadside ROW managed following status quo practices (e.g., frequent mowing and widespread pesticide application) provide limited habitat resources for wild pollinators; non-native cool season grasses typical of these areas do not expose soil for nesting, allow shrubs to provide nesting or forage, or allow wildflowers to flourish. With adjustments to intensive management practices, roadside ROW could become a significant source of wild pollinator habitat.

A Presidential Memorandum issued by the White House in 2014 encouraged federal agencies to increase and improve existing pollinator habitat nationwide, and roadside ROW were specifically suggested as areas to explore expanding habitat (White House 2014). This was a crucial impetus for state Departments of Transportation (DOTs) to engage in pollinator conservation activity by adapting vegetation management practices along roadside ROW. DOTs manage 17 million miles of road with approximately 10 million acres of adjoining roadside land (Forman et al. 2002, Wojcik and Buchmann 2012), potentially providing a wealth of pollinator habitat. The Maine DOT manages approximately 2,023 ha (5,000 ac) of land within ROW (Campanelli et al. 2019). Roadside ROW restored to a prairie-like habitat condition have greater bee abundance and species richness than weedy roadsides, with bee communities that are similar to those in remnant prairie (Hopwood 2008). Butterflies also benefit from native wildflower plantings along roadsides (Feber et al. 1996, Valtonen et al. 2007). Reducing the frequency of mowing and pesticide application further promotes bee and butterfly communities in ROW (Feber et al. 1996, Zinnecker and Larsen 2011, Kuder 2019).

Roadside ROW are found across multiple landscapes; they run through forests, agricultural land, developed areas, and shrub or herbaceous-dominant natural habitat, including grasslands and wetlands. These types of land support distinct bee communities (Du Clos et al. 2020) and may influence the effectiveness of ROW management practices to support diverse and abundant wild pollinator populations. For landscapes with few habitat resources, ROW may serve as a source of wild pollinators (Berg et al. 2016). In low-intensity agricultural landscapes, roadsides can be a vital source of forage for bumble bees (Osgathorpe et al. 2012). In a study of multiple cover types in a mixed-use landscape of the United Kingdom, roadsides had the greatest percent cover and the richest assemblage of flowers, supporting the greatest abundance and diversity of bees, butterflies, and hoverflies (Cole et al. 2017).

Potential traffic-related threats associated with roadside habitat for wild pollinators include noise and air pollution, barriers to dispersal, and mortality via vehicle collision. The effects of these threats on pollinator communities vary with road size, traffic volume, roadside habitat quality, landscape context, and pollinator traits such as tongue length or body size (Hopwood et al. 2015a, Roberts and Phillips 2019). However, this variation and the amount of potential habitat available likely mitigates overall negative outcomes for ROW habitat restoration for pollinator communities (Phillips et al. 2020).

1.3 Research objectives

We conducted a literature search and review to assess the current body of information on roadside ROW vegetation management for wild pollinators. We reviewed existing best management practices (BMPs) and supporting literature to answer three research questions: 1) Are there specific ROW management practices that successfully enhance pollinator abundance and diversity? 2) Which insect pollinator taxa respond most significantly to common ROW management practices? 3) Are there elements of landscape context that affect the success of ROW management practices for pollinator conservation? We synthesized our findings and reviewed case studies to determine the effectiveness of recommended BMPs for wild pollinators. We also identified knowledge gaps in the literature where recommendations exist with few supporting scientific studies. Along with our review, we assessed landscape composition surrounding 10 ROW sites along Priority 1 roads in Maine. Plant and pollinator communities were surveyed at these sites in 2017.

2. Methods

2.1 Study scope

We outlined a study scope using the Population, Intervention, Comparator, Outcome (PICO) approach (Villemey et al. 2018) (Table 1). Our study population includes insect pollinator taxa of Maine and the northeastern US. Habitat types, pollinator communities, and landscape patterns in this region can be grouped together owing to overall similarity.

Table 1. Outline of study scope following the PICO approach (Villemey et al. 2018)

Population	Insect pollinator taxa
Intervention	ROW management practices
Comparators	Managed vs unmanaged habitat; Landscape context
Outcome	Change in pollinator population

To avoid gathering material from beyond our geographic scope, we framed our search strategy, inclusion criteria, and interpretation of results to the northeastern US. Our focal intervention is ROW management practices, including mowing, seeding, herbicide use, burning, and grazing. Although roadside ROW are the primary focus of this study, we considered information on similar ROW types including railways, power lines, and field edges or margins when conducting our search to ensure collecting a comprehensive body of information. Our comparators to assess effectiveness of ROW management practices for pollinator communities are 1) managed vs unmanaged habitat and 2) landscape context. Studies that provide this information present comparisons that we can interpret and apply to ROW management in Maine and the northeastern US. Lastly, our focal outcome is a change in insect pollinator abundance or diversity owing to

ROW management practices. We used our PICO variables to frame our search strategy and develop criteria for papers to include in our review.

2.2 Search strategy and protocol

We conducted an initial scoping search through previously gathered literature to a) aid in refining our PICO variables and developing search keywords and b) create a test list to compare to results from initial database searches. We gathered peer-reviewed literature by first searching our reference manager using a series of ROW-related keywords, and then we conducted two Google Scholar searches for papers citing foundational papers on ROW management for pollinators (Hopwood 2008, Wojcik and Buchmann 2012). We gathered gray literature not published in peer-reviewed sources and other non-academic information by conducting a Google search for "roadside vegetation management." We gathered all relevant results using our PICO variables to test their relevance to and comprehensiveness of existing knowledge on ROW management for pollinators.

Following this initial search, we developed an *a priori* search protocol for our full literature search. The protocol began with a comprehensive search keyword list, with words generated in several subcategories of each PICO variable (Appendix B). We developed a set of inclusion criteria to determine which search results were kept or rejected. We chose three sources for our database searches, selecting Web of Science to gather peer-reviewed literature owing to its comprehensive collection of journals and supplementing Web of Science with Google Scholar to gather pre-prints, very recently published articles, and gray literature. We also chose to conduct a series of Google searches specifically for gathering gray literature from non-academic sources.

We began the full literature search by testing keyword combinations on Web of Science with the goal of building a comprehensive keyword phrase that incorporated our PICO variables and produced highly relevant search results, using truncation symbols, quotation marks, and Boolean operators. We assessed performance of keyword combinations by 1) the alignment of search results to the initial paper collection and 2) the number of duplicate results from previous test searches. The most comprehensive keyword phrase had three sections: ROW type, organism, and management practice, each represented by a keyword combination. We tested keyword phrases with a fourth section containing outcome-based keywords; however, all results from these searches were duplicates. Therefore, the final keyword phrase contained three sections. Each section was tested with multiple keyword combinations to exhaust our keyword list and to obtain the widest breadth of literature. Many search results were dominated by duplicates and provided few new articles, providing support for the comprehensiveness of our best-performing keyword phrase. Specifying type of organisms beyond "pollinators" (e.g., "bees," "bumble bees" or "butterflies") often provided more new results than modifying other sections of the keyword phrase. We tested various land cover type and landscape context keywords along with the management practice keywords; none of these searches returned new results. Our final best performing keyword in Web of Science was (Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*).

We modified the best-performing keyword from Web of Science for the Google Scholar search, as Google Scholar does not recognize truncation symbols, by expanding the organismal term to list multiple types of pollinators and using the full words referenced in the management term. We conducted five searches in Google Scholar, each featuring a unique ROW search term with the modified organismal and management terms. We further modified the search term for our general Google search. We conducted searches for road and rail ROWs, omitting power lines owing to relevance in previous searches. We tested each management term with road and rail, finding “management” to be the most relevant result; therefore, we used only “management” when testing organismal terms. We tested eight organismal terms with “road management” and retained four of them to search with “rail management.”

We conducted searches in Web of Science and Google Scholar in the summer of 2018 and again in the fall of 2019. In Google Scholar, the 2019 searches were conducted with the “since 2018” box checked to avoid redundancy in the results. In sum, we conducted 120 searches using 105 keyword combinations. All keyword combinations are listed in Appendix C.

2.3 Initial screening and cataloguing

We screened the titles of each search result to determine suitability for initial collection and gathered papers that mentioned a pollinator or pollinated plant and a type of ROW (including other linear landscape features such as field edges, margins, and hedgerows) within the title, rejecting all those that did not meet these two criteria. If the title was ambiguous, we read the abstract to find our two title criteria and made our decision on inclusion from that text.

We cataloged each reference we collected with a detailed entry in an Excel spreadsheet, assigning each reference, whether peer-reviewed or non-peer-reviewed/gray literature, a unique ID number based on its source: WOS#### (Web of Science), GS#### (Google Scholar) or GO#### (Google). We recorded many details for each reference when applicable, including the publishing journal, year published, DOI, focal organisms, focal ROW type, study variables (dependent and independent), comparators, study approach, language, and location, downloading PDF files of all available documents for full-text screening.

2.4 Full-text screening, critical appraisal, and data extraction

After the initial reference collection, we reviewed each entry in detail, reading the full-text to determine its suitability for inclusion in our review. We created an *a priori* set of inclusion criteria for each entry to meet based on relevance to our focal questions and, if applicable, study design. Criteria for full-text screening were extensive, including geographic location (USA, Canada, and Europe; we aimed to capture similar environmental and climatic conditions) and restrictions on the type of ROW and pollinators or plants. For example, while we gathered information about a variety of ROW in our initial screening, only roadside and railway ROW were included after full-text screening owing to the amount of relevant information collected. This led to the exclusion of references on field edges/margins, hedgerows, power lines, gas lines, solar or wind arrays, and others. Additionally, only bees, butterflies, moths, and hoverflies were included after full-text screening, leading to the exclusion of references on wasps, ants, and non-insect pollinators including birds, bats, and small mammals. All inclusion criteria used for full-text screening are listed in Appendix D.

Assessing details on study design, including clarity of methods and avoidance of bias, is called critical appraisal; this is a crucial component of conducting a thorough and unbiased literature review. When conducting reviews, a critical appraisal can be done separately from full-text screening; however, we chose to conduct these steps concurrently in the interest of efficiency. While reading the full text of each reference, we recorded a series of variables related to study design, including the type of study, control and experimental habitat types, any habitat manipulation or management, how sites were selected, distance between sites, spatial replication of sites, length of study in years, number of sampling occasions per year, and if the study assessed landscape context or threats associated with ROW habitat. We further assessed the susceptibility to bias of each reference, assigning a high, medium, or low bias ranking based on experimental design using a protocol from an ROW review conducted by Villemey et al. (2018). Contributing factors to susceptibility to bias included absence of replications, insufficient description of methods, major confounding factors, and unclear procedures for plot location selection.

We chose Hedge's d as our measure of effect size for a meta-analysis (Koricheva et al. 2013). If references reported sufficient quantitative data to calculate effect size via Hedge's d, met the requirements of critical appraisal, and had low or medium bias, we extracted all potentially relevant data for meta-analysis. Data required to calculate Hedge's d are a mean, sample size, and variance for two groups (typically a control and a treatment); we extracted these when reported. Other statistics can be used to approximate Hedge's d, including Z-scores, t-tests, and chi-squared tests; therefore, if these were reported, they were also extracted. Lastly, we chose the correlation coefficient as an alternate measure of effect size; if a reference reported results from F-tests, we recorded those (Koricheva et al. 2013). Full details on critical appraisal, bias assessment, and data extraction are provided in Appendix E.

2.5 Spatial analysis

We assessed any influence of the surrounding landscape on pollinator communities in Maine ROW vegetation, by analyzing the landscape composition surrounding ten sites along Priority 1 roads in five geographic regions across Maine (Figure 1). Plant and pollinator communities were surveyed at these sites in the early, mid-, and late growing season in 2017 (Drummond 2018). Groff et al. (2016) combined the 2004 Maine Landcover Dataset (https://www.maine.gov/megis/catalog/metadata/melcd.html) with ancillary data on roads (MEDOTPUBRDS), railroads (RAILROUTESYS; https://www.maine.gov/geolib/catalog.html), and wetlands http://www.fws.gov/wetlands/NWI/Index.html) to create a statewide land cover map with 5 m^2 (16 ft^2) pixel resolution and seven land cover classes representing different floral and nesting resources for wild bees: agriculture/pasture, consisting of small diversified farms, orchard crops, or pasture; coniferous forest; deciduous/mixed forest; deciduous/mixed forest edge; emergent wetland, an aggregation of forested wetland and scrub-shrub land cover; wetlands/water; and urban areas. We measured the percentage of each land cover type (PLAND; McGarigal et al. 2012) in the 1 km (0.6 mi) surrounding the survey sites on this map, as landscape variables at this scale are likely to most strongly influence bumble bee and butterfly abundance and species richness (Steffan-Dewenter et al. 2002, Davis et al. 2007).

We conducted all statistical analyses in R v.4.0.3 (R Core Team 2020). We evaluated annual and seasonal differences in bumble bee and butterfly abundance and species richness with Kruskal-Wallis tests, then determined post-hoc seasonal differences with the conservative Dunn's test of multiple comparisons using package dunn.test (Dinno 2017). We tested for spatial autocorrelation with Mantel tests on bumble bee and butterfly abundance and species richness with package ade4 (Dray and Dufour 2007). The Mantel tests compare matrices of geographic distance to matrices of data distance, determining if the data are related based on their geographic location (Dray et al. 2012). We assessed differences in bumble bee and butterfly communities in ROW owing to landscape composition over the entire growing season and at each sampling period with generalized linear models (GLMs) calculated with base R or package MASS (Venables and Ripley 2002). We determined significant relationships with post-hoc analysis of deviance. Models of bumble bee and butterfly abundance had negative binomial error distributions owing to overdispersion, whereas, with the exception of early season bumble bee species richness, models of species richness had Poisson error distributions.

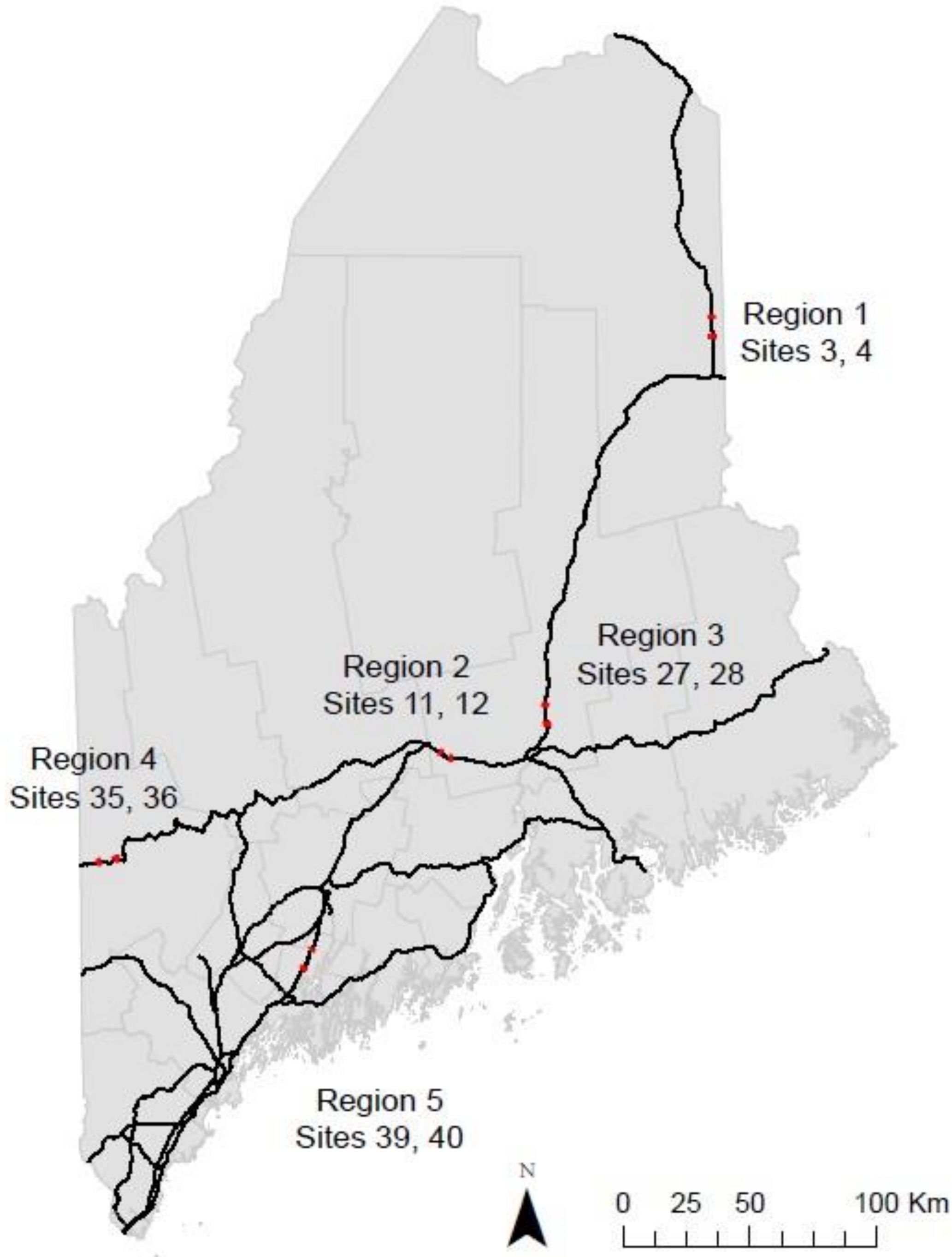

Figure 1. Locations of 10 ROW sites along Priority 1 roads in Maine where plant and pollinator communities were surveyed in 2017 by F. Drummond. 100 km = 62 mi.

3. Results

3.1 Summary of reference collection

We gathered 3,708 total references from the initial scoping search and full literature search. The initial scoping search returned 98 references; the full literature search returned 3,610 references across Web of Science, Google Scholar, and Google (Figure 2). The vast majority of search results were duplicates. Many results did not meet our search criteria through title and abstract screening, and a small number of results were not available in full-text; these were all rejected for full-text screening. Of all returned results, 555 met the criteria for full-text screening for inclusion in the narrative synthesis. Full-text screening and critical appraisal excluded 350 results; therefore, 205 results were ultimately used in our narrative synthesis (Appendix F).

This body of literature has grown rapidly over the recent decade; nearly half (47.3%) of the results included in our narrative synthesis were published after 2015, while almost three quarters (74.6%) were published after 2010. Only 1.4% of our included results were published before 2000 (Table 2). Geographically, more than half of our results (61.5%) came from peer-reviewed and non-peer-reviewed/gray literature sources in North America, while 34.1% came from Europe and 4.4% had a global focus. Most of the results included in the narrative synthesis focused solely on roadsides (63.4%) or railways (7.3%). The remainder of the included results assessed multiple types of rights-of-way. The results we included in the narrative synthesis were fairly evenly split by type of reference: 52.2% were peer-reviewed academic journal articles, while 47.8% were gray literature. The bulk of the gray literature came from our general Google search and included NGO webpages and reports, news articles, technical documents from local, state, and federal government agencies, industry and consultant reports, and academic gray literature, which consists of book chapters, conference proceedings, and Extension publications.

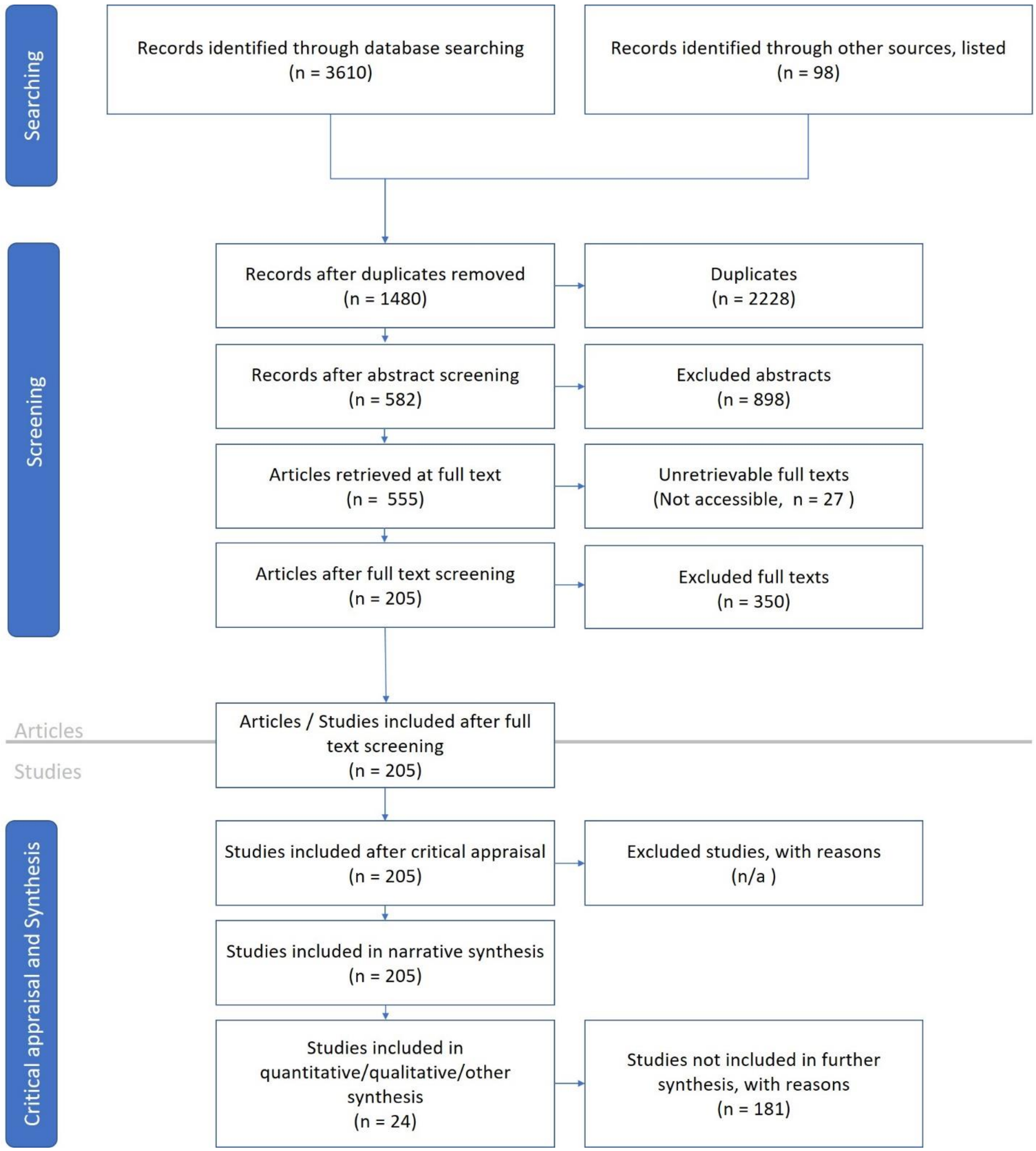

Figure 2. ROSES flow diagram outlining search results and screening (following Haddaway et al 2017).

Pollinating insects (34.6%) were the most common subject of our search results. Most of the gray literature in the narrative synthesis focused on this broad category that includes bees, butterflies, and hoverflies. Results that focused more specifically on bees (11.7%) or butterflies (28.3%) were typically peer-reviewed academic studies. Monarch butterflies were the focus of 7.3% (15) of our search results, while work on both monarchs and their host plant milkweed (*Asclepias* spp.) made up 2.9% (6) of the results. Plants, including milkweed, were the focus of 13.7% of search results, and 10.2% of the results examined both pollinators and plants (Table 2).

Table 2. Summary statistics of literature search results (n = 205)

Category	Number of results	Percent of total
Source		
Peer-reviewed literature	107	52.2
Gray literature	18	8.8
Google Search	80	39.0
Time		
Pre-2000	3	1.5
2000-2009	28	13.7
2010-2015	56	27.3
2016-Present	97	47.3
Undated	21	10.2
Location		
North America	126	64.5
Europe	70	34.1
Global	9	4.4
ROW Type		
Roadside	130	63.4
Railway	15	7.3
Multiple types	56	27.3
Other*	4	2.0
Pollinator taxa		
Bees	24	11.7
Butterflies	58	28.3
Pollinating insects	71	34.6
Plants	28	13.7
Multiple	21	10.2
Other (wildlife or people)	2	1.0
N/A (not taxa specific)	1	0.5

* includes waterway filter strips, prairie remnants, habitat edges, and a public park

We extracted quantitative data suitable for meta-analysis from 24 papers, totaling 256 cases from which we could calculate effect sizes of the influence of ROW vegetation management on plant and pollinator communities. Characteristics of these data, including variables measured, organisms studied, experimental design, and statistics reported varied widely across these papers. For example, we summarized the data collected into two categories of variables measured: amount or diversity. The amount category includes cases measuring abundance, density, survival, or mortality of plants or pollinators. The diversity category is more uniform, consisting primarily of species richness with a small number of other biodiversity measurements. We assigned two categories of organisms studied: plants or pollinators. Plants include native and non-native forbs, grasses, blooming flowers, shrubs, and trees; pollinators include live or dead solitary bees, bumble bees, butterflies, moths, and hoverflies. Some papers did not classify pollinators into groups and instead reported results for "pollinating insects." Data cases were evenly split between plants and pollinators but trended strongly toward measuring amount over diversity (Table 3). Additionally, the cases were split between measures of effect size; most were suitable for calculating Hedge's d, but some were suitable only for our alternative measure, the correlation coefficient. This variation in our data introduces difficulties in performing a reliable meta-analysis. Further, the number of cases extracted from each study varies widely; along with the variation we recorded in experimental design (Appendix F), this may introduce substantial bias to any meta-analysis (Table 4), leading to our conclusion that a meta-analysis is unsupported with the extracted data. All data extracted are presented in Appendix F.

Table 3. Summary of quantitative data collected in literature review.

Measure	Taxa	Number of cases	Number of studies
Amount	Plants	72	11
Diversity	Plants	56	10
Amount	Pollinators	101	18
Diversity	Pollinators	27	9

Table 4. Studies and cases extracted for calculation of effect size (Hedge's d or correlation coefficient) in literature review.

Study	Hedge's d cases	Correlation coef. cases	Total cases
Wigginton and Meyerson 2018	0	21	21
Kaul and Wilsey 2019	5	0	5
Haan and Landis 2019	2	0	2
Skorka et al 2018	0	4	4
Knight et al 2019	24	0	24
Mollet 2019	0	6	6
Kuder 2019	0	5	5
Entsminger et al 2017	26	6	32
Halbritter et al 2015	9	0	9
Hanley and Wilkins 2015	5	0	5
Noordijk et al 2009	12	0	12
Osgathorpe et al 2012	12	0	12
Skorka 2016	1	0	1
Zinnecker et al 2011	20	0	20
Garbuzov et al 2015	6	0	6
Wrzesien et al 2016	11	0	11
Valtonen et al 2007	2	0	2
Valtonen et al 2006b	1	0	1
Berg et al 2011	12	0	12
Moron et al 2014	6	0	6
Saarinen et al 2005	12	0	12
Phillips et al 2019	45	0	45
Seitz et al 2019	2	0	2
Dee and Baum 2019	1	0	1

3.2. Research question 1: Are there specific ROW management practices that successfully enhance pollinator abundance and diversity?

3.2.1. Mowing

There is ample documentation on ROW vegetation mowing methods that benefit pollinating insects and the plants they visit, including guidance on timing, frequency, spatial arrangement, and technique. Primary sources on these strategies include roadside vegetation management guides from the US DOT Federal Highway Administration (FHWA; Hopwood et al. 2015b, c) and the nonprofit Pollinator Partnership (Galea et al. 2016). These guides rely on scientific literature, case studies from state DOTs, and in some cases, interviews with practitioners to describe best practices in mowing of ROW vegetation. Recommendations are generally consistent across these documents.

The literature suggests that mowing be timed to avoid conflict with pollinator reproduction, which generally coincides with flower bloom throughout the growing season. Therefore, mowing late in the growing season after plants have senesced and most pollinators have completed their reproductive cycle is frequently recommended (Noordijk et al. 2009, Hopwood et al. 2015c, Galea et al. 2016). This is particularly crucial for monarch butterflies, who lay eggs on milkweed plants as they migrate north in the late spring and early summer (Hopwood et al. 2015c). If necessary, summer mowing timed to promote plant regrowth and plant diversity may still provide a variety of floral resources for pollinators (Hopwood et al. 2015c). Lastly, mowing during peak daylight hours gives foraging pollinators a chance to escape from vegetation, potentially increasing survivorship.

In addition to timing, mowing frequency throughout the growing season can be adjusted to benefit pollinators. Mowing ROW vegetation less often, with two or fewer visits, reduces maintenance and labor costs while providing improved pollinator habitat (Noordijk et al. 2009, Harrison 2014). Fewer mowing visits allow more wildflowers to flourish and bloom; additionally, allowing plants to mature promotes root development that increases soil integrity and prevents erosion. Pairing reduced mowing with selective herbicide treatment can lead to rich pollinator habitat that is still safe for drivers (O'Sullivan et al. 2017, Entsminger et al. 2019), though frequent mowing can be an effective component in establishing of planted native seed mixes (Hopwood 2013).

Strategic spatial arrangement of mowed patches benefits plants and pollinators in ROW vegetation. Partial mowing, where patches are mowed along roadsides instead of continuous strips, can provide a refuge for pollinators while the mown vegetation regrows (Noordijk et al. 2009, Hopwood et al. 2015c, Galea et al. 2016), ultimately producing a diverse habitat mosaic; this practice is also called mosaic cutting (Valtonen et al. 2006a). However, partial mowing increases maintenance costs as it requires complex planning and multiple site visits (O'Sullivan et al. 2017). One solution is to limit high frequency mowing to the clear zone or the minimum area required for safe driving visibility (Hopwood et al. 2015c).

Adjusting mowing techniques can also aid in pollinator preservation. Using a flushing bar and moving machinery slowly through vegetation allows pollinators to escape (Hopwood et al. 2015c, Galea et al. 2016). Mowing vegetation no shorter than 10 inches allows plants to recover quickly and provides pollinators with more vegetation to use; for example, butterflies can continue to lay eggs (Hopwood et al. 2015c). One frequent recommendation is to remove mowed vegetation, as this promotes pollinator and plant diversity and abundance (Noordijk et al. 2009, Hopwood et al. 2015c, Galea et al. 2016, Phillips et al. 2019).

3.2.2 Herbicides

Although prevalent in practice, few scientific studies provide empirical support for ROW vegetation management strategies involving herbicide use. Iowa's Integrated Roadside Vegetation Management (IRVM) Manual (Brandt et al. 2015) is a leading source on ROW herbicide use that informs other published documents (Hopwood et al. 2015b, c). These guidelines and BMPs suggest deliberate, selective use of herbicides for elimination of undesirable plant species and promotion of planted or native-growing wildflowers. As with mowing, the timing, frequency, and spatial arrangement of herbicide application can be adjusted to benefit surrounding plants and pollinators in ROW vegetation while also reducing maintenance costs.

Applying herbicides at vulnerable points in undesirable plant life cycles can increase effectiveness and lead to fewer applications. Systemic herbicides can be applied late in the growing season as plants begin to store more energy in their roots; this encourages root uptake of the herbicide, rendering it more effective and at the same time minimizes exposure to pollinators. Additionally, spot-treatment with targeted sprayers reduces drift and the total amount of herbicide used (Hopwood et al 2015b, c). Timing applications and adjusting chemical concentration can provide effective treatment on a flexible schedule. For example, Terry (2018) found that spraying half-rate applications in the early and late season led to longer-term effectiveness, while application late in the season allowed for a delay in timing the next season's application. For large patches of undesirable plants, calibrating equipment for accuracy and spraying in low-wind conditions can limit drift associated with broadcast spraying (Hopwood et al. 2015b, c). Pairing herbicide use with other weed management strategies can reduce potential negative effects on pollinator communities (Brandt et al. 2015), though herbicide use can be critical for establishment of planted native seed mixes (Ohio DOT 2016).

The primary risk to pollinators from herbicides is indirect, occurring through the loss of nectar, pollen, and nesting habitat from flowering plants eliminated by broadcast herbicide use. Further, while it is an emerging area of research, most studies of direct effects of herbicides on bees have been conducted on honey bees, not the unmanaged wild bees targeted by ROW habitat enhancement (Cullen et al. 2019). Similarly, few studies exist on the effects of herbicide application on butterflies. Results are mixed and suggest that effects vary by chemicals used, butterfly species, and butterfly life stage. Larvae appear to be the most vulnerable to survival where herbicides are used (Russell and Schultz 2010, Schultz et al. 2016), though not for all species (LaBar and Schultz 2012, Schultz and Ferguson 2020). Some adult butterflies are less common in areas where herbicides have been applied (LaBar and Schultz 2012), but others remain in place and reproduce at similar rates to control sites (Schultz and Ferguson 2020). Broadly, pairing herbicide use with monitoring of at-risk pollinator species can reveal any negative effects, allowing modification of management strategies to maintain pollinator populations while reducing the presence of invasive plants.

3.2.3. Restoration

There is a substantial amount of scientific literature on habitat restoration from grassy habitat to wildflower-rich natural habitat to benefit pollinators, some of which is specific to rights-of-way. Therefore, guidance and BMPs on planting wildflowers and establishing natural habitat along ROW is extensive. There are also many real-world examples of DOTs restoring ROW habitat to benefit native plants and pollinators. Restoration is a complex process that requires deliberate action at each step from site selection to establishment and planting to long-term maintenance. Clear communication is vital to successful roadside restoration; often multiple teams or agencies with varying areas of expertise are involved, and many restoration projects are highly visible to the public, which may lead to citizen engagement. As with mowing and herbicide use, strategic and deliberate habitat restoration can ultimately benefit pollinators while adhering to safety requirements and reducing maintenance costs. Conventional ROW vegetation management involves frequent mowing and herbicide application to maintain a uniform, grassy right-of-way. These conditions provide disturbed habitat prone to the introduction and establishment of invasive species, leading to a cycle of intensive maintenance (Brandt et al. 2015).

Restoring ROW vegetation to natural pollinator habitat begins with site selection. Restoration sites can be established immediately after completing construction to ensure long-term persistence (Hopwood et al. 2015c). Site characteristics such as topography and width may influence the effectiveness of restored habitat. Variation in topography can lead to greater habitat diversity at restoration sites; this may lead to greater pollinator diversity (Munguira and Thomas 1992, Hopwood et al. 2015a). Wider ROW have more area for floral resources, leading to greater pollinator abundance (Munguira and Thomas 1992, Saarinen et al. 2005, Phillips et al. 2019). Sites that require less preparation for restoration will save time and money and may be a boon to initial efforts in restoring pollinator habitat (Hopwood et al. 2015c, Galea et al. 2016). A site selection rubric is available that details other criteria for successful restoration, including soil characteristics, sun and water availability, and buy-in from the public (Galea et al. 2016). Lastly, the landscape surrounding restoration sites may influence the effectiveness of restored habitat. Invasive plants in nearby areas may encroach newly restored ROW; similarly, little available habitat surrounding the restoration site may lead to limited pollinator population establishment (Hopwood et al. 2015a, Phillips et al. 2020.)

Once selected, restoration sites often require preparation before planting can occur. Preparations include removal of invasive or other undesirable plant species and soil modifications such as grading or amendments such as lime or fertilizer. Wildflowers can then be planted from seed or by transplanting seedlings; the planting method is dependent on site characteristics including shape, size, and accessibility. The most frequent recommendation associated with restoring ROW vegetation to pollinator habitat is to use native plant species (seeds or seedlings), ideally those that are adapted to local climatic conditions (Hopwood et al. 2015a, b, c; Galea et al. 2016, McCargo 2018). Planting a variety of native plant species will provide food to support an abundant and diverse pollinator community; additionally, selecting host plants for specific pollinators (i.e., milkweeds for monarch butterflies) will increase restoration effectiveness (Hopwood 2010, 2013). Lastly, consider the arrangement of planted species. Clumping single species together allows for easier access and efficient foraging by pollinators, and leaving patches of bare ground provides nesting opportunities for ground-nesting bees (Hopwood et al. 2015c, Galea et al. 2016). Vegetation planted close to roads should be short for safety and visibility, and ideally will be tolerant of road salt application for long-term persistence (Hopwood et al. 2015c).

Long-term maintenance, monitoring, and management of restoration sites is critical for persistence in supporting pollinator populations. Management of newly established restoration sites can be intensive, involving watering, mowing, and removal of undesirable plants. Plantings may take up to five years to fully establish; maintaining an annual inventory of plant communities for the first three years can document progress and identify areas needing improvement (Hopwood et al. 2015c, Galea et al. 2016, Kuder 2019).

3.3 Research question 2: Which insect pollinator taxa respond most significantly to common ROW management practices?

3.3.1 Butterflies

Butterflies are the most studied group of pollinating insects in ROW vegetation, with multiple studies observing diverse and abundant butterfly communities in these areas (Munguira and Thomas 1992, Valtonen et al. 2006a, Moron et al. 2014, Drummond 2018). Right-of-way width and site variation provide plant diversity for feeding and resting butterflies, with habitat quality comparable to prairies or wild meadows (Munguira and Thomas 1992, Ouin et al. 2004, Saarinen et al. 2005, Kalarus and Bakowski 2015, Drummond 2018). Further, unmanaged areas associated with roadways such as on-ramps and other highway intersections support more diverse butterfly communities than those found in managed roadside habitat (Valtonen and Saarinen 2005).

Adjusting mowing timing and frequency to coincide with critical points in butterfly life cycles has been repeatedly demonstrated to benefit butterfly populations. Mid-season mowing, while beneficial for plant diversity, decreases butterfly abundance and species richness, though that effect can be mitigated by partial mowing (Munguira and Thomas 1992, Valtonen and Saarinen 2005, Valtonen et al. 2006a, Skorka et al. 2013). Late-season mowing does not reduce butterfly abundance, though mowing at any point in the butterfly life cycle is likely to have some negative effect on populations by eliminating plants used for feeding or egg-laying (Valtonen et al. 2006a). Reducing mowing frequency likely increases butterfly abundance, though that effect is difficult to isolate from correlated increases in floral abundance or late-season population size

(Garbuzov et al. 2015, Halbritter et al. 2015). When paired with frequent mowing, broad herbicide application in ROW vegetation does not further reduce butterfly populations; mowing is assumed to have a greater negative impact than herbicide application (Zinnecker and Larsen 2011). Restored ROW habitat is most beneficial to butterflies when native plant species are dominant; this influence grows with time and is enhanced by a diverse surrounding landscape (Valtonen et al. 2007). Overall, vegetation management techniques that promote native flower abundance and species richness improve butterfly abundance and species richness (Ries et al. 2001).

3.3.1.1 Monarch butterflies

Monarch butterflies in ROW have been extensively studied in recent years, owing to drastic declines in their population over the last two decades. These declines have been primarily attributed to loss of breeding habitat and their host plant, milkweeds (Thogmartin et al. 2017, Daniels et al. 2018, Knight et al. 2019); in response, establishing milkweeds along ROW is now a leading mitigation effort in saving monarch populations (Kasten et al. 2016, Daniels et al. 2018, Knight et al. 2019). Milkweeds were historically regarded as a ubiquitous, weedy plant species, with a survey conducted in roadsides and nearby crop fields in Iowa in 1999 referring to “infestations” at the numerous sites where the plant was observed (Hartzler and Buhler 2000). Nationally, the greatest loss of milkweed stems occurred within crop fields after the introduction of herbicide tolerant crops. This allowed farmers to broadcast spray crop fields with herbicides, essentially eliminating milkweed from growing among crops. Milkweed is frequently found in ROW; nearly 60% of sites assessed in recent surveys have contained milkweed stems (Kasten et al. 2016, Thogmartin et al. 2017). Milkweed establishes readily in frequently disturbed habitats; therefore, ROW are thought to have very high potential for gains in milkweed stem density

(Thogmartin et al. 2017, Kaul and Wilsey 2019). Further, mowing ROW with milkweed promotes plant regeneration and reduces monarch predator abundance, providing egg-laying substrate and food for emerging larvae (Daniels et al. 2018, Thorne 2018, Knight et al. 2019, Haan and Landis 2019). Mowing milkweed early in the season before most monarchs arrive (prior to late June in Maine) has the strongest effect on increasing stem density and butterfly abundance (Thorne 2018, Dee and Baum 2019, Knight et al. 2019).

3.3.2 Bees

In comparison to butterflies, there is little information on the effects of ROW vegetation management on bees, though it is an emerging area of research. One single-season study found that mid-summer mowing without cutting removal decreases bee abundance and diversity for the remainder of the growing season (Phillips et al. 2019). A second study that assessed bee populations over three growing seasons concluded that late season mowing promoted bee abundance, though this finding was subject to substantial variation by study site and sample year. Further, selective herbicide application had a similar outcome (Kuder 2019). Restoring ROW habitat by seeding with native grasses and blooming plants also benefits bee populations, leading to greater bee abundance and species richness in restored sites than in conventionally managed ROW (Hopwood 2008, Mollet 2019). Additionally, providing patches of bare ground in restoration sites increases ground-nesting bee abundance; this can be done by planting clumps of native grasses that grow densely and expose soil at their base (Hopwood 2008, Moron et al. 2014). Bumble bees readily adapt to prairie-like ROW restorations, particularly when flower species are chosen to complement feeding preferences of short- and long-tongued bumble bee species (Clinebell 2003). The effects of restoration on bee communities can be highly variable in the first two years after establishing habitat; longer term observations are suggested for greater certainty of outcomes (Mollet 2019, Kuder 2019).

3.3.3. Plants for pollinators

Studies of ROW plant communities generally conclude that reduced mowing frequency is beneficial, though results vary. Plant diversity can increase with less frequent mowing (Entsminger et al. 2017, Jakobsson et al. 2018, Kuder 2019), though one study found only greater plant diversity in control sites with no mowing, and mowing may allow non-native species to establish (Wigginton and Meyerson 2018, Kuder 2019). Other studies have found that mowing promotes native species (Wrzesien et al. 2016, Entsminger et al. 2017). Less frequent mowing can maintain safe visibility conditions and keep soil in place by retaining plant density (Entsminger et al. 2019). Strategic timing of selective herbicide application can increase effectiveness at reducing undesirable plant abundance. For example, conducting two half-rate herbicide applications at different times in the growing season increased the total length of time that treatments were effective (Terry 2018). An integrated vegetation management scheme consisting of infrequent mowing with cutting removal paired with selective herbicide application may lead to greater native plant diversity, benefitting pollinator communities (Jakobsson et al. 2018, Entsminger et al. 2019, Kuder 2019). Unmanaged ROW also have diverse plant communities and can grow into high-quality pollinator habitat over time (Heneberg et al. 2017).

Establishing robust plant communities through ROW habitat restoration may be sensitive to heavy equipment use in the first two years of growth, either through soil compaction or vegetation loss from mowing (Jorgensen et al. 2018, Wigginton and Meyerson 2018). Passive restoration methods such as eliminating mowing early in site establishment may be beneficial over the long term (Wigginton and Meyerson 2018), though more active management may be required in areas with lower plant diversity in the surrounding landscape (Soper et al. 2019). One long term monitoring study of restored ROW habitat indicates that seeded grasses have the greatest establishment rate, while seeded forb and shrub species are much less likely to successfully establish after five years (Ament et al. 2017). However, establishment appears to be context-dependent, with lower rates of seeded vegetation establishment in less diverse landscapes owing to reduced availability of native plants in surrounding land cover (Soper et al. 2019 and sources within).

3.4. Research question 3: Are there elements of landscape context that affect the success of ROW management for pollinator conservation?

3.4.1 Landscape composition

Plant and pollinator communities in ROW vegetation vary with the land use and natural community composition of the surrounding landscape. Natural or semi-natural grassland habitat generally enhances plant and pollinator communities in nearby ROW vegetation (Davis et al. 2007, 2008, Jakobsson and Agren 2014, Skorka et al. 2013, 2018), although the opposite has also been observed (Berg et al. 2011). In intensively farmed landscapes, ROW may be one of few sources of reliable habitat for pollinators (van Swaay 2003), and restoring ROW habitat may be especially beneficial in these landscapes (Munguira and Thomas 1992). In landscapes containing insect-pollinated crops, bee abundance in ROW habitat can be maintained by blooming crops providing ample pollen and nectar, though bee diversity decreases owing to low blooming plant diversity (Benedek 1997). Rights-of-way near organic farms have more diverse plant communities than those near conventional farms; further, plants in ROW near organic farms are of greater value to wild bees (Henriksen and Langer 2013). As such, ROW restoration efforts in conventional agriculture-dominant landscapes may require more intensive management and a seed mix containing more native and desirable plant species (Soper et al. 2019). Indeed, ROW hedgerow habitat in agriculturally intense landscapes can mitigate negative effects of crop management on bee communities (Hanley and Wilkins 2015). Crop plants have greater seed set in fields near ROW; conversely, native plants in ROW set fewer seeds when surrounded by more cropland (Jakobsson and Agren 2014, Hevia et al. 2016). The type of road in agricultural landscapes may influence bee communities; unpaved livestock roads support greater surrounding bee populations, while paved roads reduce bee density, perhaps owing to mortality associated with vehicle traffic (Hevia et al. 2016, Kallioniemi et al. 2017).

Forest land cover in the surrounding landscape can benefit butterfly abundance in roadsides and bee species richness along railway embankments (Skorka et al. 2013, Moron et al. 2014). Actively managed forests have networks of logging roads that also provide beneficial pollinator habitat; indeed, in heavily forested landscapes, these roads may serve as one of few sources of forage for pollinators (Coulson et al. 2005, Oleksa et al. 2013). Forest canopy openings created by logging roads can provide floral resources and facilitate wild bee access into 100 m of surrounding forest, where standing dead wood provides nesting habitat (Jackson et al. 2014, Westerfelt et al. 2018). Power line ROW through forests may serve as a source habitat for pollinators found foraging along forest roads within 500 m (Berg et al. 2016); similarly, a network of forest roads with wide verges through managed forests promotes some forest-specialist butterflies (Bubova et al. 2015). Research on other land cover types, including wetlands and developed areas, is scarce. Developed land can promote butterfly species richness in ROW, though it can also reduce grassland-associated plant species, potentially leading to a negative outcome for butterflies (Skorka et al. 2013, Cochard et al. 2017). Diverse wetland habitat near ROW supports specialist butterfly species that are not found in the nearby ROW habitat (Swengel and Swengel 2010).

Complexity in the composition or configuration of landscape patches is generally beneficial to pollinators. A mosaic of agricultural and grassland cover types provides diversity in floral resources and habitat substrate, leading to more diverse ROW pollinator communities (Ouin and Burel 2002, van Halder et al. 2017). Composition of the surrounding landscape may even eliminate the negative effects of mowing or selective herbicide application on bee or butterfly diversity in ROW (Valtonen et al. 2006a, Kuder 2019). Restored linear roadside habitat may contain different pollinator communities than larger block-shaped restorations owing to relationships with surrounding land cover (Davis et al. 2007, 2008). Additionally, linear habitat may facilitate butterfly movement (Valtonen and Saarinen 2005, Soderstrom and Heblom 2007). Lastly, the scale at which these relationships are assessed informs the outcomes, as bee body size determines their foraging range and effectively their landscape size (Greenleaf et al. 2007). One study found that the amount of ROW habitat at small scales (400 m) negatively affected small-sized wild bees that cannot fly longer distances to find suitable habitat, whereas large-sized species that can fly greater distances to find suitable habitat were positively affected (Schwantes 2015).

3.4.2 Threats associated with roadside habitat

3.4.2.1 Traffic volume and mortality

One recurring concern of managing ROW habitat for pollinators is incidental mortality associated with vehicle traffic. Early studies did not find substantial butterfly mortality owing to vehicle collisions when butterflies fly over multiple types of roads (Munguira and Thomas 1992, Ries et al. 2001); however, mortality has been assessed in recent studies with varied results.

Insect mortality is generally greater along roads with greater traffic volumes owing to collision or turbulence, though this does not consistently lead to lower abundance or diversity in nearby ROW habitat (Skorka et al. 2013, Baxter-Gilbert et al. 2015, Zielin et al. 2016, Martin et al. 2018, Phillips et al. 2019). One study found greater insect visitation to flowers along railway embankments with intermediate traffic volumes (Wrzesien et al. 2016). Road structure may influence mortality: four lane roads have lower mortality rates than two lane roads, perhaps owing to wider, inhospitable shoulders separating vegetation from traffic (Hopwood 2010). Vegetative medians lead to greater bee and butterfly mortality (Keilsohn et al. 2018). Further, intensive vegetation management and surrounding topography create high-mortality zones along roadways called "blackspots" (Skorka et al. 2015, Kantola et al. 2019, Mora Alvarez et al. 2019). One study conducted in Poland labeled 4% of surveyed ROW as blackspots; these sites consisted of low-quality habitat and contained 49% of the road-killed butterflies collected while surveying (Skorka et al. 2015). In North America, these mortality hotspots have detrimental effects on monarch butterflies; as they migrate from south Texas into northern Mexico, blackspots occur as topography funnels butterflies into flying along or across high-traffic roads (Kantola et al. 2019, Mora Alvarez et al. 2019).

Broad estimates of total insect mortality associated with vehicle traffic are limited and face methodological limitations. One highly publicized study estimated hundreds of billions of dead insects along North American highways every year (Baxter-Gilbert et al. 2015). The extrapolation was based on data collected from just 2 km (1.25 mi) of road, and bees and butterflies made up a small portion of the estimated mortality. Another study assessed dead butterfly persistence along roadsides and found only 5% of observed butterfly carcasses remained after 48 hours, indicating surveys of large insects likely lead to underestimated mortality rates (Skorka 2016). Mortality can be mitigated by surrounding land cover type; studies have found that ROW bordered by forests or grassland have less insect mortality, though grassland has also been linked to greater mortality (Skorka et al. 2013, 2015, Keilsohn et al. 2018). Additionally, pollinators can be prevented from crossing the road by improving habitat quality. Multiple studies demonstrate that butterflies are more likely to cross a roadway when observed in low-quality ROW habitat (Ries et al. 2001, Valtonen and Saarinen 2005, Skorka et al. 2013, Polic et al. 2014).

3.4.2.2. Pollution and pathogens

Air, soil, light, and noise pollution have all been cited as potential threats to pollinator populations in ROW vegetation. Exhaust fumes from diesel engines can degrade floral odors, confusing honey bees and potentially preventing pollination (Girling et al. 2013). Road dust on unpaved roads inhibits wildflower reproduction; seed set is reduced as pollen is replaced with dust particles (Lewis et al. 2017, Waser et al. 2017). Roberts and Phillips (2019) found a number of studies on roadside soil pollution in a similar literature search, concluding that heavy metals are highly concentrated in roadside soil and vegetation and may negatively affect pollinating insects and plant growth (Roberts and Phillips 2019 and sources within). Honey bee hives placed close to high-traffic roadways produce honey with greater concentrations of heavy metals (Bilandzic et al. 2011). Sodium exposure from road salt can alter the physiology of monarch butterflies, affecting how they fly and find food (Snell-Rood et al. 2014). In a recent review of pollinator habitat in ROW, Phillips et al. (2020) conclude that light pollution from streetlights negatively affects nocturnal pollinator populations and suggest strategies to reduce pollinator mortality from light pollution while maintaining safe visibility. Further, streetlights and bursts of ground-level light from headlights have both been found to alter plant physiology (Bennie et al.

2016). Lastly, Davis et al. (2018) found that short term exposure to simulated highway noise increased monarch larval heart rate, but long-term exposure did not; they conclude that adult monarchs can handle chronic noise stress.

Right-of-way habitat may provide a corridor for spread of invasive species, parasites, or pathogens. Non-native plant species reduce native plant diversity and butterfly abundance in ROW (Valtonen et al. 2006b, Brisson et al. 2010); their control is a crucial component of vegetation management with mowing and selective herbicides. Rights-of-way may harbor predatory species, such as fire ants that consume eggs, pupae, and larvae of the federally endangered Schaus swallowtail butterfly (*Papilio aristodemus*) (Forys et al. 2001). Research on parasites and pathogens in ROW habitat is scarce. We found one study that assessed infection rates of both a parasite and a pathogen of monarch butterflies,which did not differ in communities within ROW and managed prairies (Mueller and Baum 2014).

3.4.2.3 Habitat fragmentation

Habitat fragmentation associated with roadway presence may negatively affect pollinator populations through loss of natural prairie-like habitat or by creating a barrier to movement. Adjusting mowing regimes or restoring habitat can mitigate habitat loss and promote pollinator populations (Benedek 1997). Multiple studies have found that high or low-traffic roads are not a barrier to movement by bees (Munguira and Thomas 1992, Bhattacharya et al. 2003, Hopwood et al. 2010). Bumble bees can cross roads to and from nests, but are likely to stay on the same side of a road if they find suitable forage (Bhattacharya et al. 2003; Hopwood et al. 2010). Studies on butterfly movement across roads are less conclusive. High-speed railways do not pose a barrier for homing behavior of a displaced butterfly; butterflies returned home regardless of being displaced along or across the railway (Vandevelde et al. 2012). However, butterflies with low mobility are not abundant along roadsides (Berg et al. 2011), and other studies have observed "trapped" populations of butterflies owing to roads (Jansen et al. 2012, Polic et al. 2014). There may be behavioral differences contributing to likelihood of butterflies crossing roads, i.e., migratory butterflies cross roads easier than non-migratory species, which may turn away from roads (Halbritter et al. 2015).

3.5. Research synthesis and applications: How do answers to the questions above inform best management practices for ROW habitat enhancement for pollinators?

3.5.1 Maine ROW as pollinator habitat

The Maine DOT currently follows many of the suggested management practices for enhancing pollinator habitat in ROW vegetation. A survey of Maine and other New England DOT employees conducted by Campanelli et al. (2019) summarizes these efforts; we describe them here and relate them to the context of our review findings. Maine DOT has reduced mowing along much of its interstate ROW land, with most land outside of safety zones nearest to paved roads mowed only once yearly. Adjusting the timing of annual mowing from June-August to late August or September may provide more blooming plants for pollinators throughout the growing season. Mowing after September may be preferable for plant propagation and late-season pollinators (including monarch butterflies), though the threat of frost may make such timing unfeasible. Maine DOT practices targeted herbicide application along all of their roads, focusing on woody stems only. Owing to the lack of documentation of herbicide practices in the general literature, formal documentation and dissemination of these practices to other DOTs may lead to improved herbicide BMPs for pollinator habitat beyond Maine's borders.

Seeding practices along ROW managed by Maine DOT currently includes three standard seed mixes sourced from out of state, with a focus on reliable establishment and soil stabilization. The agency has explored native seed mixes through a collaboration with the Maine Natural Areas Program and Maine-based NGO Wild Seed Project (McCargo 2018, Campanelli et al. 2019). Maine DOT also collaborates with the Maine Natural Areas Program on plant identification training for road crew personnel, which is recommended by the FHWA (Hopwood et al. 2015c). Habitat restoration practices with native seeds and plants is not yet common along ROW in Maine; implementing this practice following guidance from the Wild Seed Project (McCargo 2018), even on a limited spatial scale, may improve existing pollinator habitat.

Maine DOT has conducted two single-year surveys of ROW vegetation. One project involved photo surveys and vegetation ranking at 40 sites (Campanelli et al. 2019). Another project focused on pollinator habitat, pairing vegetation surveys with butterfly and bumble bee surveys (Drummond 2018). These pollinator habitat surveys found high blooming plant diversity and evenness within ROW across much of the state. This suggests that high quality pollinator habitat already exists in many ROW; however, undesirable plant species were frequently observed, in some cases comprising nearly two thirds of all blooming plant species. Both butterflies and bumble bees were diverse and abundant; bumble bee species composition varied across the state, while butterfly communities were dominated three species, including one exotic (European Skipper [*Thymelicus lineola*]) Overall, blooming plant species richness promoted pollinator abundance (Drummond 2018), suggesting that managing for high quality pollinator habitat within ROW in Maine can support diverse and abundant pollinator populations. Longer term survey work on plants and pollinators in Maine ROW can provide insight on the establishment, effectiveness, and long-term maintenance of native plant-dominant pollinator habitat.

Our assessment of landscape composition found that the type of land cover surrounding Maine ROW influences pollinator communities. Butterflies were more sensitive to surrounding land cover type than bumble bees, and abundance was more sensitive than species richness. Influential land cover types were agriculture/grassland, wetlands/water, and urban/developed; generally, agriculture/grassland and wetlands/water reduced pollinator abundance, whereas the influence of urban/developed land varied by sampling period. In the early season, butterfly abundance was less in ROW surrounded by wetlands/water and urban/developed land, while it was greater in ROW surrounded by deciduous forest. Bumble bee species richness was greater in ROW surrounded by agriculture/grassland in the early season. In the mid-season, butterfly species richness was less in ROW surrounded by deciduous forest and deciduous forest edge. In the late season, total pollinator abundance was greater in ROW surrounded by urban/developed and less in ROW surrounded by agriculture/grassland; these overall relationships were driven mostly by the butterfly community (Figure 3). Over the entire growing season, we found less butterfly abundance in ROW surrounded by agriculture/grassland and greater butterfly species richness in ROW surrounded by coniferous forest. Full results of these analyses are found in Appendix G.

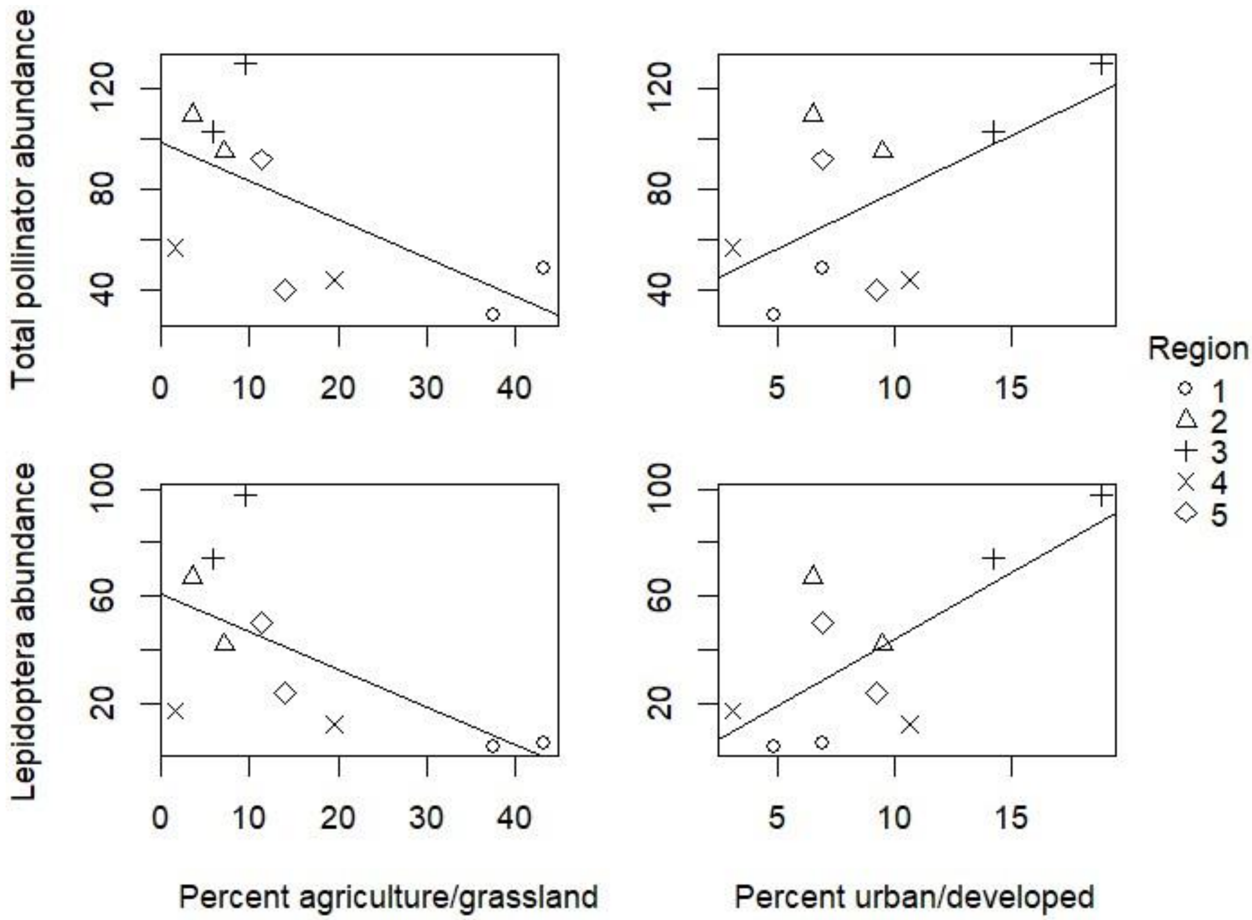

Figure 3. Late season effects of surrounding landscape composition (within 1 km of survey sites, Fig. 1) on pollinator communities in Maine ROW. Data from Drummond (2018).

3.5.2 Case study review

Many state Departments of Transportation have implemented ROW vegetation management practices that benefit pollinators, including reduced mowing regimes, more targeted herbicide use, and habitat restoration. Indeed, many states (IA, ID, MN, NY, OH, OR) were practicing reduced mowing along most rural roads before the FHWA issued any pollinator-focused management recommendations; this was generally owing to constraints on time and money, with pollinator conservation as an unintended benefit (Hopwood et al. 2016). In these states, the entire ROW along these roads is mowed 0-2 times per year at various points throughout the growing season. Research indicates that altering the timing of mowing to the late fall benefits pollinator populations (Hopwood et al. 2015c). Other states have trialed or transitioned to reduced mowing regimes in response to FHWA documentation, including Tennessee (TDOT), Colorado (O'Meara 2017, CDOT 2018), and Delaware (DelDOT 2018).

Although targeted herbicide use is a frequent management recommendation, there are few published case studies demonstrating this practice. Iowa developed their IRVM program in the 1980s owing to their dependence on herbicides for roadside vegetation management; at the time, they were exclusively using herbicides to control roadside weeds and had found the practice cost-intensive and largely ineffective. They transitioned to spot-spray application, and paired with planting native vegetation, have been able to effectively control weeds with less intensive management (Brandt et al. 2015). The Oregon DOT reduced herbicide use by up to 50% alongside roadways over five years by updating spraying equipment, diluting rates of application, and transitioning to spot sprays as opposed to routine blanket sprays (Hopwood et al. 2015c). Wider adoption of these practices may be difficult, as many DOTs cite time and funding constraints to implement changes to existing herbicide use practices in their states (Hopwood et al. 2016).

Right-of-way habitat restoration projects substantially increased in response to the FHWA documentation, either through planting native plant habitat or developing native species seed mixes. The Virginia DOT was an early adopter of this practice and planted four "Pollinator Waystation" plots in 2014, three at Park & Ride lots and one at an interstate rest area (VDOT 2016). Michigan, North Carolina, and Georgia have all planted pollinator habitat since 2015 (MDOT 2017, NCDOT via Hopwood 2017, Solomon 2018). Michigan and North Carolina have planted sunflowers; the NCDOT plants other wildflower species, while the MDOT is considering the addition of custom perennial seed mixes to their management plan. Establishing native plant habitat through seeding is a longer process. Seeds can be spread over larger areas more quickly than plants; however, sourcing native seeds can be difficult (but see McCargo 2018). The Arizona DOT has used native seeds exclusively in revegetation projects since 1992; through collaborations with native seed providers, they are able to obtain the seeds they need for multiple custom seed mixes (Hopwood et al. 2015c, 2016). North Dakota is incorporating pollinator species into seed mixes being planted at a number of roadside sites, including rest areas (North Dakota State Agencies 2018). Many states cite the cost or limited availability of native seed as the major impediment to increasing the use of native plants (Hopwood et al. 2016, Campanelli et al. 2019).

3.5.2.1. Monarch CCAA for ROW

On December 17, 2020, the US Fish and Wildlife Service (USFWS) announced that the monarch butterfly is warranted for listing as an endangered species but is precluded from listing by higher priority actions (USFWS 2020). While the USFWS conducted its review of available information on monarch populations, habitats, and threats, numerous public and private agencies collaborated to develop the Nationwide Candidate Conservation Agreement for Monarch Butterfly on Energy and Transportation Lands, which was published in March 2020 (hereafter referred to as the Monarch CCAA; Monarch CCAA 2020). The Monarch CCAA asks managers of non-Federal ROW to voluntarily adhere to management strategies that improve or establish monarch butterfly habitat by promoting native milkweed species, as suggested by Thogmartin et al. (2017). It includes a Candidate Conservation Agreement with Assurances that permits enrollees to conduct pre-approved management practices on non-Federal ROW that, should the monarch butterfly be listed as an endangered species, would permit take of monarch individuals owing to management activities. This allows ROW managers to continue existing practices while simultaneously encouraging additional conservation measures within ROW, particularly by planting native milkweed species. In Maine, this includes common milkweed (*Asclepias syriaca*) and swamp milkweed (*Asclepias incarnata*), which bloom in the mid-summer and set seed in the fall (McCargo 2018). Enrollment in the Monarch CCAA is open until the USFWS makes a final decision on listing the monarch as an endangered species, which is not expected until 2024 (UIC ERC 2021).

3.5.3 Strategies for successful implementation

Gathering public support when changing ROW vegetation management strategies is critical for project success; many projects cite stakeholder conflict as a major obstacle in implementation (Lucey and Barton 2011, Garbuzov et al. 2015, Kuder 2019, Campanelli et al. 2019). These stakeholders include adjacent landowners, vegetation management subcontractors, and the general public, who may object to less frequent mowing, the introduction of new plant species, and the appearance of "weedy" native vegetation. Stakeholder apprehension can be mitigated through various outreach channels, including mailings, brochures, public meetings, press releases, websites, videos, demonstration gardens, and signage (Lucey and Barton 2011, Garbuzov et al. 2015, Hopwood et al. 2015b, c, Galea et al. 2016, Kuder 2019).

Although many policies and legislative acts have been passed regarding roadside vegetation management for pollinators, funding for these projects remains scarce and is the primary obstacle cited by Departments of Transportation (Hopwood et al. 2016, Campanelli et al. 2019). Innovative partnerships between DOTs and non-profit organizations provide funding opportunities for high-impact environmental stewardship. The Ray C. Anderson Memorial Highway in Georgia is a partnership between the Ray C. Anderson Foundation and the Georgia

DOT; “The Ray” features a pollinator garden along the entirety of its 29 km (18 mi) vegetative median (The Ray 2018 via Solomon 2018). In Florida, the DOT has partnered with the Florida Wildflower Foundation to establish pollinator habitat along roadsides by reducing mowing and planting native wildflowers (Hopwood et al. 2016). Additionally, several states raise funds for pollinator habitat through specialty wildflower license plates (FL, OK, TX, VA; Hopwood et al. 2015b).

4. Discussion

4.1 Synthesis of current knowledge

Our review synthesized several sources of information that reach similar conclusions regarding ROW vegetation management to promote pollinator populations. Adjusting mowing regimes to reduce frequency and postponing mowing until the growing season ends provides more habitat for actively foraging and nesting pollinators. Targeting herbicide applications to spot treatments of undesirable species or waiting until the active pollinator flying season ends to make applications reduces negative outcomes for native plants and pollinators. Lastly, restoring ROW habitat to prairie-like conditions, even over small spatial scales, and featuring diverse native blooming plants and grasses enhances pollinator populations.

There are threats to pollinator populations in ROW associated with vehicle traffic, pollution, and habitat change; however, in most cases, vegetation management to benefit pollinators outweighs these threats. The landscape context surrounding ROW influences plant and pollinator populations, with flowering ROW providing a consistent source of habitat in agricultural, forested, and urban landscapes. Our analysis of ROW along Priority 1 roads in Maine supports these trends. Further, a recent meta-analysis of plant and pollinator communities in ROW and the surrounding landscape found quantitative evidence that ROW plant and pollinator communities are similar to those in prairie-like habitat and are more abundant and diverse than those in agricultural and forested areas, suggesting ROW management and restoration in agricultural and forested areas can provide suitable pollinator habitat (Phillips et al. 2020).

4.2 Knowledge gaps

Research on roadside vegetation management has substantially increased for mowing and restoration, while studies on the effects of herbicide management strategies on both plants and pollinators remain scarce. This is particularly concerning as herbicide use is ubiquitous among state DOTs; more information on how this affects pollinator populations would improve existing management strategies. Results from research on mowing and restoration would be more robust if studies a) conducted inventories of habitat before implementing habitat changes and for multiple subsequent years after implementation and b) directly compared outcomes of various management strategies through robust experimental design. Studies on wild bees are also lacking. There was only one single study in the body of literature that assessed outcomes of both mowing and herbicide use on plant and wild bee populations (Kuder 2019). Assessing wild bee populations in roadside vegetation more broadly would also be beneficial, as much of the existing literature examines butterflies and honey bees.

There is a large body of research that finds restoration of roadside habitat to native species beneficial to plant and pollinator communities, though few of these assess long-term outcomes of restoration projects. Studies that periodically monitor previously restored sites could provide insight on long-term outcomes, though yearly monitoring of plants and pollinators may be a more proactive and effective management approach. If Maine pursues ROW restoration to native-species dominant pollinator habitat, incorporating long-term monitoring could provide important insights on the efficacy of ROW restoration for pollinators.

While many studies exist that connect landscape context to pollinator populations in roadside vegetation, few connect context and vegetation management to pollinator populations. Understanding how the surrounding landscape may promote or prevent pollinator habitat establishment through mowing, herbicide use, and restoration would allow for more effective site location and targeted conservation efforts. Additionally, more assessment is needed on the influence of landscape context on wild bee populations in roadside vegetation; again, much of the existing information focuses on butterflies. In Maine, we observed an influence of landscape composition on pollinator populations, with butterflies more sensitive to surrounding land cover than bumble bees. This initial assessment would benefit from additional survey work in ROW surrounded by influential cover types including agriculture/grassland, urban/developed, and wetlands/water. Expanding survey methods to assess solitary wild bees would provide a more complete assessment of ROW pollinator communities in Maine.

Addressing these knowledge gaps in a rapidly expanding area of research presents an opportunity for meta-analysis with a large, uniform data set. Our assessment of the existing literature did not identify sufficient data for a robust meta-analysis. Future studies that employ a sampling design that incorporates landscape context and temporal and spatial replicates to evaluate effects of management strategies on ROW plant and pollinator communities will provide valuable knowledge for pollinator conservation.

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Note: * indicates the reference is a literature search result

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Appendix A: Maine state pollinator species of concern

In 2015, the Maine Department of Inland Fisheries and Wildlife (MDIFW), Maine Department of Marine Resources (DMR), and Maine Natural Areas Program (MNAP) published Maine's Wildlife Action Plan, which remains effective until 2025. The plan lists 10 bumble bee species and 47 butterfly or moth species as pollinator species of concern, which we provide below (Table A.1). The Maine Species of Greatest Conservation Need (SGCN) Tiers are defined as: 1 – highest priority, 2 – High priority, 3 – moderate priority. Priority is assigned according to criteria covering risk of extirpation, population trend, endemicity, regional conservation responsibility, climate change vulnerability, and survey knowledge. A full description of SCGN tiers and their criteria are found in Maine's Wildlife Action Plan (https://www.maine.gov/ifw/fish-wildlife/wildlife/wildlife-action-plan/index.html). The State Conservation Concern codes follow the Endangered Species Act codes and are defined as: E -- Endangered Species, T -- Threatened Species, and SC-- Special Concern Species.

Table A.1. Pollinator species of conservation concern in Maine, 2015.

Scientific Name	**Common Name**	**SGCN**	**State Conservation Concern**
Bombus affinis	Rusty-patched bumble bee	1	SC
Bombus ashtoni	Ashton's Cuckoo bumble bee	2	SC
Bombus citrinus	Lemon Cuckoo bumble bee	3	SC
Bombus fernaldae	Fernald's Cuckoo bumble bee	3	SC
Bombus fervidus	Yellow bumble bee	3	SC
Bombus griseocollis	Brown-belted bumble bee	3	SC
Bombus insularis	Indiscriminate cuckoo bumble bee	2	SC
Bombus pensylvanicus	American bumble bee	2	SC
Bombus sandersoni	Sanderson's bumble bee	3	SC
Bombus terricola	Yellow-banded bumble bee	3	SC
Atrytonopsis hianna	Dusted skipper	3	SC
Boloria chariclea grandis	Purple lesser fritillary	2	T
Boloria frigga saga	Frigga fritillary	1	E
Callophrys gryneus	Juniper hairstreak	2	E
Callophrys hesseli	Hessel's hairstreak	1	E
Callophrys lanoraieensis	Bog elfin	3	
Catocala similis	Similar underwing	3	SC
Chaetaglaea cerata	A noctuid moth	2	SC
Chaetaglaea tremula	Barrens chaetaglaea	3	SC
Citheronia sepulcralis	Pine devil	2	SC
Cucullia speyeri	A moth	3	
Cupido amyntula maritima	Western tailed blue	3	
Danaus plexippus	Monarch	3	
Erora laeta	Early hairstreak	2	SC
Erynnis brizo	Sleepy duskywing	2	T
Hemaris gracilis	Graceful clearwing	3	SC

Hemileuca lucina	New England buckmoth	3	
Hemileuca maia maia	Eastern buckmoth	2	SC
Hesperia leonardus	Leonard's skipper	3	SC
Hesperia metea	Cobweb skipper	3	SC
Lapara coniferarum	Southern pine sphinx	3	SC
Lepipolys perscripta	A moth	3	SC
Lithophane lepida lepida	Pine pinion	2	SC
Lycaena dorcas claytoni	Clayton's copper	2	T
Lycia rachelae	Twilight moth	2	T
Metarranthis apiciaria	Barrens metarranthis moth	2	SC
Nepytia pellucidaria	A moth	3	SC
Oeneis polixenes katahdin	Katahdin arctic	1	E
Paonias astylus	Huckleberry sphinx	3	SC
Papilio brevicauda gaspeensis	Short-tailed swallowtail	3	SC
Papilio Troilus	Spicebush swallowtail	3	SC
Plebejus idas	Northern blue	2	SC
Plebejus idas empetri	Crowberry blue	2	SC
Polygonia satyrus	Satyr comma	3	SC
Psectraglaea carnosa	Pink sallow	2	SC
Satyrium edwardsii	Edwards' hairstreak	2	E
Satyrium titus	Coral hairstreak	3	SC
Satyrodes Appalachia	Appalachian brown	3	SC
Spartiniphaga inops	Spartina borer moth	3	
Speranza exonerata	Barrens itame	2	SC
Thorybes bathyllus	Southern cloudywing	3	SC
Xylena thoracica	Acadian swordgrass moth	3	SC
Xylotype capax	Broad sallow	3	SC
Xystopeplus rufago	Red-winged sallow	3	SC
Zale lunifera	Bold-based zale moth	3	SC
Zale obliqua	Oblique zale	3	SC
Zanclognatha martha	Pine barrens Zanclognatha	1	T

Appendix B: Search keyword list

<u>Population keywords:</u>
<u>Study organisms</u>

Plants:

- vegetation
- flower
- flowering
- bloom
- blooming
- floral/flora
- forage
- resources
- nesting
- shrubs
- forbs
- herbs
- plant(s)
- invasive
- non-native/naturalized
- native

Animals:

- pollinating insects
- bees
- wild/solitary bees
- bumblebees
- Apoidea/vespoidea/papilionoidea
- Hymenoptera
- butterflies/moths
- Lepidoptera
- Hoverflies/Syrphidae
- wasp(s)/sphecidae
- Pollinators

Listed species:
Bees: Hymenoptera: Apoidea
State listed: (* = also federally listed)

- *Bombus affinis*
  - Rusty-patched Bumble Bee*
- *Bombus ashtoni*
  - Ashton's Cuckoo Bumble Bee
- *Bombus citrinus*
  - Lemon Cuckoo Bumble Bee
- *Bombus fernaldae*
  - Fernald's Cuckoo Bumble Bee
- *Bombus fervidus*
  - Yellow Bumble Bee
- *Bombus griseocollis*
  - Brown-belted Bumble Bee
- *Bombus insularis*
  - Indiscriminate Cuckoo Bumble Bee
- *Bombus pensylvanicus*
  - American Bumble Bee
- *Bombus sandersoni*
  - Sanderson's Bumble Bee
- *Bombus terricola*
  - Yellow-banded Bumble Bee*

Butterflies & moths: Lepidoptera
State listed: (* = also federally listed)

- *Danaus plexippus*
  - Monarch*
- *Lycaena dorcas claytoni*
  - Clayton's Copper
- *Papilio brevicauda gaspeensis*
  - Short-tailed Swallowtail

Federally listed, but not state listed

- *Speyeria Idalia*
  - Regal fritillary
- *Callophrys irus*
  - Frosted elfin
- *Lycaeides melissa samuelis*
  - Karner blue butterfly

Intervention keywords:

ROW

- roads
- roadsides
- road shoulder
- rails
- railways
- railroad
- power
- powerlines
- pipeline
- utility
- rights-of-way
- highway
- freeway
- interstate
- turnpike
- electric
- transmission line
- transportation
- infrastructure
- verge
- linear
- edge
- side
- margin
- hedgerow
- embankment
- ditch
- buffer
- strip
- corridor

Habitat

Type:

- landscape
- habitat
- semi-natural
- refuge
- meadow
- prairie
- grassland
- pasture
- agriculture
- barren
- shrubland
- wetland
- heath/bog
- scrub
- forest
- woodland
- coniferous
- deciduous
- Early succession
- Urban
- impervious

Context:

- pattern
- patch size
- shape
- complexity
- distance
- dominance
- cover/cover type

Management:

- conservation
- management
- restoration
- disturbance
- burning
- grazing
- mowing
- cutting
- plowing
- mulching
- clearing
- seeding
- planting

- fertilizer
- eradication
- logging
- harvesting
- herbicide/insecticide/ pesticide

Comparator and Outcome keywords:

- community
- population
- species
- composition
- abundance
- richness
- diversity
- assemblage
- reproduction
- persistence
- establishment
- enhancement
- success
- increase
- threat
- mortality
- decrease
- movement
- dispersal
- connectivity

Appendix C: Search keyword combination list

Web of Science:

1. rights-of-way AND management AND pollinators
2. right*-of-way AND management AND pollinators
3. roadside AND management AND pollinators
4. road* AND management AND pollinators
5. road* AND pollinators
6. right*-of-way AND pollinators
7. right*-of-way AND habitat AND management
8. highway AND management AND pollinators
9. highway AND pollinators
10. freeway AND management AND pollinators
11. freeway AND pollinators
12. interstate AND management AND pollinators
13. interstate AND pollinators
14. rail* AND management AND pollinators
15. rail* AND pollinators
16. turnpike AND pollinators
17. transportation AND management AND pollinators
18. transportation AND pollinators
19. transportation infrastructure AND pollinators
20. linear infrastructure AND pollinators
21. utility infrastructure AND pollinators
22. electric infrastructure AND pollinators
23. (Road* OR rail* OR power* OR "right* of way*") AND pollinators AND (management OR conservation OR enhancement OR restoration)
24. powerl* AND management AND pollinators
25. powerl* AND pollinators
26. "power l*" AND management AND pollinators
27. "power l*" AND pollinators
28. "power li*" AND pollinators
29. (Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*)
30. (Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (burn* OR mow* OR cut* OR plow* OR clear* OR graz* OR disturb* OR eradicat*)
31. (Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (seeding OR planting OR mulch* OR fertiliz* OR restor*)
32. (Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (herbicid* OR insecticid* OR pesticid*)

33. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (logg* OR harvest*)
34. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND conserv*
35. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND habitat
36. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND habitat AND (manag* OR conserv* OR enhanc* OR restor*)
37. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND population* AND (establish* OR reproduc* OR persist* OR success* OR increas*)
38. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND population* AND (threat* OR mortal* OR decreas*)
39. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND population* AND (movement* OR dispers* OR connect*)
40. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (population* OR communit* OR diversity OR species OR composition OR assemblage OR abundance OR richness)
41. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND landscape AND (pattern OR complex* OR context)
42. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (“patch size” OR “patch shape” OR distance)
43. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND “semi-natural” AND (habitat OR refug*)
44. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND bee(s)
45. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND bee AND (manag* OR conserv* OR enhanc* OR restor*)
46. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND bumblebee AND (manag* OR conserv* OR enhanc* OR restor*)
47. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (butterfl* OR moth OR moths) AND (manag* OR conserv* OR enhanc* OR restor*)
48. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (hoverfl* OR “hover fl*” OR syrphid*) AND (manag* OR conserv* OR enhanc* OR restor*)
49. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (wasp OR wasps OR sphecid*) AND (manag* OR conserv* OR enhanc* OR restor*)
50. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (Hymenoptera OR Lepidoptera) AND (manag* OR conserv* OR enhanc* OR restor*)
51. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (Apoidea OR Vespoidea OR Papilioidea) AND (manag* OR conserv* OR enhanc* OR restor*)
52. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND “pollinating insects” AND (manag* OR conserv* OR enhanc* OR restor*)
53. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND “insect pollinators” AND (manag* OR conserv* OR enhanc* OR restor*)

54. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (linear OR verge OR *edge* OR margin OR side OR ditch OR embankment OR buffer OR strip OR corridor)
55. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (flower* OR flora* OR bloom* OR forag*) AND (vegetation OR resources OR plants OR shrubs OR forbs OR herbs) AND pollinator*
56. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (nest*) AND (vegetation OR resources OR plants OR shrubs OR forbs OR herbs)AND pollinator*
57. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (invasive OR non-native OR native OR naturalized) AND (vegetation OR resources OR plants OR shrubs OR forbs OR herbs) AND pollinator*
58. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (meadow OR prairie OR grassland OR pasture OR agriculture OR barren OR shrubland OR scrub)
59. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (forest OR woodland OR coniferous OR deciduous OR “early succession*”)
60. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (wetland OR heath OR bog)
61. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (urban* OR impervious)
62. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND bumble* bee AND (manag* OR conserv* OR enhanc* OR restor*)
63. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus affinis” OR Rusty* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
64. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus ashtoni” OR Ashton* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
65. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus citrinus” OR Lemon* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
66. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus fernaldae” OR Fernald* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
67. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND “Bombus fervidus” AND (manag* OR conserv* OR enhanc* OR restor*)
68. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus griseocollis” OR Brown* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
69. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND “Bombus insularis” AND (manag* OR conserv* OR enhanc* OR restor*)
70. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND “Bombus pensylvanicus” AND (manag* OR conserv* OR enhanc* OR restor*)

71. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus sandersoni” OR Sanderson* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
72. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus terricola” OR Yellow* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)
73. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND Bombus AND (manag* OR conserv* OR enhanc* OR restor*)
74. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Danaus plexippus” OR monarch AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)
75. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Lycaena dorcas claytoni” OR “Clayton* copper” AND butterfl* AND (manag* OR conserv* OR enhanc* OR restor*)
76. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Speyeria idalia” OR “Regal fritillary” AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)
77. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Callophrys irus” OR “frosted elfin” AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)
78. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Lycaeides melissa samuelis” OR “Karner blue” AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)
79. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Papilio brevicauda” OR “Short-tailed swallowtail” AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)

Google Scholar:

80. (Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*)
81. Road pollinators
82. (road OR roadside OR “road shoulder” OR highway) (pollinators OR bee OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)
83. (rail OR railway OR railways OR railroad OR railroads) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)
84. (powerline OR powerlines OR “power line” OR “power lines”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)

85. (“transmission line” OR “transmission lines”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)
86. (“right of way” OR “rights of way” OR “right of ways”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)

General Google Search:

87. road management pollinator
88. road conservation pollinator
89. "road" conservation pollinator
90. road restoration pollinator
91. road enhancement pollinator
92. road management bee
93. road management bumblebee
94. road management butterflies
95. road management butterfly
96. road management moths
97. road management hymenoptera
98. road management lepidoptera
99. road management butterflies lepidoptera
100. rail management pollinator
101. rail “conservation” pollinator
102. rail restoration pollinator
103. rail enhancement pollinator
104. rail management butterflies
105. rail management lepidoptera

Appendix D: Inclusion criteria for full-text screening

- Populations: Pollinators, plants; in USA, Canada, or Europe (looking for latitudinal similarity)
    - Included:
        - pollinating insects: bees, butterflies, hoverflies, wasps
            - species of concern (endangered/threatened)
        - flowering plants: trees, shrubs, prairie plants, native plants, invasive plants, early-successional forest plants, pollen and nectar sources
        - nesting resources—bare ground, woody debris
        - People's perceptions, opinions, and experiences re: ROW management for pollinators
    - Excluded:
        - Anything outside of target geographic range
        - non-pollinating insects, arachnids: beetles, ants, dragonflies, spiders
        - Mammals, amphibians, reptiles, birds
        - Grasses
        - Pollen

- Interventions: Management practices along rights-of-way
    - Included:
        - Management practices: mowing, seeding, planting, burning, restoration, conservation
        - Rights-of-way: roads, rails
            - Regardless of width/length (forest rides and paths can be included)
        - Risks to pollinators associated with ROW: traffic, chemical exposure, habitat loss, electromagnetic fields
    - Excluded
        - powerlines, canals, gas lines
        - Other fallow or non-linear land Mines, solar farms, old fields, urban remnants
            - Field edges
        - Forest harvesting/forest edges
        - Hedgerows

- Comparators: Management or landscape context
    - Included:
        - Management: managed land vs unmanaged land
        - Landscape context: surrounding habitat type, pattern and composition
            - Role in movement across the landscape
        - Types of studies:
            - Observational or experimental field studies

            - Case studies, surveys, and interviews included if they describe management
    - Excluded:
        - Restoration/site design proposals
        - Economic effects or ecosystem services

- Outcomes: effect on diversity and/or abundance of pollinator and/or plant communities
    - Included: abundance, species richness, evenness, assemblage, diversity, presence, absence, occurrence
    - Excluded: unexecuted habitat design proposals, long term observations without intervention
        - Gray literature exempt—generally provides guidelines with no outcomes attached.

Papers are ineligible for narrative review if they meet fewer than 3 (so 0, 1, or 2) criteria or don't meet population criteria. All excluded papers will be recorded in excluded studies database with the reason(s) for exclusion.

Grey literature: Hold to population criteria, allow exemption for outcomes criteria

Appendix E: Critical appraisal, bias assessment, and data extraction protocols

Critical appraisal and bias assessment:

- Fill in the questions addressed column in the reference database:
  1) management strategy: Are there specific ROW (e.g., roadsides and powerlines) management practices that successfully enhance pollinator abundance and diversity?
  2) pollinator taxa: Which insect pollinator taxa respond most significantly to common ROW management enhancement practices?
  3) other influential variables: landscape context, threats: Are there elements of landscape context that serve to enhance (e.g., adjacent fields or wetlands) or threaten (e.g., traffic volume, road class) the success of ROW management for pollinator conservation?

- Bias assessment: ranking papers susceptibility to bias is part of critical appraisal. Following criteria of Villemey et al. 2018:
  - High: no replicates, poor methods, insufficient method description, confounding factors
  - Medium: no info on site selection, CI or BA designs instead of BACI, no spatial replication, difference in the loss of samples between control and treatment, slightly inefficient methods description
  - Low: everything that didn't have any of the previous issues

  Papers have high bias if they meet any of the high bias criteria. Papers with medium bias can have systematic site selection (random is better but is often difficult to achieve in ecological field studies). Papers with medium bias can have multiple treatments per site; this is another limitation affecting many ecological field studies. If each treatment is replicated in a block at each site, this is fine. Papers that do not meet one or both of these criteria have medium bias, while papers that do meet both will have LOW bias, even if they have a CI design. Finally, papers with sites less than 1 km apart will have medium bias, regardless of site selection strategy or treatments per site. Number of years sampled does not influence bias category.

- Quantitative eligibility criteria:
  - Papers must report means and variances for abundance and species richness to be eligible for extraction (or meet reporting requirement of other statistical tests; see effect size section).
  - Papers with extractable data that have high bias in their experimental design will be excluded from meta-analysis.
  - If studies meet all qualitative eligibility requirements but do not meet quantitative eligibility requirements:

- In the excluded studies database, papers will be separated by exclusion from narrative synthesis and meta-analysis OR exclusion from meta-analysis only. Note reason for exclusion when adding papers to database.

Data extraction:

Effect size measure: Hedge's d.

- Requirements to calculate: mean, sample size, and variance for two groups (typically a control and a treatment)
  - Can also calculate from t-test results: record t statistic, result (whether treatment was greater than control or vice versa), and p value
- Alternate effect size measure: correlation coefficient
  - From f tests: record degrees of freedom (df), F value, and p value.
  - Can extract information from other tests; will modify protocol on a case-by-case basis
  - For studies with more than one df, additional calculations will be required

Extract data to Data Extraction database:

- Each entry gets a unique accession number
- Will likely be multiple entries per paper (e.g., for abundance, species richness, or individual species counts)
- Include information on the part of the paper the data came from for easier review/retrieval later on
- Data codes fall into four categories; categories and codes are detailed below.

Data codes and categories:

1) Basic information

- Acc#: Accession number: a unique identifying number for each entry in data extraction database.
- Ref#: reference number as assigned in the reference database. Will likely be multiple accession numbers for each reference number
- Authors: paper authors
- Year: year published
- Page/source: page number, section number, or description of where in the paper to find the extracted data
- Article type: journal article, thesis, or gray literature (listed in reference database)
- Country : country where study was conducted

2) Sources of bias/effect modifiers

- Study design: one of the following
  - Observational (Obs): a study with no control; sites are surveyed for observational purposes with no comparisons made (cannot be included in meta-analysis)

    - Comparator-intervention (CI): compares separate sites in current conditions; no site modifications made (most managed vs. unmanaged site studies are CI designs)
    - Before-after-intervention (BA): same sample sites are surveyed before and after management; before management serves as the control
    - Before-after-comparator-intervention (BACI): sample sites surveyed and compared to separate control before and after management
    - Movement mark-recapture: studies of insect movement from one site to another measured with mark-recapture techniques (these studies typically have no control site for comparison unless movement is studied in multiple scenarios)
- ROW type: roadways, railways, powerlines, hedgerows
    - Modifier: type of habitat if both site types are in ROW
- Control habitat: roadways, railways, powerlines, hedgerows, or grasslands/non-ROW habitat
    - Modifier: type of habitat if both site types are in ROW
- Management type: none, mowing, planting, burning, restoration, grazing, cutting, plowing, mulching, clearing, seeding, fertilizer, eradication, logging, harvesting, herbicide, insecticide, pesticide
- Site selection: randomly selected (YES) or systematically selected (NO) (n/a if not specified)
- Site distance: should be at least 1 km (YES) to collect distinct communities. If not, mark NO. If not mentioned, mark n/a.
- Spatial replication: one plot per site = true spatial replication. Mark YES. Multiple plots per site could be pseudoreplication if they are not counted right in analyses.
- Landscape: mark YES if study compares ROW habitat in different landscape contexts, otherwise mark NO.
- Threat: list: traffic volume, barrier to movement, roadkill/mortality, chemicals, etc. (n/a if none)
- Study length: number of years surveying occurred
- Sample year: if there are multiple years of data being recorded, specify sample year (numbered 1, 2,…) here
- # of sample occasions: number of sampling occasions each year

3) Organismal information

- Type of organism: pollinator or plant
- Order
- Family
- Genus
- Species
- Status: conservation status: endangered, threatened, etc.; state, federal, or both

4) Raw data

- Variable: abundance, species richness, etc.
- Nt: number of treatment sites
- Meant: mean number of individuals/species in treatment sites
- Vart: standard deviation of individuals/species in treatment sites
- Nc: number of control sites
- meanc: mean number of individuals/species in control sites
- varc: standard deviation of individuals/species in control sites
- Ncorrected: total number of unique sites. If one control is compared to multiple treatment sites, that will be reflected in this number (so it may not equal Nt+Nc)
- Hedge's d: effect size calculated from N, mean, and var (see Koricheva et al. 2013, pg 62 and Villemey et al 2018, pg 11)
- var of d: calculated variance of Hedge's d (see Koricheva et al. 2013, pg 63 and Villemey et al. 2018, pg 11)
- From f tests:
    - degrees of freedom (df), F value, and p value.

Appendix F: Electronic files of search results

E.1: All search keyword combinations with the number of results from each search

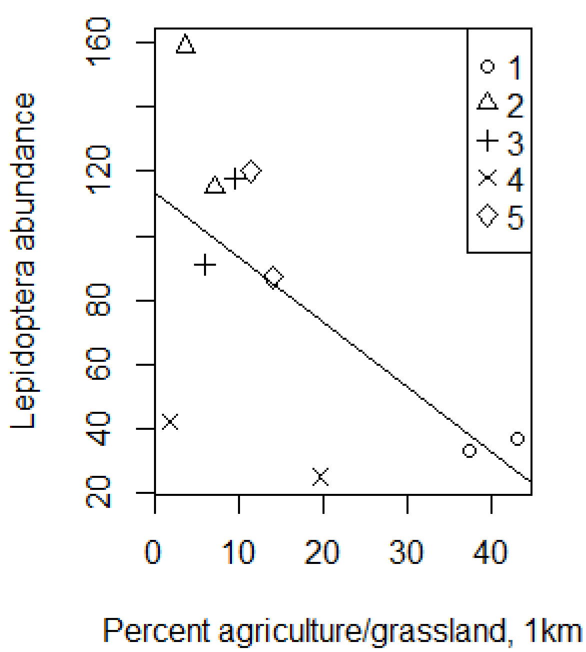
E.2: All collected references with summary information on each and details on their inclusion in or exclusion from narrative review and meta-analysis

E.3: All quantitative data extracted from references

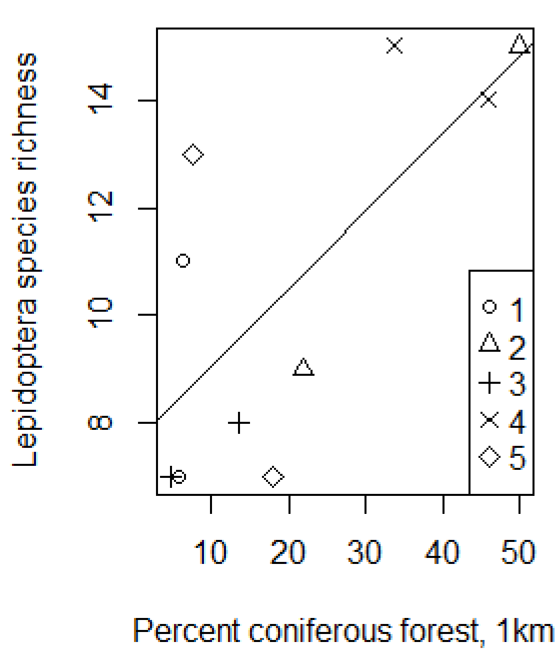
Appendix G: Full results of spatial analysis in landscape surrounding ten Priority 1 ROW sites in Maine.

Table F.1: Land cover types influencing Bombus or Lepidopteran abundance or species richness over the entire 2017 growing season.

	Ag	Con	Dec	Edge	Emg	Urb	Wet
Total abund.	--	--	--	--	--	--	--
Bombus abund.	--	--	--	--	--	--	--
Bombus richness	--	--	--	--	--	--	--
Lepidopt. abund.	d = 8.356 p = 0.004	--	--	--	--	--	--
Lepidopt. richness	--	d = 4.853 p = 0.028	--	--	--	--	--



a)

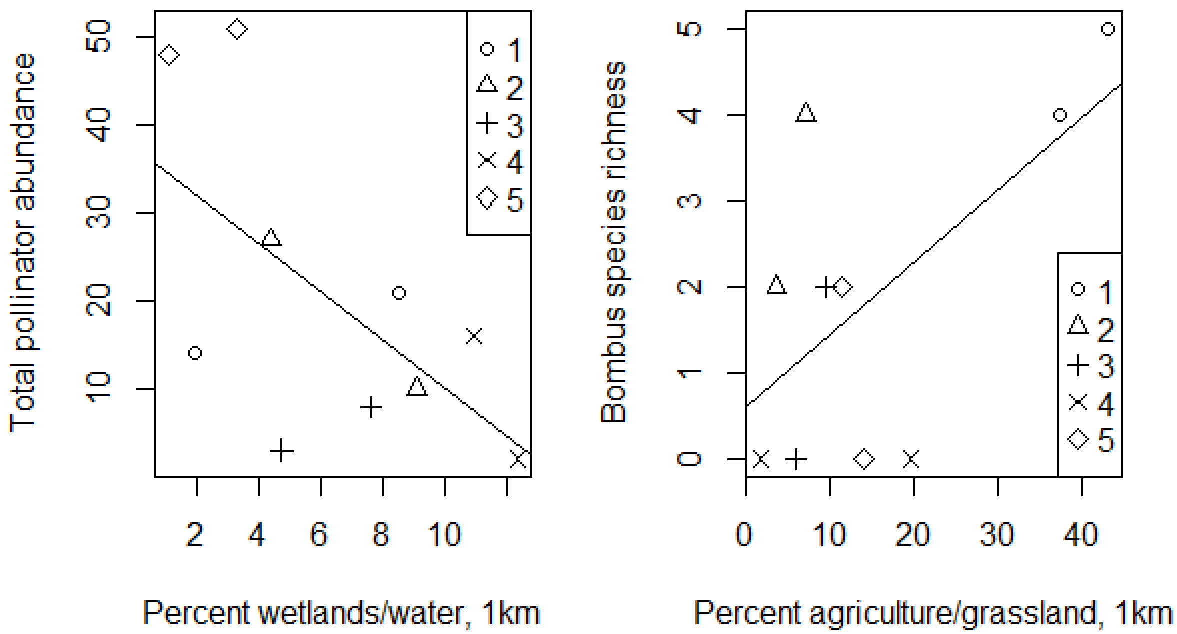


b)

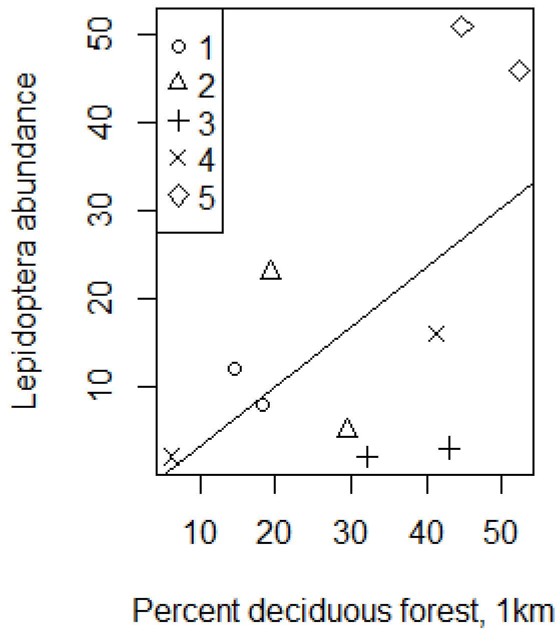
Figure F.1. Significant relationships between a) Lepidopteran abundance and percent of agriculture/grassland and b) Lepidopteran species richness and percent of coniferous forest over the entire growing season in the 1 km surrounding ten Priority 1 ROW sites in Maine. Symbols represent the five geographic regions of the state where survey sites were located.

Table F.2: Land cover types influencing Bombus or Lepidopteran abundance or species richness over the 2017 early growing season.

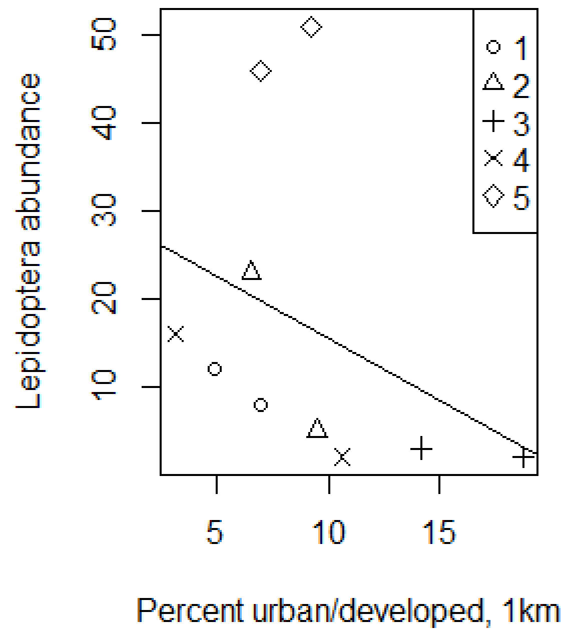
	Ag	**Con**	**Dec**	**Edge**	**Emg**	**Urb**	**Wet**
Total abund.	--	--	--	--	--	--	d = 5.950 p = 0.015
Bombus abund.	--	--	--	--	--	--	--
Bombus richness	d = 5.767 p = 0.016	--	--	--	--	--	--
Lepidopt. abund.	--	--	d = 4.505 p = 0.034	--	--	d = 0.384 p = 0.050	d = 5.409 p = 0.020
Lepidopt. richness	--	--	--	--	--	--	--



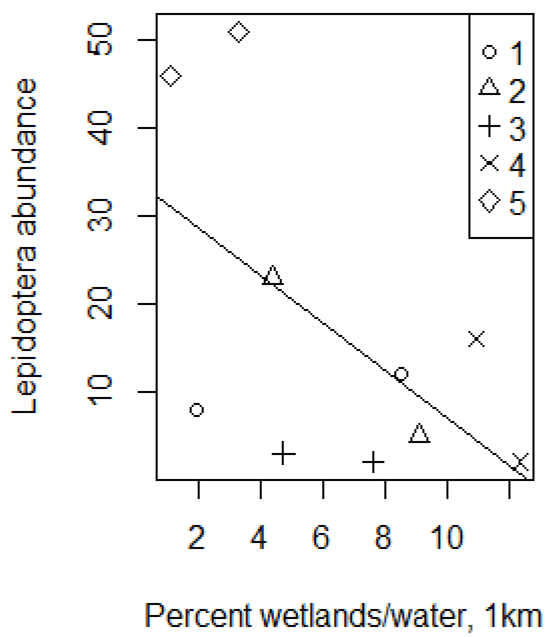
a) b)



c)



d)

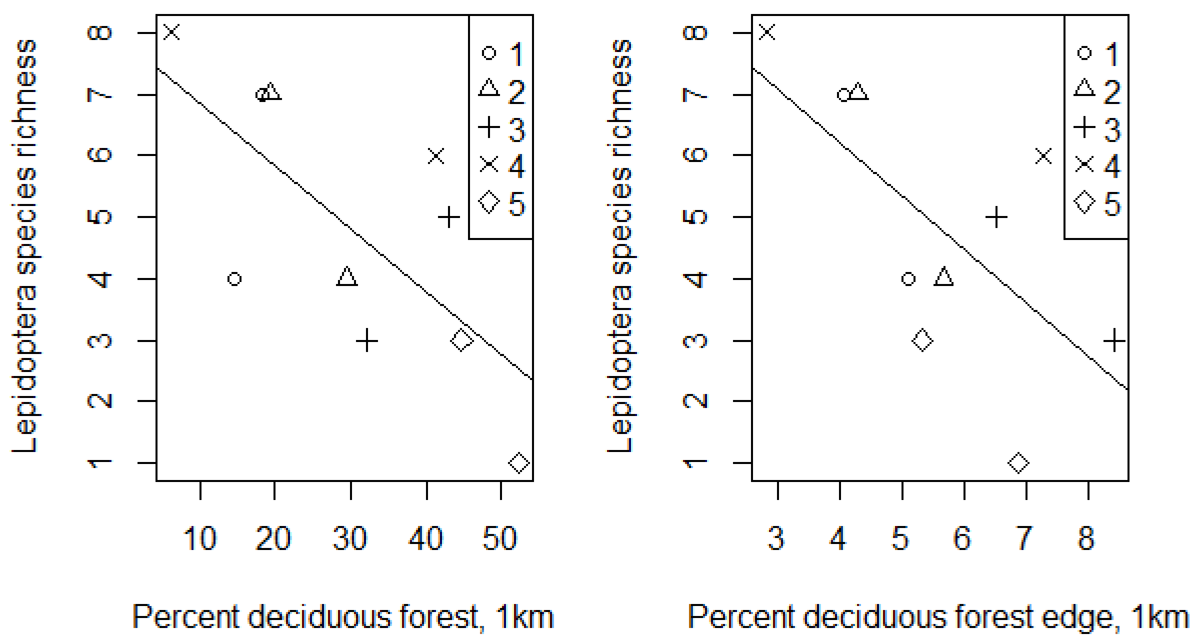


e)

Figure F.2. Significant relationships between a) Total pollinator abundance and percent of wetlands/water, b) Bombus species richness and percent of agriculture/grassland, c) Lepidopteran abundance and percent of deciduous forest, d) Lepidopteran abundance and percent of urban/developed, and e) Lepidopteran abundance and percent of wetlands/water in the early growing season in the 1 km surrounding ten Priority 1 ROW sites in Maine. Symbols represent the five geographic regions of the state where survey sites were located.

Table F.3: Land cover types influencing Bombus or Lepidopteran abundance or species richness over the 2017 mid-growing season.

	Ag	**Con**	**Dec**	**Edge**	**Emg**	**Urb**	**Wet**
Total abund.	--	--	--	--	--	--	--
Bombus abund.	--	--	--	--	--	--	--
Bombus richness	--	--	--	--	--	--	--
Lepidopt. abund.	--	--	--	--	--	--	--
Lepidopt. richness	--	--	d = 4.500 p = 0.034	d = 4.009 p = 0.045	--	--	--



a) b)

Figure F.3. Significant relationships between a) Lepidopteran species richness and percent of deciduous forest and b) Lepidopteran species richness and percent of deciduous forest edge in the mid-growing season in the 1 km surrounding ten Priority 1 ROW sites in Maine. Symbols represent the five geographic regions of the state where survey sites were located.

Table F.4: Land cover types influencing Bombus or Lepidopteran abundance or species richness over the 2017 late growing season. These results are depicted in Figure 3 of the report.

	Ag	**Con**	**Dec**	**Edge**	**Emg**	**Urb**	**Wet**
Total abund.	d = 7.981 p = 0.005	--	--	--	--	d = 3.833 p = 0.050	--
Bombus abund.	--	--	--	--	--	--	--
Bombus richness	--	--	--	--	--	--	--
Lepidopt. abund.	d = 17.21 p <0.001	--	--	--	--	d = 4.484 p = 0.034	--
Lepidopt. richness	--	--	--	--	--	--	--

search number	date	search source	search term combination	number of results	# of results reviewed	# of papers saved	papers saved	# of papers rejected	papers rejected (based on title/abstract read)	# of duplicates	sum of all results	duplicate papers	URL
1	6/11/2018	Web of Science	rights-of-way AND management AND pollinators	3	3	2	Collins and Fore 2009; Nicholls and Altieri 2013	0	0	1	3	Russell et al 2005	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6FUItZXVe4gdH8ldsWL&search_mode=GeneralSearch&prID=ac32010a-a7ae-4926-8a86-13c994a3aea9
2	6/11/2018	Web of Science	right*-of-way AND management AND pollinators	3	3	0	0	0	0	3	3	Russell et al 2005, Collins and Fore 2009, Nicholls and Altieri 2013	
3	6/11/2018	Web of Science	roadside AND management AND pollinators	11	11	2	Fernandes et al 2018; Lentini et al 2012	2	Smart et al 2016, Jacquemyn et al 2009	7	11	Hopwood 2008, Noordjik et al 2009, Halbritter et al 2015, Sydenham et al 2016, Hanula et al 2016, Hill and Bartomeus 2016, Heneberg et al 2017	
4	6/11/2018	Web of Science	road* AND management AND pollinators	30	30	8	Evans et al 2004, Marshall 2005, Watson et al 2011, Mwangi et al 2012, Jakobsson and Agren 2014, Garbuzov et al 2015, Zielin et al 2016, Wrzesien and Denisow 2016	6	Rittenhouse and Rosentreter 1994, Johansen et al 2011, Hahn et al 2013, Pellegrino et al 2014, Dakos and Bascompte 2014, Sole-Senan et al 2018	16	30	Fernandes et al 2018, Heneberg et al 2017, Kallioniemi et al 2017, Hill and Bartomeus 2016, Hanula et al 2016, Smart et al 2016, Heneberg et al 2016, Sydenham et al 2016, Halbritter et al 2015, Hatten et al 2015, Lentini et al 2012, Ogsathorpe et al 2012, Noordijk et al 2009, Collins and Fore 2009, Jacquemyn et al 2009, Hopwood 2008	

5	6/11&18/2018	Web of Science	road* AND pollinators	96 (2 more found on second search term run 6/18)	98	20	Davis et al 2018, Snell-Rood and Kobiela 2018, Pustkowiak et al 2018, Pitman et al 2018, Lewis et al 2017, Cole et al 2017, Moron et al 2017, Shankar et al 2017, Hevia et al 2016, Geslin et al 2016, Bennie et al 2016, Keret et al 2015, Sydenham et al 2014, Jackson et al 2014, Carper et al 2014, Traynor and Traynor 2013, Van Rossum 2009, Clinebell 2003, Sawyer and Anderson 1998, Orr and Pleasants 1996	39	Keilsohn et al 2018, Klein et al 2018, De Palma et al 2017, Johnson et al 2017, Chauhan et al 2017, Rewicz et al 2017, Calevo et al 2017, Tambarussi et al 2017, Hernandez-Yanez et al 2016, Herbertsson et al 2016, Greene et al 2015, Pellegrino et al 2015, Davidar et al 2015, Tokumoto et al 2014, Winfree 2013, Schorr 2013, Woteki 2013, Tokumoto et al 2013, Takano et al 2013, Berry et al 2013, Neame et al 2013, Dyer et al 2012, Jacquemyn et al 2011,	39	98	Fernandes et al 2018, Sole-Senan et al 2018, Heneberg et al 2017, Kallioniemi et al 2017, Hill and Bartomeus 2016, Kutt et al 2016, Zielin et al 2016, Hanula et al 2016, Smart et al 2016, Heneberg et al 2016, Dargas et al 2016, Sydenham et al 2016, Wrzesien and Denisow 2016, Halbritter et al 2015, Baxter-Gilbert et al 2015, Hatten et al 2015, Garbuzov et al 2015, Hanley and Wilkins 2015, Dakos and Bascompte 2014, Pellegrino et al 2014, Suarez-Esteban et al 2014,	
6	6/11/2018	Web of Science	right*-of-way AND pollinators	5	5	0	0	0	0	5	5	Wagner et al 2014, Nicholls and Altieri 2013, Collins and Fore 2009, Russell et al 2005, Orr and Pleasants 1996	
7	6/11-13/2018	Web of Science	right*-of-way AND habitat AND management	72 (missed a page in review?)	63	31	Sahley et al 2017, Richardson et al 2017, Leston and Koper 2017c, Fischer et al 2015, McCleery et al 2015, Berg et al 2013, Bennett et al 2013, Askins et al 2012, brisson et al 2010, Kubel and Yahner 2008, Clarke and White 2008, Clarke and White 2008b, Yahner 2006, Clarke et al 2006, Forrester et al 2005, Confer and Pascoe 2003, Marshall and Vandruff 2002, 9 citations from ROW 7th Environmental Concerns Conf, Russell et al 2001, Smallidge et al 1996, Breece et al 1996 (preview), Temple 1996 (preview),	23	Leston and Koper 2017, Wistrom and Nielsen 2017, DiTommaso et al 2014, McIntosh et al 2014, Arbor Vitae Ltd 2013, Schlossberg et al 2011, Ahrens et al 2011, Schlossberg et al 2010, Jones et al 2010, Gifford et al 2010, Rosen et al 2009, Collister and Wilson 2007, Taylor et al 2007, Shuster et al 2005, Litzgus and Mousseau 2004, Bissonette 2001, Poague et al 2000, Ricard and Doucet 1999, Jenkinson and Wheater 1998, Olson and Rohwer 1998, Bivins et al	9	63	Gardiner et al 2018, Thogmartin et al 2017, Leston and Koper 2017b, Kasten et al 2016, Wagner et al 2014, Komonen et al 2013, Nicholls and Altieri 2013, Lensu et al 2011, Russell et al 2005	

8	6/28/2018	Web of Science	highway AND management AND pollinators	7	7	0	0	2	Edens-Meier et al 2011, Moore 2002	5	7	Fernandes et al 2018, Heneberg et al 2017, Zielin et al 2016, Halbritter et al 2015, Hatten et al 2015	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=f90c8763-c20e-49c4-a3c6-a03d0c629cad
9	6/28/2018	Web of Science	highway AND pollinators	11	11	0	0	1	Cardel et al 1997	10	11	Davis et al 2018, Fernandes et al 2018, Heneberg et al 2017, Zielin et al 2016, Dargas et al 2016, Halbritter et al 2015, Baxter-Gilbert et al 2015, Hatten et al 2015, Edens-Meier et al 2011, Moore 2002	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=dafde4c6-88d4-468a-b11f-d411cb5c819e
10	6/28/2018	Web of Science	freeway AND management AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AfYnP89glAL83mKg6L&errorQid=12#searchErrorMessage
11	6/28/2018	Web of Science	freeway AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AfYnP89glAL83mKg6L&errorQid=10#searchErrorMessage

12	6/28/2018	Web of Science	interstate AND management AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AfYnP89glAL83mKg6L&errorQid=14#searchErrorMessage
13	6/28/2018	Web of Science	interstate AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AfYnP89glAL83mKg6L&errorQid=15#searchErrorMessage
14	6/28/2018	Web of Science	rail* AND management AND pollinators	7	7	2	Moron et al 2014, Clermont et al 2015	1	Pellegrino and Bellusci 2014	4	7	Moron et al 2017, Wrzesien et al 2016, Wrzesien and Denisow 2016, Jacquemyn et al 2009	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=17594d6a-1cf9-4231-93ab-b25b6f7a3bff
15	6/28/2018	Web of Science	rail* AND pollinators	19	19	1	Srba and Heneberg 2012	10	Shuttleworth et al 2017, Demarco 2017, Pellegrino et al 2015, Wiemer et al 2012, Endress 2010, Shuttleworth and Johnson 2009, Kunze and Wanntorp 2008, Shuttleworth and Johnson 2006, Sugiura and Yamazaki 2005, Devall 1992	8	19	Moron et al 2017, Wrzesien et al 2016, Wrzesien and Denisow 2016, Clermont et al 2015, Pellegrino and Bellusci 2014, Moron et al 2014, Jacquemyn et al 2009, Bhattacharya et al 2003	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=e86e7dcb-b0a4-433c-933e-2a26c2375222

16	6/28/2018	Web of Science	turnpike AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AfYnP89glAL83mKg6L&errorQid=35#searchErrorMessage
17	6/28/2018	Web of Science	transportation AND management AND pollinators	1	1	0	0	1	Moisan-Deserres et al 2014	0	1	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=e748d277-4777-4a83-b13d-61549edff928
18	6/28/2018	Web of Science	transportation AND pollinators	21	21	1	Jha and Kremen 2013	18	Boyle et al 2017, Zhang et al 2017, Gautam et al 2017, Schowalter et al 2016, Wang et al 2015, Strange 2015, Penalver et al 2012, Goulson 2010, Valdivia et al 2010, Nunez-Avellaneda et al 2008, Cheney 2008, da Conceicao et al 2004, Despres 2003, Lunau 2000, Huang et al 1998, Seres and Ramirez 1995, Nazarov and Efetov 1993, Ramirez 1993	2	21	Moisan-Deserres et al 2014, Davis et al 2008	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=168679e8-ec7f-4c04-9912-eacdd7dbb842

19	6/28/2018	Web of Science	transportation infrastructure AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AfYnP89glAL83mKg6L&errorQid=57#searchErrorMessage
20	6/28/2018	Web of Science	linear infrastructure AND pollinators	3	3	0	0	0	0	3	3	Heneberg et al 2017, Marshall 2005, Marshall and Moonen 2002	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=ccc6591b-c9c4-4eba-8faf-d9529c244546
21	6/28/2018	Web of Science	utility infrastructure AND pollinators	1	1	1	Semeraro et al 2018	0	0	0	1	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AfYnP89glAL83mKg6L&search_mode=GeneralSearch&prID=fbbe189f-5ef7-42e9-bdf4-38ce88c7a78d
22	6/28/2018	Web of Science	electric infrastructure AND pollinators	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=6DxIl1WfrVw7zl1DZdl&errorQid=1#searchErrorMessage

23	6/28/2018	Web of Science	(Road* OR rail* OR power* OR “right* of way*”) AND pollinators AND (management OR conservation OR enhancement OR restoration)	108	108	1	Rewicz et al 2017 [rejected in previous searches!]	45	Faleiro et al 2018, Sole-Senan et al 2018, Williams and Lonsdorf 2018, De Palma et al 2018, Gustafsson et al 2017, Campbell et al 2017, Toledo-Hernandez et al 2017, Johnson et al 2017, Miller-Struttmann et al 2017, Brandt et al 2017, Suni 2017, Calevo et al 2017, Tambarussi et al 2017, Schmidt et al 2017, Hernandez-Yanez et al 2016, Phillips et al 2016, Smart et al 2016, Loxdale 2016, Marshall et al 2015, Davidar et al 2015, Dakos	62	108	Davis et al 2018, Keilsohn et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, Pustkowiak et al 2018, Pitman et al 2018, Moron et al 2017, Johnson et al 2017, Cole et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Shankar et al 2017, Hill and Bartomeus 2016, Hernandez-Yanez et al 2016, Kutt et al 2016, Zielin et al 2016, Hanula et al 2016, Geslin et al 2016, Smart et al 2016, Heneberg et al 2016, Wrzesien et al 2016, Dargas et al 2016, Sydenham et al 2016,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5DPM1iyUbPxwIgcjlCo&search_mode=GeneralSearch&prID=b96bfc61-4a5a-4603-af4a-20984241055b
24	6/28/2018	Web of Science	powerl* AND management AND pollinators	2	2	0	0	0	0	2	2	Collins and Fore 2009, Russell et al 2005	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5DPM1iyUbPxwIgcjlCo&search_mode=GeneralSearch&prID=6b603414-8cd4-409d-b5c3-0c59376a0bc7
25	6/28/2018	Web of Science	powerl* AND pollinators	3	3	1	Shepherd et al 2018	0	0	2	3	Collins and Fore 2009, Russell et al 2005	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5DPM1iyUbPxwIgcjlCo&search_mode=GeneralSearch&prID=aa8fd416-a7d8-406f-b0d7-964a2e556da6

26	6/28/2018	Web of Science	"power l*" AND management AND pollinators	1	1	0	0	0	0	1	1	Sydenham et al 2016	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5DPM1iyUbPxwIgcjlCo&search_mode=GeneralSearch&prID=03e06621-e2ca-435e-ba0d-3cbbcf97cbe5
27	6/28/2018	Web of Science	"power l*" AND pollinators	19	19	1	Sydenham et al 2015	15	Lihoreau et al 2016, Santamaria et al 2016, Popic et al 2013, Lee et al 2013, Maeng et al 2011, Williams 2011, Ramos-Jilberto et al 2010 and 2009, Kallimanis et al 2009, Hwang et al 2009, Hwang et al 2008, Guimaraes et al 2007, Medan et al 2007, Basilio et al 2006, Jordano et al 2009	3	19	Shepherd et al 2018, Sydenham et al 2016, Sydenham et al 2015, Sydenham et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5DPM1iyUbPxwIgcjlCo&search_mode=GeneralSearch&prID=3c703992-6490-49e9-beae-2f061d7ce1ad
28	6/28/2018	Web of Science	"power li*" AND pollinators	4	4	0	0	0	0	4	4	Shepherd et al 2018, Sydenham et al 2016, Sydenham et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5DPM1iyUbPxwIgcjlCo&search_mode=GeneralSearch&prID=191aeeef-e63b-4e59-9da2-fe227d8d3e8c

29	7/2/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*)	76	76	0	0	0		76	76	Davis et al 2018, Keilsohn et al 2018, Klein et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, Pustkowiak et al 2018, Pitman et al 2018, De Palma et al 2017, Moron et al 2017, Johnson et al 2017, Cole et al 2017, Rewicz et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Calevo et al 2017, Tambarussi et al 2017, Shankar et al 2017, Hill and Bartomeus 2016, Hernandez-Yanez et al 2016, Kutt et al 2016, Herbertsson et al 2016, Zielin et al 2016,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5EOypYAScckjUJDs6Vc&search_mode=GeneralSearch&prID=45506a19-daf3-41ad-a38c-a456ddb884e0
30	7/2/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (burn* OR mow* OR cut* OR plow* OR clear* OR graz* OR disturb* OR eradicat*)	37	37	1	Tokumoto et al 2013 [rejected in previous searches!]	0		36	37	Lewis et al 2017, Moron et al 2017, Rewicz et al 2017, Kallioniemi et al 2017, Shankar et al 2017, Hanula et al 2016, Wrzesien et al 2016, Dargas et al 2016, Sydenham et al 2016, Greene et al 2015, Halbritter et al 2015, Clermont et al 2015, Pellegrino et al 2015, Garbuzov et al 2015, Hanley and Wilkins 2015, Davidar et al 2015, Pellegrino and Bellusci 2014, Tokumoto et al 2014, Srba and Heneberg 2012, Osgathorpe et al 2012, Mwangi et al 2012,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5EOypYAScckjUJDs6Vc&search_mode=GeneralSearch&prID=9fc2e698-7ae9-4158-bdfc-a12fde83d402

31	7/2/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (seeding OR planting OR mulch* OR fertiliz* OR restor*)	90	90	0	0	0		90	90	Keilsohn et al 2018, Klein et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, Pustkowiak et al 2018, Pitman et al 2018, Lewis et al 2017, Johnson et al 2017, Cole et al 2017, Moron et al 2017, Shuttleworth et al 2017, Chauhan et al 2017, Rewicz et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Calevo et al 2017, Tambarussi et al 2017, Shankar et al 2017, Hill and Bartomeus et al 2016, Hernandez-Yanez et al 2016, Kutt et al 2016, Hanula et al 2016, Hevia et	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5EOypYAScckjUJDs6Vc&search_mode=GeneralSearch&prID=82188d14-7931-49d2-bdce-635a41463891
32	7/2/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (herbicid* OR insecticid* OR pesticid*)	12	12	0	0	0		12	12	Smart et al 2016, Greene et al 2015, Baxter-Gilbert et al 2015, Hanley and Wilkins 2015, Henriksen and Langer 2013, Nicholls and Altieri 2013, Russell et al 2005, Marshall 2005, Reboud 2003, Marshall and Moonen 2002, Croft 2001, Rittenhouse and Rosenstreter 1994	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=8DcmaGNcGQBaHUHURUj&search_mode=GeneralSearch&prID=b4d8a467-e627-4fc8-a265-e2c3f25fa6b1
33	7/2/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND (logg* OR harvest*)	3	3	0	0	0		3	3	Hernandez-Yanez et al 2016, Jackson et al 2014, Tokumoto et al 2013	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=8DcmaGNcGQBaHUHURUj&search_mode=GeneralSearch&prID=5182d5c9-002f-43f5-99f8-d4f0cc7ffc77

34	7/3/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND conserv*	60	60	0	0	0		60	60	Davis et al 2018, Keilsohn et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, Pustkowiak et al 2018, Pitman et al 2018, De Palma et al 2017, Moron et al 2017, Johnson et al 2017, Cole et al 2017, Rewicz et al 2017, Heneberg et al 2017, Calevo et al 2017, Tambarussi et al 2017, Shankar et al 2017, Hill and Bartomeus 2016, Hernandez-Yanez et al 2016, Kutt et al 2016, Zielin et al 2016, Hanula et al 2016, Geslin et al 2016, Smart et al 2016, Heneberg et al 2016, Dargas	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=8DcmaGNcGQBaHUHURUj&search_mode=GeneralSearch&prID=138203b5-d1bf-45ef-b83c-d00d396b69f7
35	7/3/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND habitat	68	68	0	0	0		68	68	Shepherd et al 2018, Davis et al 2018, Keilsohn et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, Snell-Rood and Kobiela 2018, Pustkowiak et al 2018, Pitman et al 2018, Lewis et al 2017, De Palma et al 2017, Moron et al 2017, Cole et al 2017, Moron et al 2017b, Chauhan et al 2017, Rewicz et al 2017, Heneberg et al 2017, Calevo et al 2017, Shankar et al 2017, Hill and Bartomeus et al 2016, Kutt et al 2016, Herbertsson et al 2016, Zielin et al 2016, Hanula et	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=8EdnLGF5M3YhohfgKWU&search_mode=GeneralSearch&prID=5f7c937a-0eff-4363-bdc8-fc2de4662ca8

36	7/3/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinators AND habitat AND (manag* OR conserv* OR enhanc* OR restor*)	53	53	0	0	0		53	53	Davis et al 2018, Keilsohn et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, , Pustkowiak et al 2018, Pitman et al 2018, De Palma et al 2017, Moron et al 2017, Cole et al 2017, Rewicz et al 2017, Heneberg et al 2017, Calevo et al 2017, Shankar et al 2017, Hill and Bartomeus et al 2016, Kutt et al 2016, Herbertsson et al 2016, Zielin et al 2016, Hanula et al 2016, Hevia et al 2016, Heneberg et al 2016, Wrzesien et al 2016, Sydenham et al 2016,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=8EdnLGF5M3YhohfgKWU&search_mode=GeneralSearch&prID=256b7eb3-66d3-4f4e-b54d-5086def6817f
37	7/3/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND population* AND (establish* OR reproduc* OR persist* OR success* OR increas*)	38	38	0	0	0		38	38	Pustkowiak et al 2018, Moron et al 2017b, Chauhan et al 2017, Rewicz et al 2017, Kallioniemi et al 2017, Tambarussi et al 2017, Hernandez-Yanez et al 2016, Zielin et al 2016, Hanula et al 2016, Baxter-Gilbert et al 2015, Pellegrino et al 2015, Keret et al 2015, Pellegrino and Bellusci 2014, Moron et al 2014, Jakobbson and Agren 2014, Hahn et al 2013, Takano et al 2013, Berry et al 2013, Srba and Heneberg 2012, Dyer et al 2012, Jacquemyn et al 2011,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FeRbmGGAGVhGrmsUWg&search_mode=GeneralSearch&prID=0f6784ab-38cc-497c-9ac8-cafa38919ace

38	7/3/2018	Web of Science	Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND population* AND (threat* OR mortal* OR decreas*)	18	18	0	0	0		18	18	De Palma et al 2017, Moron et al 2017, Chauhan et al 2017, Kallioniemi et al 2017, Tambarussi et al 2017, Hernandez-Yanez et al 2016, Zielin et al 2016, Baxter-Gilbert et al 2015, Keret et al 2015, Jakobsson and Agren 2014, Tokumoto et al 2013, Collins and Fore 2009, Jacquemyn et al 2009, Schmalholz and Kiviniemi 2007, Ockinger and Smith 2007, Evans et al 2004, Sawyer and Anderson 1999, Rittenhouse and Rosenstreter 1994	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FeRbmGGAGVhGrmsUWg&search_mode=GeneralSearch&prID=f04c7168-c338-4372-a75b-69590d44380e
39	7/3/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND population* AND (movement* OR dispers* OR connect*)	21	21	0	0	0		21	21	Moron et al 2017, Johnson et al 2017, Moron et al 2017b, Chauhan et al 2017, Tambarussi et al 2017, Hernandez-Yanez et al 2016, Zielin et al 2016, Greene et al 2015, Keret et al 2015, Hahn et al 2013, Dyer et al 2012, Van Rossum 2009, Byrne et al 2007, Ockinger and Smith 2007, Reboud 2003, Bhattacharya et al 2003, Marshall and Moonen 2002, Richards et al 1999, Sawyer and Anderson 1998, Rittenhouse and Rosentreter 1994	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FeRbmGGAGVhGrmsUWg&search_mode=GeneralSearch&prID=868a215c-2e62-4938-9675-bbb478862702
40	7/3/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (population* OR communit* OR diversity OR species OR composition OR assemblage OR abundance OR richness)	102	102	0	0	0		102	102	saved PDF list of papers as search40citations	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FeRbmGGAGVhGrmsUWg&search_mode=GeneralSearch&prID=35bfc0ed-fbe9-4713-a63b-02513226cda3

41	7/4/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND landscape AND (pattern OR complex* OR context)	12	12	0	0	0		12	12	Pitman et al 2018, Kallioniemi et al 2017, Herbertsson et al 2016, Wrzesien et al 2016, Sydenham et al 2016, Hanley et al 2015, Sydenham et al 2014, Hahn et al 2013, Neame et al 2013, Dyer et al 2012, Van Rossum 2009, Byrne et al 2007	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6CYICBEs94iPfwriUHw&search_mode=GeneralSearch&prID=3f05e584-d439-4337-87d9-2c9dca77d654
42	7/4/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinator* AND (“patch size” OR “patch shape” OR distance)	23	23	0	0	0		23	23	Pustkowiak et al 2018, Pitman et al 2018, Lewis et al 2018, De Palma et al 2017, Moron et al 2017, Kallioniemi et al 2017, Tambarussi et al 2017, Hevia et al 2016, Wrzesien et al 2016, Clermont et al 2015, Pellegrino et al 2015, Jackson et al 2014, Jakobsson et al 2014, Hahn et al 2013, Lentini et al 2012, Dyer et al 2012, Watson et al 2011, Van Rossum 2009, Byrne et al 2007, Ockinger and Smith 2007, Reboud 2003, Richards et al 1999	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6CYICBEs94iPfwriUHw&search_mode=GeneralSearch&prID=0ab19bf6-d476-4196-a26a-a97162f26606
43	7/4/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND “semi-natural” AND (habitat OR refug*)	16	16	0	0	0		16	16	De Palma et al 2017, Moron et al 2017, Cole et al 2017, Hill and Bartomeus 2016, Kutt et al 2016, Herbertsson et al 2016, Hevia et al 2016, Sydenham et al 2014, Moron et al 2014, Jakobsson and Agren 2014, Henriksen and Langer 2013, Noordijk et al 2009, Schmalholz and Kiviniemi 2007, Ockinger and Smith 2007, Marshall 2005, Marshall and Moonen 2002	

44	7/4/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND bee(s)	199	199	18	Oleksa et al 2013, Reimer and Prokopy 2012, Strachecka et al 2012, Bilandzic et al 2011, Chaves-Alves et al 2011, Franzen et al 2009, Keasar and Shmida 2009, Mayfield et al 2006, Lipinski 2006, Coulson et al 2005, Mena and Ruz 2003, Corbett and Corbett 2003, Svensson et al 2000, Pimenta and Martins 1999, Benedek 1997, Woodward 1996, Loch and Zalucki 1996, Martins 1994	125	Jaafari et al 2018, Shui et al 2018, Mueller et al 2018, Williams et al 2018, Zhou et al 2018, Oldham et al 2018, Zhang et al 2018, Wallace et al 2018, Asadollahfardi et al 2017, Farahani et al 2017, Wang et al 2017, Meo et al 2016, Loo 2017, Banharnsakun 2017, Jovanovic et al 2017, Zhang and Zhang 2017, Olaguer et al 2017, Kambalimath et al 2017, Gao et al 2017, Khan and Pawan 2017, Zeng et al 2017, Popescu et al 2017, Jovanovic et al 2017, Pamucar et al 2016, Leong	56	199	Shepherd et al 2018, Keilsohn et al 2018, Klein et al 2018, Pustkowiak et al 2018, De Palma et al 2017, Moron et al 2017, Cole et al 2017, Chauhan et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Andersson et al 2017 [first time appearing in WoS searches, have this paper from initial search], Shankar et al 2017, Hill and Bartomeus 2016, Herbertsson et al 2016, Hanula et al 2016, Hevia et al 2016, Geslin et al 2016, Smart et al 2016, Heneberg	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/summary.do?product=WOS&parentProduct=WOS&search_mode=GeneralSearch&qid=6&SID=6CYICBEs94iPfwriUHw&page=1&action=changePageSize&pageSize=50; http://apps.webofknowledge.com.prxy4.ursus.maine.edu/summary.do?product=WOS
45	7/5/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	78	78	0	0	0		78	78	Shui et al 2018, Keilsohn et al 2018, Klein et al 2018,	http://apps.webofknowledge.com.
46	7/5/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	15	15	2	Ouin et al 2004, Utschick et al 1992	0		13	15	Cole et al 2017, Kallioniemi et al 2017, Hill and	http://apps.webofknowledge.com.
47	7/5/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND (butterfl* OR moth OR moths) AND (manag* OR conserv* OR enhanc* OR restor*)	144 (missed some in review)	130	57	Grant et al 2018, Viljur and Teder 2018, Riva et al 2018, Haaland 2017, Sybertz et al 2017, Van Halder et al 2017, Villemey et al 2016, Staab et al 2015, Kalarus and Bakowski 2015, Bubova et al 2015, Skorka et al 2015, Whitworth et al 2015, Haaland 2015, Swengel and Swengel 2015, Vu et al 2015, Tanveer et al 2015, Helldin et al 2015, Lee et al 2015, Polic et al 2014, Mueller and Baum 2014, Chong et al 2014, Dymitryzyn 2014, Skorka et al 2013, Jansen et al 2012, Ribiero and Freitas 2012, Lenda et al 2012,	40	Macgregor et al 2017, Blackburn et al 2017, Kajzer-Bonk et al 2016, Bonebrake et al 2016, Saleh et al 2016, Gomez-Zotano et al 2015, Fernandez and Nakamura 2015, Monty et al 2015, Yang et al 2014, Ohwaki et al 2014, Penone et al 2013, Ohsawa et al 2013, Kasson et al 2013, Lee et al 2013, Nagase et al 2013, Dou et al 2013, Flick et al 2012, Andrew et al 2011, Crespo-Perez et al 2011, Jersakova et al 2011, Lees et al 2011, Su et al 2011, Konvicka and Kadlec 2011, Swengel and	33	130	Davis et al 2018, Keilsohn et al 2018, Gardiner et al 2018, Pustkowiak et al 2018, Pitman et al 2018, Lampinen et al 2018, Moron et al 2017, Cole et al 2017, Thogmartin et al 2017, O'Sullivan et al 2017, Andersson et al 2017, Leston and Koper 2017, Kasten et al 2016, Zielin et al 2016, Hanula et al 2016, Berg et al 2016, Dargas et al 2016, Leston and Koper 2016, Halbritter et al 2015, Baxter-Gilbert et al 2015, Fischer et al 2015, Garbuzov et al 2015, Moron et al	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FNGE4Ng4C12EaJmrCo&search_mode=GeneralSearch&prID=f42a6b65-08e2-45bf-83dc-ee391645f304
48	7/5/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND (hoverfl* OR "hover fl*" OR syrphid*) AND (manag* OR conserv* OR enhanc* OR restor*)	9	9	3	Schaffers et al 2012, Gittings et al 2006, Lovei et al 1998	0	0	6	9	Moron et al 2017, Cole et al 2017, Rewicz et al 2017, Moron et al 2014, Van Rossum 2009, Utschick et al 1992	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FNGE4Ng4C12EaJmrCo&search_mode=GeneralSearch&prID=176c1efa-2277-4f26-bf86-0446b8f7f240

49	7/5/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (wasp OR wasps OR sphecid*) AND (manag* OR conserv* OR enhanc* OR restor*)	14	14	1	Piekarska-Boniecka et al 2015	3	McLellan et al 2012, Zaller et al 2009, Kurczewski 1998	10	14	Rewicz et al 2017, Heneberg et al 2017, Andersson et al 2017, Heneberg et al 2016, Neame et al 2013, Srba and Heneberg 2012, Wong and Balshine 2011, Clinebell 2003, Harrison 2001, Orr and Pleasants 1996	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5FNGE4Ng4C12EaJmrCo&search_mode=GeneralSearch&prID=330c0a13-84ca-4f3c-8cd9-f567d5f3de61
50	7/6/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (Hymenoptera OR Lepidoptera) AND (manag* OR conserv* OR enhanc* OR restor*)	108	108	6	Williams 2008, Bianchi et al 2008, Forys et al 2001, Tshiguvho et al 1999, Soroka and Spurr 1998, Liang et al 1997	28	Takasuka et al 2018, Kang et al 2018, Tang et al 2018, Seko et al 2018, Vanthomme et al 2017, Schowalter and Ring 2017, Wang et al 2015, Coulson 2015, Souza-Silva et al 2014, Zakharov and Zakharov et al 2014, Zanuncio et al 2013, Azcarate et al 2013, Wyckhuys et al 2013, Truxa and Fiedler 2012, Crespo-Perez et al 2011, Cho et al 2011, Tanaka et al 2011, Lees et al 2011, Oliviera et al 2011, King et al 2009, Risch et al 2008, Itzhak 2008, Roll et al 2007,	74	108	Grant et al 2018, Pustkowiak et al 2018, Riva et al 2018, Lampinen et al 2018, Sybertz et al 2017, Heneberg et al 2017, Macgregor et al 2017, Andersson et al 2017, Shankar et al 2017, Kajzer-Bonk et al 2016, Bonebrake et al 2016, Geslin et al 2016, Villemey et al 2016, Smart et al 2016, Heneberg et al 2016, Halbritter et al 2015, Bubova et al 2015, Baxter-Gilbert et al 2015, Hatten et al 2015, Fischer et al 2015, Swengel and Swengel 2015, Vu et al 2015, Piekarska-	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7CiBQk6D4mUnOfEHUVb&search_mode=GeneralSearch&prID=61abc10b-9165-4a45-8f12-99906da9a035
51	7/6/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (Apoidea OR Vespoidea OR Papilionoidea) AND (manag* OR conserv* OR enhanc* OR restor*)	11	11	0	0	0	0	11	11	Geslin et al 2016, Halbritter et al 2015, Vu et al 2015, Wagner et al 2014, Carper et al 2014, Berg et al 2013, Watson et al 2011, Wilson et al 2009, Franzen et al 2009, Hopwood 2008, de la Puente Ranea et al 2008	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6DXT66hG58J3phBcEsk&search_mode=GeneralSearch&prID=21b94e4a-0d88-4e08-a28c-d4f0cb7cd2a5

52	7/6/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND "pollinating insects" AND (manag* OR conserv* OR enhanc* OR restor*)	9	9	0	0	0	0	9	9	Sole-Senan et al 2018, Pustkowiak et al 2018, Moron et al 2017, Rewicz et al 2017, Halbritter et al 2015, Baxter-Gilbert et al 2015, Moron et al 2014, Berg et al 2013, Berg et al 2011	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6DXT66hG58J3phBcEsk&search_mode=GeneralSearch&prID=0c5f67c9-b345-4ca0-9151-1a28485d25b0
53	7/6/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND "insect pollinators" AND (manag* OR conserv* OR enhanc* OR restor*)	5	5	0	0	0	0	5	5	Cole et al 2017, Rewicz et al 2017, Kutt et al 2016, Suarez-Esteban et al 2014, Nicholls and Altieri 2013	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6DXT66hG58J3phBcEsk&search_mode=GeneralSearch&prID=fd4d1ab3-31ba-451d-acdf-a4c4bc2f5071
54	7/6/2018	Web of Science	((Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinator* AND (linear OR verge OR *edge* OR margin OR side OR ditch OR embankment OR buffer OR strip OR corridor))	68	68	0	0	0	0	68	68	Klein et al 2018, Fernandes et al 2018, Sole-Senan et al 2018, Pustokowiak et al 2018, Lewis et al 2017, Moron et al 2017, Johnson et al 2017, Cole et al 2017, Moron et al 2017b, Shuttleworth et al 2017, Demarco 2017, Chauhan et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Hill and Bartomeus 2016, Kutt et al 2016, Herbertsson et al 2016, Zielin et al 2016, Hanula et al 2016, Smart et al 2016, Wrzesien et al 2016, Bennie et al 2016, Sydenham et al 2016,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6FexbLp5hZZPjS9AAI7&search_mode=GeneralSearch&prID=452cb61a-bc51-4cf8-8ced-d60a3895ee9a

55	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND (flower* OR flora* OR bloom* OR forag*) AND (vegetation OR resources OR plants OR shrubs OR forbs OR herbs) AND pollinator*	66	66	1	Russell et al 2018	0	0	65	66	Lewis et al 2017, Johnson et al 2017, Cole et al 2017, Shuttleworth et al 2017, Rewicz et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Shankar et al 2017, Kutt et al 2016, Herbertsson et al 2016, Hanula et al 2016, Hevia et al 2016, Geslin et al 2016, Smart et al 2016, Wrzesien et al 2016, Sydenham et al 2016, Wrzesien and Denisow 2016, Greene et al 2015, Halbritter et al 2015, Baxter-Gilbert et al 2015, Hatten et al 2015, Hanley and Wilkins 2015, Sydenham et al 2015,	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7CafGNUVV8npWbNbQmz&search_mode=GeneralSearch&prID=e656d1b4-e218-4cb8-97d4-ebbf9dc71809
56	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND (nest*) AND (vegetation OR resources OR plants OR shrubs OR forbs OR herbs)AND pollinator*	10	10	0	0	0	0	10	10	Russell et al 2018, Hevia et al 2016, Geslin et al 2016, Jackson et al 2014, Carper et al 2014, Neame et al 2013, Srba and Heneberg 2012, Watson et al 2011, Hopwood 2008, Russell et al 2005	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7CafGNUVV8npWbNbQmz&search_mode=GeneralSearch&prID=b8ed43a1-faf2-422f-a181-abb53742636e
57	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND (invasive OR non-native OR native OR naturalized) AND (vegetation OR resources OR plants OR shrubs OR forbs OR herbs) AND pollinator*	24	24	0	0	0	0	24	24	Russell et al 2018, Johnson et al 2017, Moron et al 2017, Shankar et al 2017, Hernandez-Yanez 2016, Hanula et al 2016, Hevia et al 2016, Geslin et al 2016, Wrzesien et al 2016, Sydenham et al 2016, Suarez-Esteban et al 2014, Moron et al 2014, Jakobsson and Agren 2014, Carper et al 2014, Winfree 2013, Berry et al 2013, Lentini et al 2012, Mwangi et al 2012, Jacquemyn et al 2011, Watson et al 2011, Jacquemyn et al 2009, Hopwood 2008, Russell et al	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7CafGNUVV8npWbNbQmz&search_mode=GeneralSearch&prID=86771f4c-f42a-42b8-8aab-7b1bc6d15e2a

58	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinator* AND (meadow OR prairie OR grassland OR pasture OR agriculture OR barren OR shrubland OR scrub)	42	42	0	0	0	0	42	42	Keilsohn et al 2018, Fernandes et al 2018, Pustkowiak et al 2018, De Palma et al 2017, Moron et al 2017, Cole et al 2017, Moron et al 2017b, Heneberg et al 2017, Kallioniemi et al 2017, Calevo et al 2017, Tambarussi et al 2017, Hill and Bartomeus 2016, Hernandez-Yanez et al 2016, Kutt et al 2016, Herbertsson et al 2016, Smart et al 2016, Wrzesien et al 2016, Wrzesien and Denisow 2016, Clermont et al 2015, Hanley and Wilkins	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6Bl1osANuWbji3cucfQ&search_mode=GeneralSearch&prID=e4961d47-0dc0-4b18-a538-5130e9acb1a8
58b	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinator* AND (meadow	7	7	0	0	0	0	7	7	Moron et al 2017, Heneberg et al 2017, Clermont et al 2015, Moron et al 2014	http://apps.webofknowledge.com.prxy4.ursus.main
59	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinator* AND (forest OR woodland OR coniferous OR deciduous OR "early succession*")	37	37	0	0	0	0	37	37	Fernandes et al 2018, Rewicz et al 2017, Heneberg et al 2017, Kallioniemi et al 2017, Tambarussi et al 2017, Hill and Bartomeus 2016, Hanula et al 2016, Wrzesien and Denisow 2016, Clermont et al 2015, Sydenham et al 2015, Wagner et al 2014, Tokumoto et al 2014, Sydenham et al 2014, Jackson et al 2014, Carper et al 2014, Hahn et al 2013, Tokumoto et al 2013, Takano et al 2013, Berry et al 2013, Neame et al 2013, Dyer et al 2012, Mwangi et	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6Bl1osANuWbji3cucfQ&search_mode=GeneralSearch&prID=ab7fb53d-2915-4a96-8457-79c1b7f8e54f
59b	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinator* AND (forest OR woodland OR coniferous OR deciduous OR "early succession*") AND (cover OR "cover type" OR dominan*)	7	7	0	0	0	0	7	7	Heneberg et al 2017, Hanula et al 2016, Clermont et al 2015, Sydenham et al 2015, Carper et al 2014, Dyer et al 2012, Russell et al 2005	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6Bl1osANuWbji3cucfQ&search_mode=GeneralSearch&prID=21b68a0e-0d14-4f39-8f53-c474e506225d

60	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (wetland OR heath OR bog)	1	1	0	0	0	0	1	1	Devall 1992	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6Bl1osANuWbji3cucfQ&search_mode=GeneralSearch&prID=cae56107-a156-4079-ba13-ea0a2421b4b3
61	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (urban* OR impervious)	14	14	0	0	0	0	14	14	Russell et al 2018, De Palma et al 2017, Johnson et al 2017, Moron et al 2017, Hernandez-Yanez et al 2016, Geslin et al 2016, Bennie et al 2016, Clermont et al 2015, Baxter-Gilbert et al 2015, Garbuzov et al 2015, Pellegrino and Bellusci 2014, Carper et al 2014, Neame et al 2013, Van Rossum 2009	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6Bl1osANuWbji3cucfQ&search_mode=GeneralSearch&prID=c064b511-0965-46c4-8d9c-23ad697271b7
61b	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND pollinator* AND (urban* OR impervious) AND (cover OR "cover type" OR dominan*)	4	4	0	0	0	0	4	4	Moron et al 2017, Geslin et al 2016, Clermont et al 2015, Carper et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6Bl1osANuWbji3cucfQ&search_mode=GeneralSearch&prID=f94695c0-2ded-415e-b420-52fb52b6d565

62	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR power li* OR right* of way*) AND bumble* AND (manag* OR conserv* OR enhanc* OR restor*)	19	19	0	0	0	0	19	19	Klein et al 2018, Cole et al 2017, Kallioniemi et al 2017, Hill and Bartomeus 2016, Herbertsson et al 2016, Hatten et al 2015, Hanley and Wilkins 2015, Wagner et al 2014, Carper et al 2014, Meeus et al 2013, Srba and Heneberg et al 2012, Osgathorpe et al 2012, Van Rossum 2009, Jacquemyn et al 2009, Hopwood 2008, Ouin et al 2004, Bhattacharya et al 2003, Clinebell 2003, Utschick et al 1992	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=8BrfAr7Rzg63UOUM3MJ&search_mode=GeneralSearch&prID=7a0715ca-8c43-433c-97c2-a1aee43a6af1
63	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus affinis” OR Rusty* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)	1	1	0	0	0	0	1	1	Wagner et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AiVOPAiT3jp1KT9aXm&search_mode=GeneralSearch&prID=052115e5-ee38-4cac-91ca-c44676323252
64	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR “power li*” OR “right* of way*”) AND (“Bombus ashtoni” OR Ashton* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)	1	1	0	0	0	0	1	1	Wagner et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AiVOPAiT3jp1KT9aXm&search_mode=GeneralSearch&prID=c409ddd5-ddc4-4720-a1c4-dd0c4793d25e

65	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND ("Bombus citrinus" OR Lemon* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AiVOPAiT3jp1KT9aXm&errorQid=6#searchErrorMessage
66	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.
67	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND "Bombus fervidus" AND (manag* OR conserv* OR enhanc* OR restor*)	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AiVOPAiT3jp1KT9aXm&errorQid=10#searchErrorMessage
68	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	2	2	0	0	0	0	2	2	Srba and Heneberg 2012, Clinebell 2003	http://apps.webofknowledge.com.
69	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND "Bombus insularis" AND (manag* OR conserv* OR enhanc* OR restor*)	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=5AiVOPAiT3jp1KT9aXm&errorQid=12#searchErrorMessage

70	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND "Bombus pensylvanicus" AND (manag* OR conserv* OR enhanc* OR restor*)	1	1	0	0	0	0	1	1	Wagner et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AiVOPAiT3jp1KT9aXm&search_mode=GeneralSearch&prID=d358e907-cfe6-4a65-8b5a-dc4a20da1018
71	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.
72	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND("Bombus terricola" OR Yellow* AND bumble*) AND (manag* OR conserv* OR enhanc* OR restor*)	1	1	0	0	0	0	1	1	Wagner et al 2014	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=5AiVOPAiT3jp1KT9aXm&search_mode=GeneralSearch&prID=31baad53-2d19-40fb-9d32-03b167dcdd09
73	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND Bombus AND (manag* OR conserv* OR enhanc* OR restor*)	11	11	0	0	0	0	11	11	Kallioniemi et al 2017, Hill and Bartomeus 2016, Herbertsson et al 2016, Hatten et al 2015, Wagner et al 2014, Srba and Heneberg 2012, Osgathorpe et al 2012, Hopwood 2008, Ouin et al 2004, Bhattacharya et al 2003, Clinebell 2003	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7E8yx5ZM87mbpv2HvEy&search_mode=GeneralSearch&prID=53c27012-9606-4689-86d0-66bd06afe6f1
74	7/17/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	11	11	1	Weston et al 2005 [rejected in previous searches]	0	0	10	11	Davis et al 2018, Grant et al 2018, Pitman et al 2018,	http://apps.webofknowledge.com.

75	7/18/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND ("Lycaena dorcas claytoni" OR "Clayton* copper" AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=7C3lM5ChIO5kiF9GfvI&errorQid=1#searchErrorMessage
76	7/18/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	1	1	0	0	0	0	1	1	Ries and Debinski 2001	http://apps.webofknowledge.com.
77	7/18/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*")	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.
78	7/18/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND ("Lycaeides melissa samuelis" OR "Karner blue" AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)	6	6	0	0	0	0	6	6	Bennett et al 2013, Forrester et al 2005, Lowell and Lounsbury 2002, Smallidge and Leopold 1997, Smallidge et al 1996, Swengel 1996	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7C3lM5ChIO5kiF9GfvI&search_mode=GeneralSearch&prID=f89838a4-7372-43dc-a0a1-67ea2f5ce7c4
79	7/18/2018	Web of Science	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND ("Papilio brevicauda" OR "Short-tailed swallowtail" AND butterfl*) AND (manag* OR conserv* OR enhanc* OR restor*)	0	0	0	0	0	0	0	0	0	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=7C3lM5ChIO5kiF9GfvI&errorQid=8#searchErrorMessage

80	8/21/2018	Google Scholar	(Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*)	7180; checked first 50	50	5	Waser et al 2017, Nabhan 2001, Senapathi et al 2017, Goodell et al 2010, Totland et al 2005	39	7 abstracts read; others rejected by title	6	50	Hevia et al 2016, O'Sullivan et al 2017, Fernandes et al 2018, Nicholls and Altieri 2013, Fekete et al 2017, Gardiner et al 2018	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28Road*+OR+rail*+OR+powerli*+OR+%E2%80%9Cpower+li*%E2%80%9D+OR+%E2%80%9Cright*+of+way*%E2%80%9D%29+AND+pollinators+AND+%28manag*+OR+conserv*+OR+enhanc*+OR+restor*%29&btnG=
81	8/21/2018	Google Scholar	road pollinators	23200	50	0	N/A	0	N/A	50	50	N/A	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=road+pollinators&btnG=
82	8/21/2018	Google Scholar	(road OR roadside OR "road shoulder" OR highway) (pollinators OR bee OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	329000	50	11	Swengel and Swengel 2007, Feber and Smith 1995 (preview), Colla et al 2006, Sparks et al 1996, Decourtye et al 2010, Samways et al 1997, Dover and Sparks 2000, Huntzinger 2003, Greatorex-Davies et al 1993, Feber et al 1996, Valtonen et al 2006	27	New et al 1995, Williams and Osborne 2009, Pollard and Yates 1994, Bee et al 2007, Balmer and Erhardt 2000, Noss 1987, Buchmann 1996, Dicks et al 2010, Brown and Paxton 2009, Swengel 2001, Allen-Wardell et al 1998, Simberloff and Cox 1987, Goulson et al 2008, Van Swaay 2002, Syed 1992, Fussell and Corbet 1992, Pullin 2012, Soberon et al 2000, Wenzel et al 2006, Menz et al 2011, Redpath et al 2010, Goulson et al 2015, Doane and McManus 1981,	12	50	Hopwood 2008, Ries et al 2001, Noordijk et al 2009, Bhattacharya et al 2003, Saarinen et al 2005, Munguira and Thomas 1992, Ouin et al 2004, Valtonen et al 2006, Tshiguhvo et al 1999, Skorka et al 2013, Smallidge and Leopold 1997, Wynhoff et al 2011,	https://scholar.google.com/scholar?as_vis=1&q=%E2%80%A2%09(road+OR+roadside+OR+%E2%80%9Croad+shoulder%E2%80%9D+OR+highway)+(pollinators+OR+bee+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+Hymenoptera+OR+Lepidoptera)+(management+OR+conservati

83	8/22/2018	Google Scholar	(rail OR railway OR railways OR railroad OR railroads) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	114000	50	11	Warren 1987, Brown and Freitas 2002, Sparks and Parish 1995, Wagner et al 2003, Richards and Kevan 2002, Sutcliffe and Thomas 1996, Haaland et al 2011, Angold et al 2006, Jarosik et al 2011, Krauss et al 2009, Penone et al 2012	28	Warren 1993, Thomas et al 2009, Pyle 1976, Oostermeijer and Van Swaay 1998, Gathmann and Tscharntke 2002, New 2004, Van Dyck et al 2009, Thomas et al 2011, Nowicki et al 2005, Vanbergen et al 2013, Pyle et al 1981, Dennis et al 2013, Aizen and Feinsinger 1994, Osborne et al 1999, Emmel et al 1990, Kevan 1999, Liebhold et al 1992, Van Swaay et al 2015, Brown Jr 1991, Kevan et al 1990, Tscharntke et al 1998, Kreyer et al 2004, O'Dwyer and Attiwill 1999, Hennig	11	50	Bhattacharya et al 2003, Hopwood 2008, Pollard and Yates 1994, Allen-Wardell et al 1998, Moron et al 2014, Decourtye et al 2010, Konvicka and Kadlec 2011, Russell et al 2005, Noordijk et al 2009, Davis et al 2007, Valtonen et al 2007	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28rail+OR+railway+OR+railways+OR+railroad+OR+railroads%29+%28pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera%29+%28management
84	8/23/2018	Google Scholar	(powerline OR powerlines OR “power line” OR “power lines”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	14500	50	7	Swengel and Swengel 1997, van Halder et al 2007, Haas et al 2005, Wagner and Ascher 2008, Goosem 2004, Saarinen et al 2005, van Halder et al 2011	12	Peters et al 2013, Moron et al 2009, Ockinger et al 2009, Potts et al 2003, Swengel and Swengel 2001, Swengel et al 2011, Moron et al 2008, Schweitzer et al 2012, Haack 1993, Gibbs and Sheffield 2009, Ellis et al 2012, Williams 2008	31	50	Hopwood 2008, Ockinger and Smith 2007, Russell et al 2005, Forrester et al 2005, Dicks et al 2010, Berg et al 2013, Swengel and Swengel 2007, Aizen and Feinsinger 1994, Komonen et al 2013, Smallidge and Leopold 1997, Gathmann and Tscharntke 2002, Wojcik and Buchmann 2012, Black et al 2011, Berg et al 2011, Wagner et al 2003, Berg et al 2016, Saarinen et al 2005, Lensu et al 2011, Eldegard et al 2015, Dennis et al 2013, Sydenham et al 2016, Kevan et al 1990,	https://scholar.google.com/scholar?hl=en&as_sdt=1%2C10&as_vis=1&q=%28powerline+OR+powerlines+OR+%E2%80%9Cpower+line%E2%80%9D+OR+%E2%80%9Cpower+lines%E2%80%9D%29+%28pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR

85	8/23/2018	Google Scholar	("transmission line" OR "transmission lines") (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	10700	50	8	Arnold 1993, Bramble et al 1997, Vaughan et al 2007, Gobeil and Gobeil 2014, Genua 2004, Parry et al 2004, Scott 1999, van der Merwe and Cook 2012	31	Idris et al 2009, Rahim et al 2010, Rahim et al 2010b, Deb et al 2012, Idris et al 2009 again, Harrison et al 2008, Deb et al 2016, Thangalakshmi et al 2013, Idris et al 2010, Saranya et al 2015, Deb et al 2013, Minhat et al 2012, Verma et al 2016, Pravallika et al 2016, Lenin et al 2014, Saurabh et al 2017, Minhat et al 2014, Idris et al 2010, Shayeghi et al 2012, Pandiarajan et al 2013, Valsalal et al 2016, Yavarian et al 2013, Thangalakshmi and Valsalal 2014, Mugiira	11	50	Smallidge et al 1996, Wojcik and Buchmann 2012, Wagner et al 2014, Wagner et al 2014b, Hill and Bartomeus 2016, Leston and Koper 2016, Lanham and Whitehead 2011, Russell et al 2005, Russell et al 2018, Leston and Koper 2017, Hill and Bartomeus 2015 (2016 preprint),	https://scholar.google.com/scholar?start=0&q=+(%E2%80%9Ctransmission+line%E2%80%9D+OR+%E2%80%9Ctransmission+lines%E2%80%9D)+(pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera)+(manag
86	8/23/2018	Google Scholar	("right of way" OR "rights of way" OR "right of ways") (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	14800	50	10	Yahner 2004, Goodrich-Mahoney et al 2004, Viljur and Teder 2016, Opler 1981, Lentz and Christianson 2011, Rudd et al 2002, Huijser and Clevenger 2006, Dillon 2010, Rudolph et al 2006, Isibister 2016	13	Collins 1987, Collinge et al 2003, Yahner 2001, Krauss and Steffan-Dewenter 2003, Williams 2008, Pickens and Root 2008, Simpson et al 2009, Flockhart et al 2015, Durkin 2009, Keller and Yahner 2002, Alcock et al 2016, Burt 2012, McIntyre and Barrett 1992	27	50	Smallidge et al 1996, Russell et al 2005, Wojcik and Buchmann 2012, Forrester et al 2005, Smallidge and Leopold 1997, Wagner et al 2014, Davis et al 2007, Bramble et al 1997, Thogmartin et al 2017, Lensu et al 2011, Hopwood et al 2015, Fischer et al 2015, Wagner et al 2008, Berg et al 2016, Hopwood 2013, Russell et al 2001, Williams 2008, Wojcik and Buchmann 2012 (again), Leston and Koper 2016, McCleery et al 2015, Lucey and Barton 2011, Hopwood	https://scholar.google.com/scholar?as_vis=1&q=(%E2%80%9Cright+of+way%E2%80%9D+OR+%E2%80%9Crights+of+way%E2%80%9D+OR+%E2%80%9Cright+of+ways%E2%80%9D)+(pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hyme
104	8/19/2019	Web of Science	((Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*))	95	95	12	Phillips et al 2019, Nooten and Rehan 2019, Seitz et al 2019, Dee et al 2019, Wagner et al 2019, Hall et al 2019, Westerfelt et al 2018, Martin et al 2018, Nagase et al 2018, Jachula et al 2018, Abi-Akar et al 2018, Kutt et al 2016	7	Garcia-Fernandez et al 2019, Tracy et al 2019, Richardson et al 2019, Ruppert et al 2019, Hall 2018, de la Pena et al 2018, Sanderson 2016	76	95	Russell et al 2018, Davis et al 2018, Klein et al 2018…Kutt et al previously rejected but saved this time	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=6C9i9AgjYMJeLEjImxl&search_mode=GeneralSearch&prID=b06d3adf-55a5-4a1e-bf5c-39616ad060e8

105	9/10/2019	Web of Science	((Road* OR rail* OR powerli* OR "power li*" OR "right* of way*") AND pollinators AND (manag* OR conserv* OR enhanc* OR restor*))	95	95	0		0		95	95	95	http://apps.webofknowledge.com.prxy4.ursus.maine.edu/Search.do?product=WOS&SID=7EDZyFSYTe9pHSohZVx&search_mode=GeneralSearch&prID=fa3dfac4-0686-410c-87c3-ca64cbcd67ae
106	9/10/2019	Google Scholar	(road OR roadside OR "road shoulder" OR highway) (pollinators OR bee OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	401000	50	3	Conradt et al 2001, Orlowski 2008, Severns 2007	11	Aviron et al 2007, Launer and Murphy 1994, Emmel and Austin 1990, Pleasants 2017, Brower et al 2011, Weiss and Murphy 1990, Hall et al 2017, Fussell and Corbet 1992, Collins 2012, Sparrow et al 1994, Ramirez et al 2003	36	50	Hopwood et al 2008, Ries et al 2001, Noordijk et al 2009, Bhattacharya et al 2003, Saarinen et al 2005, New et al 1995, Munguira et al 1992, Tshiguvho et al 1999, Williams and Osborne 2009, Valtonen et al 2006, Wynhoff et al 2011, Valtonen et al 2006, Skorka et al 2013, Decourtye et al 2010, Samways et al 1997, Huntzinger 2003, Ouin et al 2004, Smallidge and Leopold 1997, Colla et al 2006, Syed 1992, Feber and Smith 1995, Pullin 2012, Hanley and Wilkins 2015,	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28road+OR+roadside+OR+%E2%80%9Croad+shoulder%E2%80%9D+OR+highway%29+%28pollinators+OR+bee+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+Hymenoptera+OR+Lepidoptera%29+%28management
106b	9/10/2019	Google Scholar	(road OR roadside OR "road shoulder" OR highway) (pollinators OR bee OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration) **SINCE 2018**	17000	50	19	Kantola et al 2019, Mora Alvarez et al 2019, Wigginton and Meyerson 2018, Soper et al 2019, Franklin 2018, Daniels et al 2018, Kaul and Wilsey 2019, Ghesini et al 2018, Chong et al 2019, Habel et al 2018, Campanelli et al 2019, Jakobsson et al 2018, Roberts and Phillips 2019, Paterson et al 2019, Hall and Steiner 2019, Kim and Kwon 2018, Swengel and Swengel 2018, Montejo-Kovacevich et al 2018, Wix et al 2019	22	Grant and Bradbury 2019, Schultz et al 2019, Girardello et al 2019, Fattorini et al 2017, Guthrie and Oswald 2018, Larsen et al 2018, Knight et al 2018, van Langevelde et al 2018, Malcolm 2018, Cunningham et al 2019, Johansen et al 2019, Sielezniew et al 2019, Sing et al 2019, Motlep et al 2018, Kral et al 2018, Happe et al 2018, Baldock et al 2019, Rivers et al 2018, Woodrow et al 2018, Williams et al 2018, Penn et al 2019, Mohammadi et al 2018	9	50	Davis et al 2018, Keilsohn et al 2018, Weiss 2018, Pitman et al 2018, Leonard et al 2018, Gardiner et al 2018, Riva et al 2018, Tracy et al 2019, Fernandes et al 2018	https://scholar.google.com/scholar?as_ylo=2018&q=(road+OR+roadside+OR+%E2%80%9Croad+shoulder%E2%80%9D+OR+highway)+(pollinators+OR+bee+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+Hymenoptera+OR+Lepidoptera)+(management+OR+conservation+OR+enha

107	9/10/2019	Google Scholar	(rail OR railway OR railways OR railroad OR railroads) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	127000	50	4	Vandevelde et al 2012, Thomas 1983 (no access), Van Swaay 2003, Westrich 1996	9	Rands and Sotherton 1986, Warren 1993, Hines and Hendrix 2005, Potts et al 2005, Konvicka et al 2006, Cheshire 1888, Pyle et al 1981, Ahrne et al 2009, Dennis and Thomas 2000	37	50	Bhattacharya et al 2003, Hopwood 2008, Moron et al 2014, Thomas et al 2009, Ries et al 2001, Pyle 1976, Gathmann and Tscharntke 2002, Allen-Wardell et al 1998, Warren 1987, Hennig and Ghazoul 2012, Van Dyck et al 2009, Kalarus et al 2015, Pollard and Yates 1994, Sparks and Parish 1995, Konvicka and Kadlec 2011, Liebhold et al 1992, Decourtye et al 2010, Bubova et al 2015, Davis et al 2008, Russell et al 2005, Warren 1993, Haaland et al 2011, Thomas et al 2011,	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28rail+OR+railway+OR+railways+OR+railroad+OR+railroads%29+%28pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera%29+%28management
107b	9/11/2019	Google Scholar	(rail OR railway OR railways OR railroad OR railroads) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration) **SINCE 2018**	8790	50	6	Barrientos et al 2019, Kajzer-Bonk et al 2019, Haan and Landis 2019, Swengel and Swengel 2013, Skorka et al 2018, Morrison 2018	33	Wang et al 2018, Leong et al 2019, Qin et al 2019, Langellotto et al 2018, Spivak et al 2019, Turo and Gardiner 2019, Franklin et al 2019, Kawahara et al 2018, Stewart et al 2018, Nikolic et al 2019, New 2018, Hughes 2018, Kadej and Tarnawski 2018, Basselot et al 2019, Freeborough et al 2019, Twerd et al 2018, Guzman et al 2019, Eggenberger et al 2019, Frankie et al 2019, Vossler 2019, Coster et al 2019, O'Neill and Montgomery 2018, Bee et	11	50	Abi-Akar et al 2018, Gardiner et al 2018, van Langevelde et al 2018, Pustkowiak et al 2018, Schultz et al 2019, Baldock et al 2019, Ghesini et al 2018, Grant et al 2018, Phillips et al 2019, Sielezniew et al 2019, Roberts and Phillips 2019	https://scholar.google.com/scholar?as_ylo=2018&q=(rail+OR+railway+OR+railways+OR+railroad+OR+railroads)+(pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera)+(management+OR+conservation+OR+enha

108	9/11/2019	Google Scholar	(powerline OR powerlines OR "power line" OR "power lines") (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	16200	50	2	Wahlberg et al 2002, Hollmen et al 2008	7	Bergmann et al 2004, Tuell and Issacs 2009, Eskov 1990, Swengel 1998, Han et al 2014, Woodcock et al 2016, Kaiser-Bunbury et al 2017	41	50	Russell et al 2005, Forrester et al 2005, Berg et al 2013, Hopwood 2008, Komonen et al 2013, Berg et al 2016, Wojcik et al 2012, Black et al 2011, Lensu et al 2011, Dicks et al 2010, Sydenham et al 2016, Wagner and Ascher 2008, Berg et al 2011, Smallidge and Leopold 1997, Schweitzer et al 2012, Hanula et al 2016, Thogmartin et al 2017, Haas et al 2005, Eldegard et al 2015, Swengel and Swengel 1997, Saarinen et al 2005, Russell et al 2018, Hopwood 2013, Hill and Bartomeus	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28powerline+OR+powerlines+OR+%E2%80%9Cpower+line%E2%80%9D+OR+%E2%80%9Cpower+lines%E2%80%9D%29+%28pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+
108b	9/11/2019	Google Scholar	(powerline OR powerlines OR "power line" OR "power lines") (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration) **SINCE 2018**	1340	50	16	Lindholm et al 2019, McPhail 2018, Milam et al 2018, Sydenham et al 2018, Ohwaki et al 2018b, Coban et al 2019, Biasotto and Kindel 2018, Knight et al 2019, Leston and Koper 2019, Swengel and Swengel 2000, Vanbergen et al 2019, Unterweger et al 2018, Swengel and Swengel 2018, Craig 2018, Riva et al 2018b, Riva 2019	18	Ohwaki et al 2018, Wojcik et al 2018, Parsons 2019, Bergman et al 2018, Wang et al 2018, Odemer and Odemer 2019, Ockinger et al 2018, Taki et al 2018, Verma et al 2018, Rajagopalan et al 2018, Li et al 2018, Bamford 2019, Herold and McCracken 2018, Du Clos 2019, Schmolke et al 2019, Greenslit 2018, Hanevik 2018, Swengel and Swengel 1999	16	50	Russell et al 2018, Abi-Akar et al 2018, Lampinen et al 2018, Wagner et al 2019, Steinert and Moe 2018, Gardiner et al 2018, Sielezniew et al 2019, Tonietto et al 2018, Seitz et al 2019, Turo and Gardiner 2019, Shepherd et al 2018, Viljur and Teder 2018, Riva et al 2018, Pustkowiak et al 2019, Villemey et al 2018, New 2018	https://scholar.google.com/scholar?as_ylo=2018&q=(powerline+OR+powerlines+OR+"power+line"+OR+"power+lines")+(pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera)+(management+OR+conservation

109	9/11/2019	Google Scholar	(“transmission line” OR “transmission lines”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	13700 (short one on reviewed list)	49	1	Bindokas et al 1989 (citation)	32	Rahim et al 2010, Rahim et al 2010b, Deb et al 2012, Yavarian et al 2013, Verma et al 2016, Idris et al 2009, Idris et al 2009, Pravallika and Rao 2016, Thangalakshmi et al 2013, Idris et al 2010, Deb et al 2013, Idris et al 2010, Peesapati et al 2018, Choudekar et al 2016, Yusoff et al 2017, Deb et al 2015, Saranya et al 2015, Kwannetr et al 2010, Kondo et al 2002, Saurabh and Gupta 2017, Minhat et al 2012, Ebrahim et al 2018, Lenin et al 2014, Adaryani	16	49	Wojcik and Buchmann 2012, Wagner et al 2014, Wagner et al 2014b, Leston and Koper 2017, Russell et al 2005, Smallidge et al 1996, Komonen et al 2013, Bramble et al 1997 (came up twice), Hill and Bartomeus 2016, Russell et al 2018, Vaughan et al 2007, Wagner et al 2019, Williams 2008, Goodrich-Mahoney et al 2011, Leston and Koper 2016	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28%E2%80%9Ctransmission+line%E2%80%9D+OR+%E2%80%9Ctransmission+lines%E2%80%9D%29+%28pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+O
109b	9/11/2019	Google Scholar	(“transmission line” OR “transmission lines”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration) **SINCE 2018**	1470	50	3	Thorne 2018, IL DNR 2018 (ComEd Transmission Line Plan), Bowers 2018	40	Sharma et al 2019, Peesapati et al 2018, Venkatraman et al 2018, Srivastava et al 2018, Sharma et al 2018, Nagi and Kaur 2018, Ebrahim et al 2018, Rajagopalan et al 2018, Ragaleela et al 2019, Wang et al 2018, Durkovic et al 2020, Reddy et al 2019, Arzeha 2018, Xu et al 2018, Sankaramurthy et al 2019, Kapoor et al 2019, Borkar et al 2018, Dawn and Gope 2018, Salkuti et al 2019, Abu Talib et al 2018, Srinivasulu et al 2018, Mishra et al 2018, Bagheri	7	50	Wagner et al 2019, Russell et al 2018, Gardiner et al 2018, Leston and Koper 2019, Odemer and Odemer 2019, Shepherd et al 2018, Vanbergen et al 2019	https://scholar.google.com/scholar?as_ylo=2018&q=(%E2%80%9Ctransmission+line%E2%80%9D+OR+%E2%80%9Ctransmission+lines%E2%80%9D)+(pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera)+(man

110	9/11/2019	Google Scholar	(“right of way” OR “rights of way” OR “right of ways”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration)	15500	50	2	Caldwell 2019, Bleser and Swengel 1993 (citation)	6	Collins 1987, Rudd et al 2002, Krauss et al 2003, Leon-Cortes et al 2000, Landis 2017, Collinge et al 2003	42	50	Smallidge et al 1996, Wojcik and Buchmann 2012 (twice), Russell et al 2005, Ries and Debinski 2001, Thogmartin et al 2017, Hopwood et al 2015, Wagner et al 2014, Forrester et al 2005, Smallidge and Leopold 1997, Lensu et al 2011, Bramble et al 1997, Pyle 1976, Huijser and Clevenger 2006, Komonen et al 2013, Fischer et al 2015, Hopwood et al 2016, Leston and Koper 2017, Yahner 2001, McCleery et al 2015, Davis et al 2007, Berg et al 2016,	https://scholar.google.com/scholar?hl=en&as_sdt=0%2C10&q=%28“right+of+way”+OR+“rights+of+way”+OR+“right+of+ways”%29+%28pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+Hymenoptera+OR+Lepidoptera%29+%28manageme
110b	9/11/2019	Google Scholar	(“right of way” OR “rights of way” OR “right of ways”) (pollinators OR bee OR bees OR bumblebee OR bumblebees OR butterfly OR butterflies OR moth OR moths OR Hymenoptera OR Lepidoptera) (management OR conservation OR enhancement OR restoration) **SINCE 2018**	812	50	10	Entsminger et al 2019, Miller et al 2018, Swengel and Swengel 2005, Mollet 2019, Daniels K et al 2018 (listed twice), Terry 2018, Kuder 2019, Jorgensen et al 2019, Booth 2018, Eskew 2018	13	Majewska and Altizer 2019, Tzortzakaki et al 2019, Zarrillo and Stoner 2019, Sheffield and Heron 2018, Stein 2018, Forister et al 2019, Collado et al 2019, Siebert et al 2018, Prendergast 2018, NL Beekeepers 2019, Warziniack et al 2018, Gaines 2018, Blackmore 2019	27	50	Abi-Akar et al 2018, Gardiner et al 2018, Leston and Koper 2019, Russell et al 2018, Hall et al 2019, Wagner et al 2019, McPhail 2018, Knight et al 2019, Haan and Landis 2019, Thorne 2018, Viljur and Teder 2018, Swengel and Swengel 2018, Bowers 2018, Daniels J et al 2018, Daniels K et al 2018 Soper et al 2019, Ford 2018, Roberts ahd Phillips 2019, Craig 2018, Wigginton and Meyerson 2018, Herold and McCracken 2018, Lindholm et al 2019, Campanelli et al	https://scholar.google.com/scholar?as_ylo=2018&q=(%E2%80%9Cright+of+way%E2%80%9D+OR+%E2%80%9Crights+of+way%E2%80%9D+OR+%E2%80%9Cright+of+ways%E2%80%9D)+(pollinators+OR+bee+OR+bees+OR+bumblebee+OR+bumblebees+OR+butterfly+OR+butterflies+OR+moth+OR+moths+OR+H
					3000	291		707		2002	3000		

number	reference	author/organization	type	source type	year	DOI/web address	search keyword combination	search #	organism	ROW type	dependent var	independent var	Comparators	Study approach	Summary Points	Obs vs Exp	Conservation or Mngmt?	Keywords	country	region	language	narrative synthesis	meta-analysis	bias (?)
GO0018	Pollinator Conservation at 60 MPH	The Xerces Society	blog post	NGO	2017	https://xerces.org/2017/03/12/pollinator-conservation-at-60-mph/	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes potential of roadside habitat management for pollinators; shows photos of a project in North Carolina	N/A	Both	N/A	USA	throughout (highlights NC)	Eng	Y	N	N/A
GO0019	Public Roads - Save the bees and butterflies!	US DOT Federal Highway Administration	blog post	gov't agency (federal)	2017	https://www.fhwa.dot.gov/publications/publicroads/17sept/01.cfm	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes best management practices developed by FHWA, how they benefit pollinators, and why pollinator habitat management is importan	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0020	Major Threats to Pollinators	Great Pollinator Project	blog post	NGO	2014	http://greatpollinatorproject.org/conservation/major-threats-to-pollinators	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Mentions habitat fragmentation by roads as detrimental to pollinator populations	N/A	Conservation	N/A	USA	throughout	Eng	Y	N	N/A

GO0023	Can cities save bees?	The Nature of Cities	blog post	NGO	2016	https://www.thenatureofcities.com/2016/01/20/can-cities-save-bees-how-can-urban-habitats-be-made-to-serve-pollinator-conservation-how-can-that-	"road" conservation pollinator	88b	bees	roadsides	N/A	N/A	N/A	N/A	A collection of short articles from academics, beekeepers, conservationists, and managers about the role urban restoration can	N/A	Conservation	N/A	global	throughout	Eng	Y	N	N/A
GO0025	Habitat Restoration	Great Pollinator Project	blog post	NGO	2014	http://greatpollinatorproject.org/management/habitat-restoration	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes potential of roadsides as pollinator habitat given proper management	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0036	Protecting Pollinators: on the road for Pollinators	SeedWorld	blog post	private entity	2018	https://seedworld.com/on-the-road-for-pollinators/	road enhancement pollinator	90	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Describes the Syngenta summer tour along I-35, features some of the professionals they met with and projects they toured	N/A	Both	N/A	USA	Central (TX, OK, KS, IA, MN)	Eng	Y	N	N/A

GO0038	Can the Monarch Highway Help Save a Butterfly Under Siege?	Yale Environment360	blog post	University	2017	https://e360.yale.edu/features/can-the-monarch-highway-help-save-a-butterfly-under-siege	road management butterflies	93	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Describes the monarch highway, the history of its development, and reviews a number of relevant roadside studies.	N/A	Both	N/A	global	throughout	Eng	Y	N	N/A
GO0049	Railway lines serve as corridors for pollinators	Conservation Corridor	blog post	NGO	2017	https://conservationcorridor.org/2017/09/railway-lines-serve-as-corridors-for-pollinators/	rail management pollinator	98	Pollinators	railways	N/A	N/A	N/A	N/A	describes study by Moron et al (2017) of pollinator habitat resources along railway embankments	N/A	Both	N/A	Poland	Krakow	Eng	Y	N	N/A
GO0050	How the railway can help bees and insect pollinators	Mike O'Connor	blog post	blogger	2018	https://www.linkedin.com/pulse/how-railway-can-help-bees-insect-pollinators-mike	rail management pollinator	98	bees	railways	N/A	N/A	N/A	N/A	Reviews (but doesn't cite) studies on railway habitat for pollinators, lists management strategies, and gives examples of	N/A	Both	N/A	England	throughout	Eng	Y	N	N/A
GO0062	Belmont Pollinator Garden	Village of Downers Grove, IL	blog post	gov't agency (city)	2018	http://www.downers.us/top-stories/2018/05/15/belmont-pollinator-garden	"rail" conservation pollinator	99	Pollinators	railways, roadsides	N/A	N/A	N/A	N/A	Describes a local garden established around an underpass and links to a monarch corridor along a nearby railroad	N/A	Both	N/A	USA	Illinois	Eng	Y	N	N/A

GO0065	A Bold Plan for Saving Pollinators	American Society of Landscape Architects	blog post	NGO	2015	https://dirt.asla.org/2015/06/25/a-bold-plan-for-saving-pollinators/	rail restoration pollinator	100	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes a meeting held with the Pollinator Partnership; discusses federal legislation on roadside pollinator habitat	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0068	How we're working with nature	Network Rail	blog post	gov't agency (federal)	N/A	https://www.networkrail.co.uk/communities/environment/sharing-railway-wildlife/how-were-working-with-nature/	rail management butterflies	102	large blue butterfly	railways	N/A	N/A	N/A	N/A	Describes a partnership with Butterfly Conservation UK to create habitat for the rare large blue butterfly	N/A	Both	N/A	UK	Somerset	Eng	Y	N	N/A
GO0069	Managing railways and habitats	Network Rail	blog post	gov't agency (federal)	N/A	https://www.networkrail.co.uk/managing-railways-habitats/	rail management butterflies	102	wildlife	railways	N/A	N/A	N/A	N/A	General information and motivations behind wildlife habitat management along rail greenways; links to management documents	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A

GO0081	What's the Buzz about pollinators and roadsides?	Minnesota Department of Natural Resources and The Xerces Society	brochure	NGO and gov't agency (state)	N/A	https://files.dnr.state.mn.us/assistance/nrplanning/community/roadsidesforwildlife/beesforroadsides.pdf	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes habitat potential, restoration, benefits, and threats, links to further information, and management tips for roadside habitats	N/A	Both	N/A	USA	Minnesota	Eng	Y	N	N/A
GO0093	Managing Transport Corridors for Pollinators	Buglife	brochure	NGO	N/A	https://www.buglife.org.uk/sites/default/files/Transport%20Corridors%20Pollinator%20Sheet%20Final_1.pdf	road management pollinator	87	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Describes importance of transport corridors, habitat features for pollinators, and how to establish and manage habitat: improve soil, remove	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A
GO0122	Butterflies in towns and cities: Guidelines for managing urban habitats for butterflies	Butterfly Conservation UK	brochure	NGO	N/A	https://butterfly-conservation.org/files/habitat-towns-and-cities.pdf	road management butterflies	93	butterflies	hedgerows, road verges, and field margins	N/A	N/A	N/A	N/A	Provides management guidelines for hedgerows and field margins/roadsides, including pruning methods and timing.	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A

GO0136	Local Lepidoptera: Biodiversity Action for Butterflies and Moths.	Butterfly Conservation UK	brochure	NGO	N/A	https://butterfly-conservation.org/files/lbap_pages.pdf	road management lepidoptera	96	Lepidoptera	roads	N/A	N/A	N/A	N/A	Lists the Dingy Skipper as a roadside-dwelling species of concern. Management--mowing once a year--encourages growth of it's	N/A	Both	N/A	UK	Northern Ireland	Eng	Y	N	N/A
GO0187	Grizzled Skipper	Butterfly Conservation UK	brochure	NGO	N/A	https://butterfly-conservation.org/sites/default/files/habitat-grizzled-skipper.pdf	rail management butterflies	102	Grizzled skipper	railway	N/A	N/A	N/A	N/A	A threatened butterfly species has most of its existing habitats along railways; this asks citizens to monitor these sites and perhaps	N/A	Both	N/A	UK	Eastern	Eng	Y	N	N/A
GO0126	Inviting butterflies into your garden	National Garden Clubs, Inc.	bulletin	NGO	2017	http://gardenclub.org/resources/projects/ngc-inviting-butterflies-into-your-garden.pdf	road management butterflies	93	butterflies	roadsides, gardens	N/A	N/A	N/A	N/A	Mentions roadsides and power line ROW as butterfly habitat, suggests adding signage to educate the public. Also mentions roadside	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A

GO0181	Councils: actions to help pollinators. The All-Ireland Pollinator Plan	National Biodiversity Data Centre	bulletin	NGO	N/A	https://www.biodiversityireland.ie/wordpress/wp-content/uploads/Pollinator-Council-Guide-FINAL.pdf	rail enhancement pollinator	101	Pollinators	roadsides	N/A	N/A	N/A	N/A	Has a really interesting infographic to help county and city councils (local governing boards) to enhance pollinator habitat, including roadside	N/A	Conservation	N/A	Ireland	throughout	Eng	Y	N	N/A
GO0190	Grizzled Skipper Species Action Plan	Worcestershire Biodiversity Partnership	bulletin	NGO	2008	https://www.worcestershire.gov.uk/downloads/file/10864/s22_grizzled_skipper_species_action_plan	rail management butterflies	102	Grizzled skipper	railways	N/A	N/A	N/A	N/A	Detailed descriptions of railway habitat for Grizzled Skipper and conservation work done to reduce scrub encroachment, which is eliminati	N/A	Both	N/A	UK	Worcestershire	Eng	Y	N	N/A
GO0145	Valtonen, A. 2006. Roadside environments as habitats for Lepidoptera. PhD Dissertation, University of Joensuu, Finland. 119 pp.	Anu Valtonen, University of Joensuu	dissertation	University	2006	http://epublications.uef.fi/pub/urn_isbn_952-458-880-3/urn_isbn_952-458-880-3.pdf	road management lepidoptera	96	Lepidoptera	roadsides	abundance, species richness, diversity	roadside surroundings, habitat type (road, managed grassland, fields)	habitat characteristics, landscape context	field study	Abundance and richness higher along rural roads than urban roads and in semi-natural grassland over roads. Nectar abundan	Observational	Management	alternative habitat, butterflies, communities, diversity, grassland species, intersections, invasive species, moths, mowing management, road verges, species	Finland	Southern	Eng	Y	N	N/A

GO0046	Insect Conservation and Urban Environments	Tim R. New	ebook	private entity	2015	10.1007/978-3-319-21224-1	road management lepidoptera	96	Insects	Open space, roadsides	N/A	N/A	N/A	N/A	Describes urban open spaces and their threats/habitat resource potential to insects, including pollinators	N/A	Conservation	N/A	global	throughout	Eng	Y	N	N/A
GO0085	Vegetation Management Practices to Increase and Enhance Roadside Pollinator and Wildlife Habitat: Literature Search	Minnesota Department of Transportation	internal document	gov't agency (state)	2017	https://www.dot.state.mn.us/research/RFP/Lit/LS-505.pdf	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	List of 20 document titles, abstracts, and links on pollinator habitat management along roadsides. Many of these did not come up in my lit search; this	N/A	Both	N/A	USA	Minnesota	Eng	Y	N	N/A
GO0089	Identifying programs, funding, and partner roles for Minnesota pollinator habitat	Minnesota Board of Water and Soil Resources	internal document	gov't agency (state)	N/A	http://www.bwsr.state.mn.us/practices/pollinator/pollinator-tool1.pdf	road management pollinator	87	Pollinators	roadsides, open space	N/A	N/A	N/A	N/A	Lists/links to MnDOT's pollinator page	N/A	Both	N/A	USA	Minnesota	Eng	Y	N	N/A
GO0094	Pollinator Habitat Program	Virginia Department of Transportation	Leaflet	gov't agency (state)	2016	http://www.virginiadot.org/business/resources/maintenance/php_dec_2015.pdf	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes VDOT's pollinator habitat development efforts, including a garden at a rest stop and incorporating IVM into statewide practices. Mentions	N/A	Both	N/A	USA	Virginia	Eng	Y	N	N/A

GO0119	Pollinator Recovery Act of 2016	Jeff Merkley, U.S. Senator	Legislation	gov't agency (federal)	2016	https://www.merkley.senate.gov/download/pollinator-bill	road enhancement pollinator	90	Pollinators	roadsides	N/A	N/A	N/A	N/A	Mentions roads as source of native plants, calls for collaborations to develop roadside vegetation BMPs.	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0013	2014 Pollinator Presidential Memo	White House	Memorandum	gov't agency (federal)	2014	https://www.nps.gov/subjects/pollinators/presidential-memo.htm	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Directs federal and state DOTs to "promote pollinator friendly practices and corridors" and educate privately managed transportation entities on	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0011	Pollinator Week Has the Industry Buzzing With Excitement	Ag Professional	news article	private entity	2018	https://www.agprofessional.com/article/pollinator-week-has-industry-buzzing-excitement	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Mentions Syngenta promotion tour along I-35, the "monarch highway" to connect with researchers, conservation professionals, and	N/A	Both	N/A	USA	Central (TX, OK, KS, IA, MN)	Eng	Y	N	N/A

GO0014	Study shows Maine's roadside habitats an important area for pollinators	Bangor Daily News	news article	private entity	2017	http://bangordailynews.com/2017/08/07/homestead/study-shows-maines-roadside-habitats-an-important-area-for-pollinators/	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes MeDOT's vegetation survey and UMaine's pollinator study along I-95	N/A	Both	N/A	USA	Maine	Eng	Y	N	N/A
GO0021	Pollinator corridor aims for 37 miles of bee-friendly plants	The Buffalo News	news article	private entity	2018	https://buffalonews.com/2018/07/06/imagine-this-37-miles-of-plants-to-attract-bees-and-butterflies-conservationists-already-have/	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes a regional conservation plan developed by a partnership between academics, managers, and conservation groups to plant	N/A	Conservation	N/A	New York	throughout	Eng	Y	N	N/A
GO0028	"Bee road" plans to save key pollinators	The Guardian	news article	private entity	2011	https://www.theguardian.com/environment/2011/apr/12/bee-road-pollinators	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	A partnership between industry and an NGO to restore native plants along roadsides in Yorkshire, UK	N/A	Conservation	N/A	UK	Yorkshire, England	Eng	Y	N	N/A

GO0031	Buzz about the Colorado Pollinator Highway	Colorado State University Extension	news article	Extension	2017	http://www.dailycamera.com/lifestyles/ci_31080641/omeara-buzz-about-colorado-pollinatorhighway	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes the Colorado highway plan and management strategies: reduce mowing, spot treat with herbicides, and introduce biological controls	N/A	Both	N/A	USA	Colorado	Eng	Y	N	N/A
GO0032	Migrating Monarch Butterflies Might Actually Take to the Highway	Smithsonian.com	news article	private entity	2015	https://www.smithsonianmag.com/innovation/migrating-monarch-butterflies-might-actually-take-to-the-highway-180955436/	road restoration pollinator	89	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Describes the Monarch Highway along I-35 in the central US and its national NGO partners. Also mentions negative reactions from conserva	N/A	Both	N/A	USA	Central (TX, OK, KS, IA, MN)	Eng	Y	N	N/A
GO0034	Meet Georgia's Solar Road	US News and World Report	news article	private entity	2018	https://www.usnews.com/news/best-states/articles/2018-07-17/dont-miss-this-highways-solar-road-and-pollinator garden	road enhancement pollinator	90	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes a multifaceted highway sustainability project that includes a large pollinator garden. A partnership between an NGO and the	N/A	Conservation	N/A	USA	Georgia	Eng	Y	N	N/A

GO0037	Highways Could Help Bears and Butterflies	Scientific American	news article	private entity	2017	https://www.scientificamerican.com/article/highways-could-help-bears-and-butterflies/	road management butterflies	93	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Describes threats from roads, the monarch highway and a roadside pollinator habitat project by the New York DOT	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0040	How Obama's 'butterfly highway' paves way to save embattled monarchs	Christian Science Monitor	news article	private entity	2015	https://www.csmonitor.com/Environment/2015/0522/How-Obama-s-butterfly-highway-paves-way-to-save-embattled-monarchs	road management butterflies	93	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Describes the monarch highway and the motivation for it's development	N/A	Both	N/A	USA	Central (TX, OK, KS, IA, MN)	Eng	Y	N	N/A
GO0041	Impact of road salt on butterflies examined	ScienceDaily	news article	blog	2014	https://www.sciencedaily.com/releases/2014/06/140609153423.htm	road management butterflies	93	Monarch butterflies	roadsides	sodium tissue content	habitat type (roadside or prairie)	environmental variables	field study	Describes a peer-reviewed study comparing sodium content in monarch tissues from specimens collected along roadsides: road salt	Observational	Both	N/A	USA	Minnesota	Eng	Y	N	N/A

GO0070	Buddleia: the plant that dominates Britain's railways	BBC	news article	gov't agency (federal)	2014	https://www.bbc.com/news/magazine-28196221	rail management butterflies	102	Buddleia, an invasive plant	railways	N/A	N/A	N/A	N/A	Describes spread in fallow areas and gardens of an invasive plant that is favored for it's beauty and attractiveness to butterflies	N/A	Management	N/A	UK	throughout	Eng	Y	N	N/A
GO0072	Four decades of hard labour and Battenburg cake: what it takes to bring the large blue butterfly back to Britain	The Guardian	news article	private entity	2009	https://www.theguardian.com/environment/2009/jun/16/large-blue-butterfly	rail management butterflies	102	large blue butterfly	railways	N/A	N/A	N/A	N/A	describes the history of large blue butterfly conservation; mentions its habitat on railway embankments managed by Network	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A
GO0100	Havens, K. and Vitt, P. 2016. The importance of phenological diversity in seed mixes for pollinator restoration. Natural Areas Journal 36(4): 531-537.	Natural Areas Journal	peer-reviewed journal	academic literature	2016	10.3375/043.036.0418	"road" conservation pollinator	88b	plants	roadsides	Seed mix	phenological diversity	management strategy	internet search	lists roadsides and DOTs as potentially restored habitat through reduced mowing and pollinator-friendly seed mixes. Most examine	Observational	Management	phenological diversity, pollinator conservation, restoration seed mixes	USA	throughout/ upper Midwest	Eng	Y	N	Medium

GO0124	McKenna, D.D., et al. 2001. Mortality of Lepidoptera along roadways in central Illinois. Journal of the Lepidopterists' Society 55(2): 63-68.	Journal of the Lepidopterists' Society	peer-reviewed journal	academic literature	2001	https://pdfs.semanticscholar.org/41e9/429632a1bba7c950d6830ee3a410801d57d0.pdf	road management butterflies	93	Lepidoptera	roadsides	mortality	traffic rate	habitat characteristics	field study	Greatest mortality found at mid-range traffic rates. Monarch butterfly migration peak may lead to greater traffic mortality. Estimate	Observational	Conservation	N/A	USA	Illinois	Eng	Y	N	HIGH
GO0131	van Swaay, C. et al. 2012. Dos and Don'ts for butterflies of the habitats directive of the European Union. Nature Conservation 1: 73-153. 10.3897/	Nature Conservation	peer-reviewed journal	academic literature	2012	10.3897/natureconservation.1.2786	road management butterflies	93	butterflies	roadsides	N/A	N/A	N/A	Review	Mentions road verges as good butterfly habitat; lists specific species associations (including one specific to forest roads). Dos and don't are	Observational	Both	Butterfly, Europe, European Union, Biodiversity, Natura 2000, Habitats Directive	Europe	throughout	Eng	Y	N	N/A
GO0146	Snell-Rood, E.C., Espeset, A., Boser, C.J., White, W.A., and Smykalski, R. 2014. Anthropogenic changes in sodium affect neural and muscle	Proceedings of the National Academy of Sciences	peer-reviewed journal	academic literature	2014	10.1073/pnas.1323607111	road management butterflies	93	Monarch butterflies, cabbage white butterfly	roadsides	flight muscle, brain size	exposure to road salt	management strategy, traits	lab study	Exposure to road salt increases sodium levels in monarchs, leading to changes in flight muscle mass and brain size. These outcomes differ	Experimental	Both	nutritional ecology, Danaus plexippus, Pieris rapae, ecological stoichiometry	USA	Minnesota	Eng	Y	N	Medium
GO0178	Kleijn, D.,	Journal of Applied	peer-	academic	2018	10.1111/	rail	101	wild bees	field	bee	presence of a	landscape	field	Paired	Both	Both	agri-	Netherla	througho	Eng	Y	N	Medium

GO0008	I-76 is Buzzing about new Pollinator Highway Designation	Colorado Department of Transportation	Press release	gov't agency (state)	2018	https://www.codot.gov/news/2018/july/i-76-is-buzzing-about-new-pollinator-highway-designation-1	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes a legislative resolution and a reduced mowing regime along a stretch of CO Interstate.	N/A	Both	N/A	USA	Colorado	Eng	Y	N	N/A
GO0012	National Pollinator Week: Pollinator Practices Take Root at DelDOT	Delaware Department of Transportation	Press release	gov't agency (state)	2018	https://news.delaware.gov/2018/06/18/national-pollinator-week-pollinator-practices-take-root-deldot/	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes problems with traditional roadside vegetation management, links to more information on DelDOT's modifications to manage	N/A	Both	N/A	USA	Delaware	Eng	Y	N	N/A
GO0057	New strategy to support bees' needs	UK Government	Press release	gov't agency (federal)	2014	https://www.gov.uk/government/news/new-strategy-to-support-bees-needs	rail management pollinator	98	bees	railways, roadsides, open space	N/A	N/A	N/A	N/A	Announces a collaboration between government agencies for roads, rails, and conservation to promote bee habitat	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A

GO0067	MDOT expands sunflower planting, increases late season food source for pollinators	Michigan Department of Transportation	Press release	gov't agency (state)	2017	https://www.michigan.gov/mdot/0,4616,7-151-9620449779--,00.html	rail enhancement pollinator	101	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes sunflower planting sites along highways in Michigan and future efforts to find a diverse seed mix to plant elsewhere	N/A	Both	N/A	USA	Michigan	Eng	Y	N	N/A
GO0118	Opportunities for pollinators along rights-of-way.	Jennifer Hopwood, The Xerces Society	slide show for a webinar	NGO	2015	http://www.erc.uic.edu/news-events/webinar-opportunities-for-pollinators-along-rights-of-way	road enhancement pollinator	90	Pollinators	roadsides, power lines	N/A	N/A	N/A	N/A	Presents results from literature review. Suggests maintaining diverse wildflowers with invasive species removal, timed mowing, and prescribe	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0080	Minnesota State Agency Pollinator Report: 2017 Annual Report	MN Interagency Pollinator Protection Team	technical report	gov't agencies (State)	2017	https://www.eqb.state.mn.us/2017-state-agency-pollinator report	road management pollinator	87	Pollinators	roadsides, solar sites, open space	N/A	N/A	N/A	N/A	Mentions various ROW as potential sources of pollinator habitat restoration	N/A	Both	N/A	USA	Minnesota	Eng	Y	N	N/A
GO0083	Technical Manual for Maintaining Roadsides for Pollinators: Establishment, Restoration, Management, and Maintenance, A Guide for	Pollinator Partnership	technical report	NGO	2016	http://pollinator.org/roadsides	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Four steps to make roadside vegetation management beneficial for pollinators: 1) reduce mowing, 2) use IVM for weed and pest	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A

GO0084	The Maryland Pollinator Protection Plan	Maryland Department of Agriculture	technical report	gov't agency (state)	2016	https://mda.maryland.gov/plants-pests/Documents/MP3-PollinatorPlan.pdf	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Suggests roads near crop fields as places for habitat enhancement, encourages right-of-way planting and describes planting timeline through year 3	N/A	Management	N/A	USA	Maryland	Eng	Y	N	N/A
GO0086	Conservation strategy for Monarchs (Danaus plexippus) and at-risk pollinators in Nebraska	Nebraska Monarch Pollinator Initiative and Nebraska Game and Parks Commission	technical report	NGO and gov't agency (state)	2017	https://outdoornebraska.gov/wp-content/uploads/2017/04/Monarch-PollinatorPlan_NE_April2017.pdf	road management pollinator	87	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Mentions road salt runoff as a threat, encourages roadside habitat management for pollinators, seeks to remove barriers in state law preventin	N/A	Both	N/A	USA	Nebraska	Eng	Y	N	N/A
GO0088	Pollinator Research Action Plan	White House Pollinator Health Task Force	technical report	gov't agency (federal)	2015	https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Research%20Action%20Plan%202015.pdf	road management pollinator	87	Pollinators	roadsides, open space, Power lines	N/A	N/A	N/A	N/A	Aims to assess negative effects of road management on pollinator habitat, identifies ROW managers as important stakeholder group to	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A

GO0091	Pollinator Partnership Action Plan	White House Pollinator Health Task Force	technical report	gov't agency (federal)	2016	https://www.whitehouse.gov/sites/whitehouse.gov/files/images/Blog/PPAP_2016.pdf	road management pollinator	87	Pollinators	roadsides, open space, Power lines	N/A	N/A	N/A	N/A	Mentions DOT/Xerces federal documents as output of the Pollinator Research Action Plan, monarch ROW plantings in Iowa and I-35, and	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0092	The Native Pollinator Habitat Restoration Guide: BMPs for the Puget Sound lowlands	EarthCorps	technical report	NGO	2018	https://www.earthcorps.org/wp-content/uploads/The-Native-Pollinator-Habitat-Restoration-Guide-EarthCorps.pdf	road management pollinator	87	Pollinators	roadsides, open space, Power lines	N/A	N/A	N/A	N/A	Give recommendations specific to corridors and roadsides: 1) minimize disturbance and 2) establish native plants. Provides implementaton	N/A	Both	N/A	USA	Washington (Puget Sound)	Eng	Y	N	N/A
GO0099	Yolo Natural Heritage Program Pollinator Conservation Strategy	The Xerces Society	technical report	NGO	2009	https://xerces.org/guidelines/yolo-natural-heritage-program-ncpnccp-pollinator-conservation-strategy/	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Reviews grazing, mowing, fire; suggests mowing regimes should be adjusted along roadsides as existing practices have reduced pollinator habitat.	N/A	Both	N/A	USA	Yolo County, California	Eng	Y	N	N/A

GO0103	A Citizen's Guide to Creating Pollinator Habitat in Connecticut	The Connecticut Agricultural Experiment Station (Kim Stoner)	technical report	gov't agency (state)	2018	http://www.ct.gov/caes/lib/caes/documents/publications/pollinators/a_citizen%E2%80%99s_guide_to_creating_pollinator_habitat_in_connecticut.pdf	road restoration pollinator	89	Pollinators	roadsides, power lines	N/A	N/A	N/A	N/A	Presents literature review on ROW management for pollinators. Start ROW restoration by surveying existing vegetation, then plant new native	N/A	Both	N/A	USA	Connecticut	Eng	Y	N	N/A
GO0107	Transportation Research Synthesis 1601: Partnerships for promoting pollinator habitat	Minnesota Department of Transportation	technical report	gov't agency (state)	2016	http://www.dot.state.mn.us/research/TRS/2016/TRS1601.pdf	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Combines a literature review with a survey of "selected state DOTs and Minnesota counties." DOTs describe pollinator habitat practices and	N/A	Both	N/A	USA	Minnesota	Eng	Y	N	N/A
GO0109	New York State Pollinator Protection Plan	New York Department of Environmental Conservation	technical report	gov't agency (state)	2016	https://www.dec.ny.gov/docs/administration_pdf/nyspollinatorplan.pdf	road restoration pollinator	89	Pollinators	roadsides, power lines, canals	N/A	N/A	N/A	N/A	New York state has 15,000 miles of highway and over 1000 miles of powerline and canal ROW. Both use IPM for vegetation management.	N/A	Both	N/A	USA	New York State	Eng	Y	N	N/A

GO0110	Strategy for Implementing Pollinator-Friendly Landscaping Design and Maintenance at Department of the Interior Sites	US Department of the Interior	technical report	gov't agency (federal)	2016	https://www.nps.gov/dscw/upload/PollinatorFriendlyLandscapingStrategy_Attach1_DOIMemo_2-9-16.pdf	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Recognizes roadsides as existing pollinator habitat and their vegetation as potential pollinator forage	N/A	Both	N/A	USA	Michigan	Eng	Y	N	N/A
GO0112	Texas Monarch and Native Pollinator Conservation Plan	Texas Parks and Wildlife	technical report	gov't agency (state)	2016	https://tpwd.texas.gov/publications/pwdpubs/media/pwd_rp_w7000_2070.pdf	road restoration pollinator	89	Monarchs, pollinators	roadsides	N/A	N/A	N/A	N/A	Mentions multiple partnerships with the University of Texas to develop and monitor pollinator-friendly management practices along roadsides	N/A	Both	N/A	USA	Texas	Eng	Y	N	N/A
GO0113	The Wisconsin Pollinator Protection Plan: Best Management Practices for improving pollinator habitat in prairies, roadsides, and open spaces	Wisconsin Department of Agriculture, Trade, and Consumer Protection	technical report	gov't agency (state)	2016	https://datcp.wi.gov/Documents/PPPOpenSpaces.pdf	road restoration pollinator	89	Pollinators	roadsides, open space	N/A	N/A	N/A	N/A	Provides establishment timeline and guidelines for planning and planting habitat. Covers ongoing maintenance and monitoring. Includes	N/A	Both	N/A	USA	Wisconsin	Eng	Y	N	N/A

GO0135	Barbour, S., and Kiviat, E. 1986. A survey of Lepidoptera in Tivoli North Bay (Hudson River Estuary).	Hudson River Foundation	technical report	NGO	1986	http://www.hudsonriver.org/ls/reports/Polgar_Barbour_TP_03_85_final.pdf	road management lepidoptera	96	Lepidoptera	roadsides, railways, wetlands	N/A	N/A	N/A	field survey	Surveyed along a road and railway in wetland land cover. Found 30 butterfly species. Suggests reduced mowing and timing to promote larval develop	Observational	Both	N/A	USA	New York State	Eng	Y	N	HIGH
GO0150	Transport Corridor: Tailored advice on managing land for pollinators	Defra	technical report	gov't agency (federal)	N/A	https://www.bumblebeeconservation.org/wp-content/uploads/2018/03/6192_defra_info_sheet_transport_corridors_final.pdf	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Describes importance of transport corridors, cutting management for roads, sowing in roads and rails, cites peer-reviewed sources	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A
GO0152	Great Barrington Pollinator Action Plan	Great Barrington, MA	technical report	gov't agency (local)	2018	https://www.townofgb.org/sites/g/files/vyhlif636/f/uploads/greatbarringtonpollinatoractionplan2018.pdf	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Describes a variety of potential habitat resources, then provides opportunities for implementing new management techniques, including	N/A	Both	N/A	USA	Great Barrington, MA	Eng	Y	N	N/A

GO0153	Managing urban areas for insect pollinators	Living With Environmental Change	technical report	gov't agency (local)	2015	https://research-information.bris.ac.uk/en/publications/managing-urban-areas-for-insect-pollinators-as-town-and-cities-co	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Mentions roadsides and railways as beneficial habitats for pollinators in urban areas, suggests reducing mowing frequency	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A
GO0171	North Dakota Monarch Butterfly and Native Pollinator Strategy	Multiple NGOs and gov't agencies	technical report	NGOs and gov't agencies	2018	https://gf.nd.gov/gnf/conservation/docs/nd-monarch-butterfly-native-pollinator-strategy.pdf	rail restoration pollinator	100	Pollinators	roadsides	N/A	N/A	N/A	N/A	Contains an appendix from NDDOT describing projects along roadsides and at rest areas. Work involved custom seed mixes for	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0175	Status and Trends of Pollinator Health in Ontario	University of Guelph	technical report	University	2017	https://rainelab.files.wordpress.com/2015/12/status-and-trends-of-pollinator-health-in-ontario-march-8-2017-tagged.pdf	rail restoration pollinator	100	Pollinators	roadsides, railways	N/A	N/A	N/A	Review	Extensive review on pollination ecology, with a section on ROW habitat that describes potential effects of various management strategie	N/A	Both	N/A	Canada	Ontario	Eng	Y	N	N/A

GO0193	Karner Blue Butterfly Recovery Plan	US Fish and Wildlife Service	technical report	gov't agency (federal)	2003	https://www.fws.gov/midwest/endangered/insects/kbb/kbbRecPlan.html	rail management butterflies	102	Karner blue butterfly	roadsides, railways, power lines	N/A	N/A	N/A	N/A	Mentions ROW as habitat for KBB. Suggests adjusting herbicide application and mowing schedules to accommodate early season use. Mentions	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0001	The Xerces Society: Roadsides	The Xerces Society	webpage	NGO	N/A	https://xerces.org/pollinator-conservation/roadsides/	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Page provides multiple resources on roadside vegetation management to benefit pollinators, some authored by Xerces, others from	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0002	Roadsides | Pollinator.org	Pollinator Partnership	webpage	NGO	N/A	http://pollinator.org/roadsides	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Page provides resources on roadside vegetation management for pollinators and news related to PP's work with pollinators and	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A

GO0006	Pollinators | Gold Ridge Resource Conservation District	Gold Ridge Resource Conservation District	webpage	NGO	N/A	http://www.goldridgercd.org/htm/pollinators.htm	road management pollinator	87	Pollinators	field margins, hedgerows, roadsides	N/A	N/A	N/A	N/A	Describes a pollinator habitat enhancement project on marginal areas of seven farms in northern CA, including roadsides. Links to habitat	N/A	Both	N/A	USA	northern California	Eng	Y	N	N/A
GO0009	Pollinator Habitat Program	Tennessee Department of Transportation	webpage	gov't agency (state)	N/A	https://www.tn.gov/tdot/environmental-home/environmental-highway-beautification-office/beautification-pollinator-habitat-program.html	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes TDOT's pollinator habitat program, which incorporates Integrated Roadside Vegetation Management (IRVM) practices including	N/A	Both	N/A	USA	Tennessee	Eng	Y	N	N/A
GO0016	Bee Pollinator Program	Ohio Department of Transportation	webpage	gov't agency (state)	2016	https://www.transportation.ohio.gov/wps/portal/gov/odot/programs/pollaintor-habitat-program/pollinator-habitat-program	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes a restoration effort along Ohio's roadsides to convert grassy edges to pollinator habitat. Provides resources on seed selection, sources,	N/A	Both	N/A	USA	Ohio	Eng	Y	N	N/A

GO0027	Department of Transportation	Monarch Joint Venture	webpage	NGO	N/A	https://monarchjointventure.org/get-involved/i-am-a/department-of-transportation	road restoration pollinator	89	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Describes the Monarch Highway along I-35 in the central US, the role of participating state DOTs, and a number of other state DOT initiatives	N/A	Both	N/A	USA	throughout	Eng	Y	N	N/A
GO0044	Biodiversity along road verges: mowing management in the roadsides	South Karelia Allergy and Environmental Institute	webpage	private entity	N/A	https://www.ekay.net/in-english/biodiversity-along-road-verges/	road management butterflies	93	butterflies and moths	roadsides	communities, movement	mowing time and frequency	management strategy	field study	Describes one of the Valtonen et al Finnish road studies, but not its results	Observational	Both	N/A	Finland	Imatra-Lappeenranta	Eng	Y	N	N/A
GO0053	Pollinators | raleighnc.gov	City of Raleigh, NC	webpage	gov't agency (city)	2018	https://www.raleighnc.gov/business/content/AdminServSustain/Articles/Pollinators.html	rail management pollinator	98	Pollinators	railways, roadsides, open space	N/A	N/A	N/A	N/A	Describes local projects at a train station, wastewater treatment plant, and along a road that have been planted with wildflowers for	N/A	Both	N/A	USA	North Carolina	Eng	Y	N	N/A
GO0054	Rights-of-way as Habitat	Energy Resources Center, University of Illinois at Chicago	webpage	University	2018	http://www.erc.uic.edu/biofuels-bioenergy/pollinator-habitat/rights-of-way-as-habitat	rail management pollinator	98	Pollinators	power lines, roadsides, railways	N/A	N/A	N/A	N/A	This habitat working group connects professionals for habitat conservation on rights-of-way; webpage highlights pollinators	N/A	Conservation	N/A	USA	Illinois	Eng	Y	N	N/A

GO0056	Pollinator Habitat	North Carolina Department of Transportation	webpage	gov't agency (state)	N/A	https://www.ncdot.gov/initiatives-policies/environmental/wildflower/Pages/pollinator-habitats.aspx	rail management pollinator	98	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes wildflower planting program along NC's highways	N/A	Both	N/A	USA	North Carolina	Eng	Y	N	N/A
GO0058	Bayer Vegetation Management Resource Library	Bayer CropScience	webpage	private entity	N/A	https://www.backedbybayer.com/vegetation-management/resource-library	rail management pollinator	98	Pollinators	railways, roadsides, open space	N/A	N/A	N/A	N/A	Herbicide product sheets and directions for use in IVM programs along roads, rails, and in open space	N/A	Management	N/A	global	throughout	Eng	Y	N	N/A
GO0059	The railway and our pollinators	Network Rail	webpage	gov't agency (federal)	N/A	https://www.networkrail.co.uk/the-railway-and-our-pollinators/	"rail" conservation pollinator	99	Pollinators	railways	N/A	N/A	N/A	N/A	Describes three projects Network Rail is conducting to create pollinator habitat	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A
GO0075	Avoiding invasives: butterfly bush	Penn State Extension	webpage	Extension	N/A	https://extension.psu.edu/avoiding-invasives-butterfly-bush	rail management butterflies	102	Buddleia, an invasive plant	railways, roadsides, open space	N/A	N/A	N/A	N/A	Buddleia is found on both coasts of the US, particularly in fallow areas such as roadsides, railways, and fallow areas	N/A	Management	N/A	USA	coastal	Eng	Y	N	N/A

GO0076	Large Blue Butterfly	Centre for Ecology and Hydrology	webpage	gov't agency (federal)	N/A	https://www.ceh.ac.uk/large-blue-butterfly	rail management butterflies	102	large blue butterfly	railways	N/A	N/A	N/A	N/A	Network Rail partners with CEH to do research on the large blue butterfly at its restored railway habitats	N/A	Both	N/A	UK	throughout	Eng	Y	N	N/A
GO0077	Species at Risk Management Plan; the Monarch	Species at Risk Public Registry	webpage	gov't agency (federal)	2014	https://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=D5AAB693-1	rail management butterflies	102	Monarch butterflies	railways, roadsides, power lines	N/A	N/A	N/A	N/A	Part of Canada's monarch management plan is to create BMPs for ROW that are regionally and context specific. Timeline: 2014-2017	N/A	Both	N/A	Canada	throughout	Eng	Y	N	N/A
GO0005	Pollinators: Help the Pollinators	Audubon Society of Rhode Island	webpage	NGO	N/A	https://asri.org/pollinators/help-the-pollinators.html	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Links to a press release describing pollinator habitat road signs developed in partnership with the RI DOT: https://asri.org/news-	N/A	Both	N/A	USA	Rhode Island	Eng	N (but linked article on roadside signs may be)	N	N/A
GO0024	New EPRI Initiative to Foster Utility Collaboration on Pollinator Conservation	Electric Power Research Institute	blog post	NGO	2018	http://eprijournal.com/power-to-the-pollinators/	"road" conservation pollinator	88b	Pollinators	power lines	N/A	N/A	N/A	N/A	Describes the Power-in-Pollinators initiative and the role of early adopters in the project	N/A	Both	N/A	USA	throughout (highlights WI)	Eng	N	N	N/A

GO0026	"Restoration Economy" Strives to Protect Pollinators, Create Jobs	Scientific American	blog post	private entity	2016	https://www.scientificamerican.com/article/ldquo-restoration-economy-rdquo-strives-to-protect-pollinators-create-jobs/	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes an effort in the southwest US to plant a patchwork corridor of pollinator habitat on fallow lands	N/A	Conservation	N/A	USA	Southwest	Eng	N	N	N/A
GO0029	Pollinator Habitat Restoration	Sand Hill Bees (Meghan Milbraith)	blog post	blogger	2017	http://www.sandhillbees.com/blog/	road restoration pollinator	89	Pollinators	field margins	N/A	N/A	N/A	N/A	Describes restoring three sites to pollinator habitat with native seed mixes and NRCS support	N/A	Both	N/A	USA	Michigan	Eng	N	N	N/A
GO0033	The Native Pollinator Habitat Restoration Guide	Green Seattle Partnership	blog post	NGO	2018	https://www.greenseattle.org/the-native-pollinator habitat-restoration-guide/	road restoration pollinator	89	Pollinators	bike trail	N/A	N/A	N/A	N/A	Describes Puget Sound BMPs and a restoration project along a popular bike trail	N/A	Both	N/A	USA	Washington (Puget Sound)	Eng	N	N	N/A
GO0060	Meet a conservation hero: Andrea Reid	Auckland Council	blog post	gov't agency (city)	2017	http://ourauckland.aucklandcouncil.govt.nz/articles/news/2017/07/meet a-conservation-hero-andrea-reid/	"rail" conservation pollinator	99	Pollinators	railways, roadsides, open space	N/A	N/A	N/A	N/A	Features Pollinator Paths, a local effort to plant pollinator habitat along existing infrastructure corridors	N/A	Both	N/A	New Zealand	Auckland	Eng	N	N	N/A

GO0063	Great Pollinator Project: NYC Highline	Great Pollinator Project	blog post	NGO	N/A	http://greatpollinatorproject.org/	rail restoration pollinator	100	Pollinators	railways	N/A	N/A	N/A	N/A	Briefly describes the Highline restoration project, featuring native plants that benefit pollinators	N/A	Conservation	N/A	USA	New York City	Eng	N	N	N/A
GO0064	ComEd Pollinator Habitat Restoration	Stantec	blog post	private entity	N/A	https://www.stantec.com/en/projects/united-states-projects/c/comed-pollinator habitat-restoration	rail restoration pollinator	100	Pollinators	power lines	N/A	N/A	N/A	N/A	Commonwealth Edison is establishing pollinator habitat on utilty ROW in Illinois	N/A	Both	N/A	USA	Illinois	Eng	N	N	N/A
GO0066	The Pollinator Predicament	Defenders of Wildlife	blog post	NGO	2015	https://defenders.org/magazine/spring-2015/pollinator-predicament	rail restoration pollinator	100	Pollinators	railways, roadsides, power lines	N/A	N/A	N/A	N/A	Mentions ROW as a source of habitat restoration, along with landfills and mine sites	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0074	Populations of grassland butterflies decline almost 50% over two decades	De Vlinderstichting	blog post	NGO	2013	https://www.vlinderstichting.nl/actueel/nieuws/nieuwsbericht/populations-of-grassland-butterflies-decline-almost-50-over-two-decades	rail management butterflies	102	butterflies	railways, roadsides, open space	N/A	N/A	N/A	N/A	describes a report from the European Environment Agency on butterfly decline; mentions roads and rails as habitat butterflies have been	N/A	Conservation	N/A	Europe	throughout	Eng	N	N	N/A

GO0194	Vandevelde J.C., and Penone, C. 2017. Ecological Roles of Railway Verges in Anthropogenic Landscapes: A Synthesis of Five Case Studies in Northern	Railway Ecology	book chapter	academic literature	2017	10.1007/978-3-319-57496-7_16	rail management butterflies	102	butterflies	railways	homing ability	location of displacement	landscape context	field study	Butterflies displayed homing behavior across a high-speed railway.	Both	Conservation	Lepidoptera, dispersal, mark-recapture, homing behavior, grassland	France	outside Paris	Eng	N	N	Medium
GO0114	Washington Native Pollinator Plant Glossary	Green Seattle Partnership	bulletin	NGO	2018	https://www.greenseattle.org/wp-content/uploads/2016/03/WNPS-pollinatorglossary.pdf	road restoration pollinator	89	plants	roadsides, hedgerows	N/A	N/A	N/A	N/A	Roadside plants can thrive in disturbed areas and several do well in poor soils; however, they may be weedy and need to be constrained to	N/A	Management	N/A	USA	Washington (Puget Sound)	Eng	N	N	N/A
GO0120	Protecting and enhancing pollinators in urban landscapes for the US North Central Region	Michigan State University Extension	bulletin	Extension	2016	http://msue.anr.msu.edu/uploads/236/78920/ProtectPollinatorsInLandscape_FINAL-HigherRes.pdf	road enhancement pollinator	90	Pollinators	urban remnants	N/A	N/A	N/A	N/A	Lists plants attractive to bees, describes establishment of new pollinator habitat, has extensive description of herbicides used in urban vegetatio	N/A	Both	N/A	USA	North Central	Eng	N	N	N/A

GO0125	Managing for butterflies in prairie	North American Butterfly Association (Ann B. Swengel)	bulletin	NGO	1998	http://www.naba.org/ftp/buttman.pdf	road management butterflies	93	butterflies	prairie	N/A	N/A	N/A	N/A	general advice and motivations for habitat managers to incorporate butterfly conservation into their properties	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0156	Pollinator-friendly parks: How to enhance parks, gardens, and other greenspaces for native pollinator insects	The Xerces Society	bulletin	NGO	2008	https://xerces.org/publications/guidelines/pollinator-friendly-parks	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	A guide to create pollinator habitat in generally marginal pieces of land in urban areas.	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0165	RFP: Monarch Butterfly and Pollinators Conservation Fund	National Fish and Wildlife Foundation	bulletin	NGO	2018	https://www.nfwf.org/programs/monarch-butterfly-and-pollinators-conservation-fund	rail restoration pollinator	100	Monarch butterfly, pollinators	roadsides, railways, power lines	N/A	N/A	N/A	N/A	An RFP for projects to restore/enhance pollinator habitat; one area of focus is roadside, railway, and power line ROW	N/A	Conservation	N/A	USA	throughout	Eng	N	N	N/A
GO0172	Get Britain Buzzing: A Manifesto for Pollinators	Buglife	bulletin	NGO	2014	https://cdn.buglife.org.uk/2019/08/Pollinator manifesto-with-covers_0-1.pdf	rail restoration pollinator	100	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Categorizes roadsides and railways as brownfield sites that can be restored to pollinator habitat.	N/A	Conservation	N/A	UK	throughout	Eng	N	N	N/A

GO0177	Corporate Social Responsibility Statement 2016	Irish Rail	bulletin	gov't agency (federal)	2016	https://www.irishrail.ie/IrishRail/media/Imported/ie_csr_brochure_24pp_a4_ev_lr_r3.pdf	rail enhancement pollinator	101	Pollinators	railways	N/A	N/A	N/A	N/A	Mentions cooperation with the All Ireland Pollinator Plan and the role of railway embankments as pollinator habitat, but does not provide any	N/A	Both	N/A	Ireland	throughout	Eng	N	N	N/A
GO0180	Planning for Urban Pollinators: a best practices guide to conserving native bees in cities	Environmental Youth Alliance	bulletin	NGO	2013	http://eya.ca/wp-content/uploads/2015/05/Planning-for-Pollinators-Report-web-version1.pdf	rail enhancement pollinator	101	Pollinators	roadsides, railways, open space	abundance, diversity	type of urban habitat	habitat characteristics	field study	Describes ways to enhance pollinator habitat in cities; has a section called site selection that emphasizes ROW as good places for new and improved	Both	Both	N/A	Canada	Vancouver, BC	Eng	N	N	Medium
GO0186	Butterflies of Montgomeryshire	Butterfly Conservation UK	bulletin	NGO	2017	https://butterfly-conservation.org/sites/default/files/butterflies-of-montgomeryshire-2017.pdf	rail management butterflies	102	Butterflies	roadsides, railways	N/A	N/A	N/A	N/A	A list of butterfly species and their habitats, which include railways and roadsides.	N/A	Conservation	N/A	UK	Montgomeryshire	Eng	N	N	N/A

GO0141	Non, W.C., and de Vries, H.H. 2013. Successful forest edge management for butterflies (Lepidoptera) in: Proceedings of the Netherlands Entomolo	Netherlands Entomological Society	Conference proceedings	academic literature	2013	https://www.nev.nl/pages/publicaties/proceedings/nummers/24/35-44.pdf	road management lepidoptera	96	butterflies, vegetation	forest edge	abundance, species richness	enhanced forest edges	habitat characteristics, environmental variables	field study	Enhancement did not change plant species composition, but increased butterfly species richness and abundance.	Both	Both	N/A	Netherlands	throughout	Eng	N	N	Medium
GO0047	Lepidoptera and Conservation	Tim R. New	ebook	private entity	2013	10.1002/9781118409220	road management lepidoptera	96	butterflies and moths	Open space, roadsides	N/A	N/A	N/A	N/A	Describes butterfly and moth conservation, including habitat management	N/A	Conservation	N/A	global	throughout	Eng	N	N	N/A
GO0105	Proposed Litzinger Road Ecology Center Pollinator Survey	Litzinger Road Ecology Center	internal document	NGO	2004	https://www.yumpu.com/en/document/view/53438452/proposed-litzsinger-road-ecology-center-pollinator survey	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes methods to survey prairie and woodland areas at LREC for bees and butterflies. Unclear if these surveys are roadside-focused	N/A	Conservation	N/A	USA	Missouri (St. Louis)	Eng	N	N	N/A
GO0087	Native Pollinators	NRCS Wildlife Habitat Management Institute	Leaflet	gov't agency (federal)	2005	https://outdoornebraska.gov/wp-content/uploads/2017/04/Monarch-Pollinator Plan_NE_April2017.pdf	road management pollinator	87	Pollinators	open space	N/A	N/A	N/A	N/A	general information on pollinators and habitat requirements	N/A	Conservation	N/A	USA	throughout	Eng	N	N	N/A

GO0123	Conserving Karner Blue Butterflies in Wisconsin: A development of management techniques. American Entomologist 61(2): 96-113. 10.1093/a	American Entomologist (Robert J. Hess and Anna N. Hess)	magazine article	magazine	2015	10.1093/ae/tmv022	road management butterflies	93	Karner blue butterfly	roadsides, power lines	N/A	N/A	N/A	N/A	Karner blues are frequently found in disturbed areas including roadsides and power lines, which then must be managed under the	N/A	Both	N/A	UK	Wisconsin	Eng	N	N	N/A
GO0162	Utilities Take Action on Habitat Restoration	Neil Palmer for Electric Perspectives	magazine article	magazine	2016	https://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Pollinator-Initiative-EEI-Pollinatorarticle.pdf	"rail" conservation pollinator	99	Monarch butterfly	Power lines	N/A	N/A	N/A	N/A	Describes an effort by Xcel Energy to promote monarch habitat on its power line ROW	N/A	Both	N/A	USA	Upper Midwest (MN/WI)	Eng	N	N	N/A
GO0133	Williams, E.H. 2009. Managing habitat for lupines and rare butterflies. News of the Lepidopterists' Society 51(2): 64-66.	News of the Lepidopterists' Society	newsletter	NGO	2009	https://www.lepsoc.org/sites/all/themes/nevia/lepsoc/Conservation%20Matters%20-%20Lupines%20&%20Butterflies.pdf	road management butterflies	93	rare butterflies, lupines	sand plains	N/A	N/A	N/A	N/A	Describes habitat restoration for frosted elfin and Karner blues, which both use lupine as a host plant: plant lupine seedlings in the summer	N/A	Both	N/A	USA	New York State	Eng	N	N	N/A

GO0164	Ohio Pollinator Partnership Initiative	Environmental Education Council of Ohio	newsletter	NGO	2017	http://www.eeco-online.org/resources/Publications/Newsletters/2017%20Summer%20Newsletter.pdf	rail restoration pollinator	100	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Describes a number of local efforts in Ohio to restore native plants and pollinator habitat; mentions prairie habitat only existing along roadsides	N/A	Conservation	N/A	USA	Ohio	Eng	N	N	N/A
GO0101	Tepedino, V.J., Bowlin, W.R., and Griswold, T.L. 2012. Pollinators complicate conservation of an endemic plant: *Physaria obcordata* (Crucifera	Natural Areas Journal	peer-reviewed journal	academic literature	2012	10.3375/043.032.0202	"road" conservation pollinator	88b	*Physaria obcordata* (Cruciferae), wild bees	roadsides	seed production, fruit set	pollinator visits, distance btw pollinated plants	pollinator exposure, efficiency	field study	This rare plant only grows in this one location along roadsides. Seed set not pollinator or distance limited, can hybridize with congener	Both	Conservation	breeding system, native bees, pollination, pollinator limitation, rare plant	USA	Colorado	Eng	N	N	Medium
GO0115	Giovanetti, M., Ramos, M., and Maguas, C. 2018. Why so many flowers? A preliminary assessment of mixed pollination strategy enhancing sexual	Web Ecology	peer-reviewed journal	academic literature	2018	10.5194/we-18-47-2018	road enhancement pollinator	90	*Acacia longifolia*, an invasive plant	roadsides	seed set	insect visitation	pollinator exposure, efficiency	field study	Conducted pollination experiments of this plant in roadside patches. It is mostly wind-pollinated with few insect visitors	Both	N/A	N/A	Portugal	coastal	Eng	N	N	Medium

GO0116	Hicks, D.M. et al. 2016. Food for Pollinators: quantifying the nectar and pollen resources of urban flower meadows. PLoS One 11(6): e0158117 .	PLoS One	peer-reviewed journal	academic literature	2016	10.1371/journal.pone.0158117	road enhancement pollinator	90	plants	urban remnants	nectar and pollen rewards	seed mix type (perennial or annual), floral characteristics	community composition, species traits	field study	British native weeds were the top 5 nectar producers and 2 of the top 10 pollen producers. Perennial mixes produced up to 20x more nectar	Both	Management	N/A	UK	throughout (Edinburgh, Leeds, Bristol, and Reading)	Eng	N	N	Medium
GO0127	Ojanen, S.P., et al. 2013. Long-term metapopulation study of the Glanville fritillary butterfly (*Melitaea cinxia*): survey methods, data management, and	Ecology and Evolution	peer-reviewed journal	academic literature	2013	10.1002/ece3.733	road management butterflies	93	Glanville fritillary butterfly (*Melitaea cinxia*)	roadsides	life history traits, metapopulation traits	habitat type, area; landscape context	habitat characteristics, landscape context	field study	Mapped roadside habitat patches of this species. Don't mention results, just describe survey methods.	Observational	Conservation	Climate change, EarthCape, Glanville fritillary, habitat fragmentation, long-term population survey, management of ecological data, spatial synchrony of	Finland	Aland Islands	Eng	N	N	N/A
GO0128	Saraf, K.K., and Jadesh, M. 2017. A preliminary study on road-killed butterflies at National Highway 50, Karnataka, India. International	International Journal of Entomology	peer-reviewed journal	academic literature	2017	http://www.entomologyjournals.com/download/77/2-1-15-881.pdf	road management butterflies	93	butterflies	roadsides	mortality	N/A	habitat characteristics	field survey	Collected 180 dead butterflies at one survey site. The most common family killed was Nymphalidae, the least common family killed was	Observational	Conservation	N/A	India	Karnataka	Eng	N	N	HIGH

GO0129	Sony, R.K., and Arun, P.R. 2015. A case study of butterfly road kills from Anaikatty Hills, Western Ghats, Tamil Nadu, India. Journal of Threatene	Journal of Threatened Taxa	peer-reviewed journal	academic literature	2015	https://threatenedtaxa.org/index.php/JoTT/article/view/1743	road management butterflies	93	butterflies	roadsides	mortality	N/A	habitat characteristics	field survey	Collected 135 dead butterflies at one survey site. The most common family killed was Nymphalidae though it was not the most abundant family	Observational	Conservation	Annual mass movement, impact of forest roads, insects, invertebrates, Lepidoptera, Nymphalidae, road traffic.	India	Tamil Nadu	Eng	N	N	HIGH
GO0130	Swengel, A.B., and Swengel, S.R. 2018. Patterns of long-term population trends of three lupine-feeding butterflies in Wisconsin. Diversity 10, 31: 10.3390/	Diversity	peer-reviewed journal	academic literature	2018	10.3390/d10020031	road management butterflies	93	Frosted elfin, Karner blue, and Persius duskywing	roadsides, power lines	abundance	habitat type (reserve, forestry land, or ROW)	habitat characteristics	field study	Reserve sites were more favorable for conservation than forestry land or ROW. Frosted elfin and Persius duskywing did better in forestry	Observational	Conservation	Frosted Elfin; Karner Blue; Persius Duskywing; conservation evidence; long-term trend; long-term monitoring; pine barren; habitat managem	USA	Wisconsin	Eng	N	N	N/A
GO0138	Leuenberger, W., et al. 2016. A comparison of Lepidoptera communities inhabiting restored and late successional pitch pine-scrub oak barrens in	Natural Areas Journal	peer-reviewed journal	academic literature	2016	10.3375/043.036.0109	road management lepidoptera	96	Lepidoptera	barrens	abundance, species richness, diversity	habitat type (restored or late successional)	habitat characteristics	field study	Found few differences overall, but several species were unique to each habitat type. Recommends a mix of successional	Observational	Both	biodiversity, conservation, Lepidoptera, pitch pine–scrub oak barrens, prescribed fire	USA	Pennsylvania	Eng	N	N	Medium

GO0140	Merckx, T. et al. 2012. Conserving threatened Lepidoptera: toward an effective woodland management policy in landscapes under intense	Biological Conservation	peer-reviewed journal	academic literature	2012	10.1016/j.biocon.2012.02.005	road management lepidoptera	96	macro-moths	forest harvest, rides	presence/absence, abundance, species richness	six woodland management treatments	habitat characteristics, landscape context	field study	Late successional, dark, dense deciduous forest is beneficial for moths, especially so for some species of concern. Partial cutting and trail	Both	Both	Coppicing, landscape scale, moths, widespread species, woodland biodiversity, woodland rides	UK	Salisbury	Eng	N	N	Medium
GO0142	Schlicht, D.W., and Orwig, T.T. 1998. The status of Iowa's Lepidoptera. The Journal of the Iowa Academy of Science 105(2): 82-88.	The Journal of the Iowa Academy of Science	peer-reviewed journal	academic literature	1998	http://scholarworks.uni.edu/jias/vol105/iss2/9	road management lepidoptera	96	Lepidoptera	prairie remnants, roadsides	presence/absence	land use change, human impacts	historical records	Review	Notes widespread declines of butterflies in Iowa. Presents fire management of prairies as detrimental to butterflies, compare	Observational	Both	N/A	USA	Iowa	Eng	N	N	N/A
GO0143	Schmitt, T. 2003. Influence of forest and grassland management on the diversity and conservation of butterflies and burnet moths. Animal Biodiversi	Animal Biodiversity and Conservation	peer-reviewed journal	academic literature	2003	https://www.researchgate.net/publication/26411020_Influence_of_forest_and_grassland_management_on_the_diversity_and_conservation_of_butterflies_and_b	road management lepidoptera	96	Lepidoptera	open space, forest harvest	abundance, species richness, diversity	habitat type (forest vs non-forest)	habitat characteristics	field study	Diversity was much lower in forests than non-forest areas. Mulched meadows has lower diversity than hay meadows. Quarries and sand pits had	Observational	Both	Butterfly conservation, Meadows, Windblows, Clearings, Quarries, Sandpits.	Germany	Bavaria	Eng	N	N	Medium

GO0182	Potts, S.G., Imperatriz-Fonseca, V., Ngo, H.T., Aizen, M.A., Biesmeijer, J.C., Breeze, T.D., Dicks, L.V., Garibaldi, L.A., Hill, R., Settele, J.	Nature	peer-reviewed journal	academic literature	2016	10.1038/nature20588	rail enhancement pollinator	101	Pollinators	roadsides, railways	N/A	N/A	N/A	Review	Review of possible policy and management responses to promote pollinator populations and mitigate loss.	N/A	Both	N/A	global	throughout	Eng	N	N	N/A
GO0192	Tallent-Halsell, N.G., and Watt, M.S. 2009. The invasive Buddleja davidii (Butterfly Bush). The Botanical Review 75: 292. 10.1007/s12229-009-9033-0	The Botanical Review	peer-reviewed journal	academic literature	2009	10.1007/s12229-009-9033-0	rail management butterflies	102	Butterfly bush	railways, roadsides	N/A	N/A	N/A	Review	Describes the spread of butterfly bush along disturbed areas, including railways and roadside ROW.	N/A	N/A	Buddleja davidii, Buddlejaceae, Butterfly Bush, Invasive Species	global	throughout	Eng	N	N	N/A
GO0169	ROW for Pollinators & Birds	IVM Partners	presentation	NGO	N/A	https://www.ivmpartners.org/pollinator/	rail restoration pollinator	100	Pollinators	roadsides, railways, power lines	N/A	N/A	N/A	N/A	Describes a large number of case studies on habitat restoration under power line ROW	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A

GO0170	Using native plants to create pollinator habitat: lessons learned and new perspectives	Tom D. Landis	presentation	private entity	2016	https://westernforestry.org/wp-content/uploads/2016/10/SeventhNativePlants_Landis.pdf	rail restoration pollinator	100	Pollinators	N/A	N/A	N/A	N/A	N/A	Describes habitat restoration for monarch butterflies and mentions the creation of a "monarch railroad" for migration	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0061	Press Release: Illinois Pollinator-friendly solar energy bill passes, adds momentum to solar energy development	Environmental Law and Policy Center	Press release	NGO	2018	http://elpc.org/issues/clean-energy/solar/press-release-illinois-pollinator-friendly-solar-energy-bill-passes-adds-momentum-solar-energy-	"rail" conservation pollinator	99	Pollinators	solar farms	N/A	N/A	N/A	N/A	Legislation encourages solar developers to create pollinator habitat on farms; developed with the Center for Pollinators and Energy	N/A	Both	N/A	USA	Illinois	Eng	N	N	N/A
GO0082	Management Recommendations for Native Insect Pollinators in Texas	Texas Parks and Wildlife	technical report	gov't agency (state)	2016	https://tpwd.texas.gov/publications/pwdpubs/media/pwd_bk_w7000_1813.pdf	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Cites NRCS on pollinator plantings: blocks preferred, but if strips, they need to be at least 20 feet wide.	N/A	Both	N/A	USA	Texas	Eng	N	N	N/A

GO0090	Massachusetts Pollinator Protection Plan	Massachusetts Department of Agricultural Resources	technical report	gov't agency (state)	2017	https://www.mass.gov/files/documents/2017/06/zw/pollinator-plan.pdf	road management pollinator	87	Pollinators	roadsides, open space	N/A	N/A	N/A	N/A	Links to USDOT FHWA sources on pollinator habitat management along roadsides, suggests partnering with relevant state departm	N/A	Both	N/A	USA	Massachusetts	Eng	N	N	N/A
GO0095	Enhancing pollinator habitats at Waste Management Sites	Ontario Waste Management Association	technical report	industry group	2017	https://www.owma.org/articles/enhancing-pollinator-habitat-at-waste-management-sites	road management pollinator	87	Pollinators	waste management sites	N/A	N/A	N/A	N/A	Suggests establishing habitat in fallow areas at waste management sites in patches, strips, or large gardens at capped sites. Recomm	N/A	Both	N/A	Canada	Ontario	Eng	N	N	N/A
GO0096	West Virginia Pollinator Protection Plan	West Virginia Department of Agriculture	technical report	gov't agency (state)	N/A	https://agriculture.wv.gov/SiteCollectionDocuments/WVPollinator.pdf	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Suggests incorporating pollinator friendly seed into roadside seed mixes and spot-spraying herbicides on problem areas to reduce pesticide exposure	N/A	Both	N/A	USA	West Virginia	Eng	N	N	N/A

GO0097	Rapid assessment of pollinators' status: A contribution to the international initiative for the conservation and sustainable use of pollinators	United Nations Food and Agriculture Organization	technical report	NGO	2008	http://www.fao.org/uploads/media/raps_2.pdf	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Mentions DOTs as producers of pollination services owing to road shoulder vegetation	N/A	Both	N/A	global	throughout	Eng	N	N	N/A
GO0098	Pollinator conservation and farm system planning	USDA Natural Resources Conservation Service	technical report	gov't agency (federal)	2011	https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/kspmctn10378.pdf	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Recognizes linear features as existing pollinator habitat and their vegetation and potential pollinator forage	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0102	DNR Pollinator Best Management Practices and Habitat Restoration Guidelines	Minnesota Department of Natural Resources	technical report	gov't agency (state)	2014	https://files.dnr.state.mn.us/natural_resources/npc/2014_draft_pollinator_bmp_guidelines.pdf	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Suggests adjusting roadside vegetation management on DNR lands to be more pollinator friendly: time mowing better and spray herbicide	N/A	Both	N/A	USA	Minnesota	Eng	N	N	N/A

GO0104	Pollinator Initiatives in EU Member States: Success Factors and Gaps	The Institute for European Environmental Policy	technical report	gov't agency (international)	2017	http://ec.europa.eu/environment/nature/conservation/species/pollinators/documents/iep_2017_pollinator_initiatives_in_eu_member_states.pdf	road restoration pollinator	89	Pollinators	roadsides, railways, water edges	N/A	N/A	N/A	N/A	Mentions ROW as source of pollinator habitat, lists EU initiatives in the Netherlands, UK, and Belgium where ROW are being actively managed for	N/A	Both	N/A	Europe	throughout	Eng	N	N	N/A
GO0106	Maryland Department of Natural Resources Pollinator Habitat Plan	Maryland Department of Natural Resources	technical report	gov't agency (state)	2017	https://dnr.maryland.gov/wildlife/Documents/PollinatorHabitatPlan_June2017.pdf	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	The Maryland Park Service is "examining opportunities to create pollinator edge habitat in strips of land adjacent to roads" by reducing	N/A	Both	N/A	USA	Maryland	Eng	N	N	N/A
GO0108	Pollinator Biology and Habitat	USDA Natural Resources Conservation Service	technical report	gov't agency (federal)	2013	https://efotg.sc.egov.usda.gov/references/public/MI/Biol_TN_20_Pollinator-Biology-and-Habitat_v1-1_honey_bee_preferences.pdf	road restoration pollinator	89	Pollinators	roadsides	N/A	N/A	N/A	N/A	Recognizes linear features as existing pollinator habitat and their vegetation as potential pollinator forage	N/A	Both	N/A	USA	Michigan	Eng	N	N	N/A

GO0111	Pollinator Plan	Minnesota Board of Water and Soil Resources	technical report	gov't agency (state)	2017	http://www.bwsr.state.mn.us/practices/pollinator/pollinator-plan.pdf	road restoration pollinator	89	Pollinators	open space	N/A	N/A	N/A	N/A	Focuses on wetland restoration and protection, agricultural conservation, and urban water quality projects as sources of	N/A	Both	N/A	USA	Minnesota	Eng	N	N	N/A
GO0117	Pollinator Enhancement (Cranberry BMPs)	University of Massachusetts Amherst Extension	technical report	Extension	2010	https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1022&context=cranberrybmp2010	road enhancement pollinator	90	Pollinators	roadsides, hedgerows, water edges	N/A	N/A	N/A	N/A	Mentions road edges as potential source of habitat; has long list of plants associated with cranberry beds that pollinators feed on outside of crop	N/A	Both	N/A	USA	Massachusetts	Eng	N	N	N/A
GO0121	Butterflies and Moths of Pacific Northwest Forests and Woodlands: Rare, Endangered, and Management-Sensitive Species.	USDA Forest Service	technical report	gov't agency (federal)	2007	https://www.fs.fed.us/foresthealth/technology/pdfs/MILLER_LEPIDOPTERA_WEB.pdf	road management butterflies	93	butterflies and moths	roadsides	N/A	N/A	N/A	N/A	Mentions multiple butterfly species associations with forest roadsides; repeatedly describes roadsides as helpful habitat for species of	N/A	Both	N/A	USA	Pacific Northwest	Eng	N	N	N/A

GO0132	Selfridge, J., et al. 2018. Conservation and management of rare wetland butterflies: strategies for monitoring, modeling, and wetland	Wildlife Management Institute	technical report	NGO	2018	https://rcngrants.org/sites/default/files/final_reports/RCN%202015-2%20Wetland%20Butterflies%20FINAL%20REPORT%2026FEB2018%20FORMATTED.pdf	road management butterflies	93	butterflies	roadsides	N/A	N/A	N/A	field survey	Roadside sites adjacent to wetlands were surveyed in Maryland; species of concern were found in these sites. Report features	Observational	Conservation	N/A	USA	Mid-Atlantic (MD, PA, NJ)	Eng	N	N	N/A
GO0137	Managing woodland for butterflies and moths	Butterfly Conservation UK	technical report	NGO	2011	https://butterfly-conservation.org/files/woodland_management_for_butterflies_managingwoodland.pdf	road management lepidoptera	96	butterflies	rides (forest trails)	N/A	N/A	N/A	N/A	Important open areas in woodland with butterfly habitat resources. Four key factors: 1) amount of shade, 2) amount of vegetatio	N/A	Both	N/A	UK	throughout	Eng	N	N	N/A
GO0139	Maskey, A.M., and Loope, L.M. Butterfly and moth ((Lepidopteran) Survey of Pictured Rocks National Lakeshore, 2000-2006	Science and Natural Resources Division, Pictured Rocks National Lakeshore	technical report	gov't agency (federal)	2006	https://www.nps.gov/piro/learn/nature/upload/PIRO-Lepidopteran-Survey-2000-2006.pdf	road management lepidoptera	96	Lepidoptera	roadsides, open space, wetlands	N/A	N/A	N/A	field survey	Surveyed butterflies and moths along roads and in other open space; found a species typically found further south along a road	Observational	Conservation	N/A	USA	Michigan	Eng	N	N	HIGH

GO0144	Summerville, K.S., Saunders, M.R., and Lane, J.L. 2013. The lepidoptera as predictable communities of herbivores: a test of niche assembly using the moth	USDA Forest Service	technical report	gov't agency (federal)	2013	https://www.fs.usda.gov/treesearch/pubs/42925	road management lepidoptera	96	moths	forest harvest	species assemblages	plant basal area, plant species, plant density	habitat characteristics, environmental variables	field study	moths linked to density of trees, oak presence, and basal area of shrubs and saplings, though much variance was left unexplained.	Observational	Management	N/A	USA	Indiana	Eng	N	N	Medium
GO0147	All-Ireland Pollinator Plan: Year 2 Review	National Biodiversity Data Centre, The Heritage Council	technical report	gov't agency (federal)	2017	https://pollinators.ie/	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Describes progress on All-Ireland schemes to create pollinator habitat along roadsides and railways; they will be published in 2018.	N/A	N/A	N/A	Ireland	throughout	Eng	N	N	N/A
GO0148	All-Ireland Pollinator Plan: Brief summary note	National Biodiversity Data Centre, The Heritage Council	technical report	gov't agency (federal)	N/A	https://pollinators.ie/	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Summarizes longer report, emphasizing actions citizens can take to create pollinator habitat.	N/A	N/A	N/A	Ireland	throughout	Eng	N	N	N/A

GO0149	Bees and Pollination: Will the wind produced by the high-speed train disrupt bee pollination activity?	California High Speed Rail Authority Agricultural Working Group	technical report	gov't agency (state)	2012	n/a	rail management pollinator	98	Bees	railways	N/A	N/A	N/A	Review	Describes potential risk to bees pollinating flowers near railways from high wind speeds associated with passing trains.	Observational	Both	N/A	USA	California	Eng	N	N	N/A
GO0151	Glasgow Pollinator Plan: 2017-2027	Glasgow City Council	technical report	gov't agency (local)	2017	https://www.glasgow.gov.uk/chttphandler.ashx?id=40410&p=0#:~:text=The%20Glasgow%20Pollinator%20Plan%20sets,'%20(Scottish%20Natural%20Heritage).	rail management pollinator	98	Pollinators	N/A	N/A	N/A	N/A	N/A	Details a 10 year plan for pollinator habitat in Glasgow, Scotland. Mentions railways once, but no other mentions of ROW.	N/A	Both	N/A	UK	Glasgow, Scotland	Eng	N	N	N/A
GO0154	NL Pollinator Strategy: Bed and Breakfast for Bees	The Hague	technical report	gov't agency (federal)	2018	https://www.government.nl/documents/reports/2018/02/02/nl-pollinator-strategy-bed--breakfast-for-bees	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Reviews a series of projects happening throughout the Netherlands to create pollinator habitat, including some along roadsides and	N/A	Both	N/A	The Netherlands	throughout	Eng	N	N	N/A

GO0155	REVIEW OF POLLINATORS AND POLLINATION RELEVANT TO THE CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY IN ALL ECOSYSTE	IPBES, Convention on Biological Diversity	technical report	NGO	2018	https://www.cbd.int/agro/peer_review_pollinators.pdf	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	A literature review of the role of pollinators beyond agriculture: their value, status, trends, and shifts in population, and suggestions for	N/A	Both	N/A	global	throughout	Eng	N	N	N/A
GO0157	Pollinator Strategy for Scotland: 2017-2027 Technical Annex	Scottish Natural Heritage, The Scottish Government	technical report	gov't agency (federal)	2017	https://www.nature.scot/sites/default/files/2018-04/Pollinator%20Strategy%20for%20Scotland%202017-2027%20-%20Technical%20Annex.pdf	rail management pollinator	98	Pollinators	railways	N/A	N/A	N/A	N/A	Review of Scotland's pollinator species and threats to their populations.	N/A	Conservation	N/A	Scotland	throughout	Eng	N	N	N/A
GO0158	A consultation on the National Pollinator Strategy: for bees and other pollinators in England	Defra	technical report	gov't agency (federal)	2014	https://consult.defra.gov.uk/plant-and-bee-health-policy/a-consultation-on-the-national-pollinator-strategy/supporting_documents/140305%20National	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	This document presents accumlated evidence on UK pollinator populations, threats, and proposed management strategies, then	N/A	Both	N/A	UK	throughout	Eng	N	N	N/A

GO0159	The National Pollinator Strategy: for bees and other pollinators in England	Defra	technical report	gov't agency (federal)	2014	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794706/national-pollinator-strategy.pdf	rail management pollinator	98	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Presents the UK's 10 year National Pollinator Strategy, which suggests roadside and railway habitat enhancement.	N/A	Both	N/A	UK	throughout	Eng	N	N	N/A
GO0160	EU Pollinator Initiative: What will success look like?	Multiple NGOs	technical report	NGO	2018	https://cdn.buglife.org.uk/2019/07/Full-Pollinator-Initiative-response-Final.pdf	"rail" conservation pollinator	99	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Mentions roads and rails as sources of pollinator habitat enhancement within a possible EU-wide pollinator conservation strategy	N/A	Conservation	N/A	EU	throughout	Eng	N	N	N/A
GO0161	Pollinator Strategy for Scotland: 2017-2027	Scottish Natural Heritage, The Scottish Government	technical report	gov't agency (federal)	2017	https://www.nature.scot/sites/default/files/2018-04/Pollinator%20Strategy%20for%20Scotland%202017-2027.pdf	"rail" conservation pollinator	99	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Mentions roads and rails as sources of pollinator habitat enhancement within Scotland's national pollinator conservation strategy	N/A	Both	N/A	Scotland	throughout	Eng	N	N	N/A

GO0163	National pollinator strategy: Progress report 2016	Defra	technical report	gov't agency (federal)	2016	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794670/nps-progress-report2016.pdf	"rail" conservation pollinator	99	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Updates on progress of the UK national pollinator strategy, including new habitat along roadsides and railways	N/A	Both	N/A	UK	throughout	Eng	N	N	N/A
GO0166	Native Pollinator and Native Plant Demonstration Project	DENIX	technical report	gov't agency (federal)	N/A	https://denix.osd.mil/nr/focus-areas/pollinators/technical-reports/native-pollinators-native-plant-demonstration-project-dyess-air-force-base/	rail restoration pollinator	100	Pollinators	N/A	N/A	N/A	N/A	N/A	Details a restoration project on an air force base in Texas.	N/A	Both	N/A	USA	Abilene, Texas	Eng	N	N	N/A
GO0168	EU Pollinator Initiative	European Commission	technical report	gov't agency	2018	https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=152821373713&uri=CELEX:52018DC0395	rail restoration pollinator	100	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Mentions roadsides and railways as one solution for restoring pollinator habitat	N/A	Both	N/A	Europe	throughout	Eng	N	N	N/A

GO0173	Pollinator Resource Values for Upland and Wetland Prairies	Minnesota Department of Natural Resources	technical report	gov't agency (state)	2014	https://files.dnr.state.mn.us/natural_resources/npc/pollinator_booklet_single.pdf	rail restoration pollinator	100	Pollinators	railways	N/A	N/A	N/A	N/A	Mentions MN Biological Survey data on Railroad right-of-way prairies as a reference on native plant restoration for pollinator communities	N/A	Management	N/A	USA	Minnesota	Eng	N	N	N/A
GO0174	Pollinator Strategy for Scotland: 2017-2027 Implementation Plan	Scottish Natural Heritage, The Scottish Government	technical report	gov't agency (federal)	2017	https://www.nature.scot/sites/default/files/2018-04/Pollinator%20Strategy%20for%20Scotland%202017-2027%20-%20Implementation%20Plan.pdf	rail restoration pollinator	100	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Mentions roads and rails as sources of pollinator habitat enhancement within Scotland's national pollinator conservation strategy	N/A	Both	N/A	Scotland	throughout	Eng	N	N	N/A
GO0176	Summary for policymakers of the thematic assessment on pollinators, pollination and food production (deliverable 3 (a))	IPBES	technical report	NGO	2016	https://ipbes.net/sites/default/files/downloads/IPBES-4-3-Corr-1_EN.pdf	rail enhancement pollinator	101	Pollinators	roadsides, railways	N/A	N/A	N/A	N/A	Summarizes full IPBES assessment; mentions that roads and rails are a place to enhance pollinator habitat.	N/A	Conservation	N/A	global	throughout	Eng	N	N	N/A

GO0179	Submission to Ontario's Draft Pollinator Health Action Plan	Ontario Beekeeper's Association	technical report	NGO	2016	https://www.ontariobee.com/sites/ontariobee.com/files/OBA-Response-Ontario-Pollinator-Action-Plan-FINAL-Mar1.pdf	rail enhancement pollinator	101	Honey bees	roadsides, railways	N/A	N/A	N/A	N/A	Describes threats to pollinators in agricultural landscapes from pesticide exposure; warns against establishing road/rail ROW habitat in	N/A	Conservation	N/A	Canada	Ontario	Eng	N	N	N/A		
GO0184	Managed Pollinator Protection Plan	Hank Uhden, Agriculture Program Manager, Wyoming Department of Agriculture	technical report	gov't agency (state)	2015	https://wyoextension.org/laramiecounty/wp-content/uploads/WyomingPollinatorPlan-2015.pdf	rail enhancement pollinator	101	Pollinators	roadsides, power lines	N/A	N/A	N/A	N/A	General BMPs for pollinator habitat creation and maintenance.	N/A	Both	N/A	USA	Wyoming	Eng	N	N	N/A		
GO0185	Conservation advice: Ogyris subterrestris petrina -- Arid bronze azure (a butterfly)	Australian Government Department of Agriculture, Water, and the Environment	technical report	gov't agency (federal)	2015	http://www.environment.gov.au/biodiversity/threatened/species/pubs/77743-conservation-advice.pdf	rail management butterflies	102	Ogyris subterrestris petrina -- Arid bronze azure (a butterfly)	railway	N/A	N/A	N/A	N/A	A critically endangered Australian butterfly has one of its few extant populations within railway ROW. Makes recommendations for best	N/A	Both	N/A	Australia	Lake Douglas, Western Australia	Eng	N	N	N/A		

GO0188	Conservation Strategy for the Eastern Monarch Butterfly (Danaus plexippus) in Iowa	Iowa Monarch Conservation Consortium	technical report	NGO	2018	https://monarch.ent.iastate.edu/files/file/iowa-monarch-conservation-strategy.pdf	rail management butterflies	102	Monarch butterfly	roadsides, railways, power lines	N/A	N/A	N/A	N/A	One piece of this plan is to establish formal BMPs for monarch conservation on rights-of-way; they will be released in a future version of the	N/A	Both	N/A	USA	Iowa	Eng	N	N	N/A
GO0189	On the right lines? Vegetation Management on London's Railway Embankments	London Assembly/ Greater London Authority	technical report	gov't agency (local)	2012	https://www.london.gov.uk/about-us/londonassembly/meetings/mgConvert2PDF.aspx?ID=7843	rail management butterflies	102	butterflies	railways	N/A	N/A	N/A	N/A	Mentions that butterflies live along London's railway embankments.	N/A	Both	N/A	UK	throughout	Eng	N	N	N/A
GO0191	Species action plan: Small Blue (Cupido minimus)	Butterfly Conservation UK	technical report	NGO	2000	https://butterfly-conservation.org/sites/default/files/small-blue-action-plan.doc	rail management butterflies	102	Small blue butterfly	railways, roadsides	N/A	N/A	N/A	N/A	Describes habitat for a threatened butterfly species: its food source was common along managed railway embankments; as railways fell into	N/A	Both	N/A	UK	throughout	Eng	N	N	N/A

GO0134	New, T.R. 2015. Insect Conservation and Urban Environments. Springer Interntational Publishing.	Tim R. New	textbook	academic literature	2015	https://www.springer.com/us/book/9783319212234	road management lepidoptera	96	Insects	urban remnants	N/A	N/A	N/A	N/A	Lists traffic as an urban threat to insects, and many mentions of roads as a negative impact on insect populations. No sections specific to ROW	N/A	Both	N/A	global	throughout	Eng	N	N	N/A
GO0167	From Nothing to Something: Repurpose and Restoration of Abandoned Railroads	Elaine Palacios, UC Davis	Thesis	academic literature	2013	https://humanecology.ucdavis.edu/sites/g/files/dgvnsk161/files/inline-files/EPalacios.pdf	rail restoration pollinator	100	n/a	railways	N/A	N/A	N/A	N/A	A landscape architecture project describing restoration potential along railways, including food for people and pollinator	N/A	Both	N/A	USA	Alameda, CA	Eng	N	N	N/A
GO0183	Scenarios for Pollinator Habitat at Denver International Airport	University of Michigan	Thesis	academic literature	2018	https://deepblue.lib.umich.edu/bitstream/handle/2027.42/143173/Scenarios%20for%20Pollinator%20Habitat%20at%20Denver%20International%20Airport_328.	rail enhancement pollinator	101	wild bees	Airport	abundance	Scenario type	habitat characteristics	Scenarios/modeling	Uses the InVEST Crop Pollination Model to assess potential outcomes of incorporating pollinator habitat into two different development scenarios	Both	Both	N/A	USA	Denver, CO	Eng	N	N	N/A

GO0003	Pollinators of Wisconsin	Wisconsin Department of Natural Resources	webpage	gov't agency (state)	2018	https://dnr.wi.gov/topic/endangeredresources/pollinators.html	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Mentions roadways as a source of pollinator habitat loss, degradation, and fragmentation. Links to many general resources on pollinators and	N/A	Both	N/A	USA	Wisconsin	Eng	N	N	N/A
GO0004	Operation Pollinator | Syngenta	Syngenta	webpage	private entity	N/A	http://www.syngenta-us.com/beehealth/operationpollinator.aspx	road management pollinator	87	Pollinators	field margins, hedgerows	N/A	N/A	N/A	N/A	Describes two avenues of pollinator habitat restoration: field margins in agricultural landscapes and golf courses in human-impacted	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0007	Pollinator Best Practices Summit: 2018	Pollinator Friendly Alliance	webpage	NGO	N/A	https://www.pollinatorfriendly.org/pollinator-friendly-summit-2018/	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Conference website describing sessions on roadside vegetation management for pollinators.	N/A	Both	N/A	USA	Minnesota	Eng	N	N	N/A

GO0007b	Pollinator Best Practices Summit 2018: Success!	Pollinator Friendly Alliance	webpage	NGO	2018	https://www.pollinatorfriendly.org/news/2018/2/21/best-practices-for-pollinators-summit-success-february-8-2018	road management pollinator	87	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes conference talks, including mention of roadsides as potential habitat.	N/A	Both	N/A	USA	Minnesota	Eng	N	N	N/A
GO0010	Pollinators - Boulder County	Boulder County	webpage	gov't agency (County)	N/A	https://www.bouldercounty.org/open-space/management/agriculture/pollinators/	road management pollinator	87	Pollinators	Open space	N/A	N/A	N/A	N/A	Boulder County's Open Space Department has a multipronged pollinator habitat program, including scientific research projects and multiple habitat	N/A	Both	N/A	USA	Colorado	Eng	N	N	N/A
GO0015	ROW Paths for Pollinators	Integrated Vegetation Management Partners	webpage	private entity	N/A	https://www.ivmpartners.org/pollinator/	road management pollinator	87	Pollinators	power lines	N/A	N/A	N/A	N/A	Describes projects and management strategies under power line ROW to reduce invasive plants, promote pollinators	N/A	Both	N/A	USA	mid-Atlantic coast (MD, NJ)	Eng	N	N	N/A

GO0017	Pollinator-friendly solar resources	University of Vermont Extension	webpage	Extension	N/A	https://www.uvm.edu/extension/agriculture/pollinatorfriendly-solar	road management pollinator	87	Pollinators	solar farms	N/A	N/A	N/A	N/A	Encourages solar farm owners/ managers to plant pollinator habitat; provides strategies and resources to do so	N/A	Both	N/A	USA	Vermont	Eng	N	N	N/A
GO0022	Conservation, Reclamation, Wildflowers, and Pollinators	Northeast Agricultural Sales, Inc.	webpage	private entity	N/A	https://www.neagsales.com/conservation-reclamation-wildflower-pollinators.htm	"road" conservation pollinator	88b	Pollinators	roadsides	N/A	N/A	N/A	N/A	Describes two pollinator seed mixes developed for the northeast US: one for bees, one for birds and butterflies	N/A	Both	N/A	Northeast US	throughout	Eng	N	N	N/A
GO0030	Corridors for Pollinators	Save our Monarchs	webpage	NGO	N/A	https://www.saveourmonarchs.org/corridors-for-pollinators.html	road restoration pollinator	89	Pollinators	power lines	N/A	N/A	N/A	N/A	Describes efforts and existing partnerships with utility companies and state DOTs to manage power line and roadside ROW as pollinator habitat	N/A	Both	N/A	USA	IL, NB	Eng	N	N	N/A

GO0035	Pollinator Project	Hampton Lumber	webpage	private entity	2018	http://www.hamptonlumber.com/sustainability/sustainable-forests/pollinator-project/	road enhancement pollinator	90	wild bees	forest harvest	N/A	N/A	N/A	N/A	Describes a project in which recently harvested forest is augmented with seeds and nesting habitat to promote pollinator populations	N/A	Both	N/A	USA	Oregon	Eng	N	N	N/A
GO0039	Monarch Butterfly Inventory and Habitat Management Plan	City of Goleta, CA	webpage	gov't agency (city)	2018	http://www.cityofgoleta.org/city-hall/planning-and-environmental-review/monarch-butterfly-inventory-and-habitat-management-plan	road management butterflies	93	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	Open space plan for a city within southern California's monarch overwintering habitat.	N/A	Both	N/A	USA	California	Eng	N	N	N/A
GO0042	Regal Fritillary Butterfly Habitat at Fort Indiantown Gap	Pennsylvania Dept of Military and Veterans Affairs	webpage	gov't agency (state)	2018	https://www.dmva.pa.gov/dmvaoffices/Environmental-Resources/Pages/Regal-Fritillary-Butterfly-FTIG.aspx	road management butterflies	93	Regal fritillary	Open space	N/A	N/A	N/A	N/A	This is the location of the largest regal butterfly population in the eastern US; the miltary base works with state and federal agencies	N/A	Both	N/A	USA	Pennsylvania	Eng	N	N	N/A

GO0043	Karner blue butterfly	Wisconsin Department of Natural Resources	webpage	gov't agency (state)	2018	https://dnr.wi.gov/topic/endangeredresources/karner/	road management butterflies	93	Karner blue butterfly	Open space	N/A	N/A	N/A	N/A	Links to resources regarding habitat conservation and enhancement for the endangered Karner blue; its largest populations occur in Wisconsi	N/A	Both	N/A	USA	Wisconsin	Eng	N	N	N/A
GO0045	Monarch Butterfly Sanctuary	city of Pacific Grove, CA	webpage	gov't agency (city)	N/A	https://www.cityofpacificgrove.org/visiting/monarch-butterfly-sanctuary	road management butterflies	93	Monarch butterflies	Open space	N/A	N/A	N/A	N/A	Information and management plan for a preserve within the southern California monarch overwintering habitat	N/A	Both	N/A	USA	California	Eng	N	N	N/A
GO0048	The Xerces Society: Joan DeWind Award	The Xerces Society	webpage	NGO	2018	https://xerces.org/joan-dewind-award/	road management lepidoptera	96	Monarch butterflies	roadsides	N/A	N/A	N/A	N/A	highlights a Minnesota research project on the effects of road salt on monarch butterflies	N/A	Both	N/A	USA	Minnesota	Eng	N	N	N/A

GO0051	IVM - Nature and Technology: A Beautiful Partnership	Bayer CropScience	webpage	private entity	2017	https://www.cropscience.bayer.com/en/stories/2017/integrated-vegetation-management-nature-and-technology-a-beautiful-partners	rail management pollinator	98	Pollinators	power lines	N/A	N/A	N/A	N/A	Describes motivations behind using IVM in power lines and benefits to pollinators. Partners with the NGO IVM Partners to establish BMPs	N/A	Both	N/A	USA	throughout	Eng	N	N	N/A
GO0052	TWPD: Native Pollinators and Private Lands	Texas Parks and Wildlife	webpage	gov't agency (state)	N/A	https://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/native-pollinators/	rail management pollinator	98	Pollinators	Open space	N/A	N/A	N/A	N/A	Links to state management plans, background information, citizen science projects, and NGOs	N/A	Both	N/A	USA	Texas	Eng	N	N	N/A
GO0055	Energy groups seek best practices for restoring pollinator habitats	Energy News Network	webpage	private entity	2017	https://energynews.us/2017/05/05/midwest/energy-groups-seek-best-practices-for-restoring-pollinator-habitats/	rail management pollinator	98	Pollinators	power lines	N/A	N/A	N/A	N/A	Reviews efforts in IL, MN, and a study in FL to create pollinator habitat on ROW: reduces management costs and creates beneficial habitat	N/A	Both	N/A	USA	IL, MN, FL	Eng	N	N	N/A

GO0078	Ryton Wood Meadows Butterfly Reserve	Butterfly Conservation UK Warwickshire	webpage	NGO	N/A	https://www.warwickshire-butterflies.org.uk/reserve.php	rail management butterflies	102	butterflies	railways, open space	N/A	N/A	N/A	N/A	Species of concern for this group, the grizzled skipper, dingy skipper, and green hairstreak, are all found along railway clearings	N/A	Conservation	N/A	UK	Warwickshire	Eng	N	N	N/A
GO0079	Brownfield sites as butterfly and moth habitat	Butterfly Conservation UK NE England	webpage	NGO	N/A	http://www.northeast-butterflies.org.uk/habitats_and_sites/brownfield.html	rail management butterflies	102	butterflies	brownfield sites	N/A	N/A	N/A	N/A	Describe brownfield sites, including railways, mines, and quarries, where diverse and abundant butterfly communities have been observed	N/A	Conservation	N/A	UK	Northeast	Eng	N	N	N/A
GO0195	see citation list for last result!																							

Acc#	Ref#	Authors	Year	Article type	Country	Study design	ROW type	ROW modifier	Control habitat	Ctrl modifier	Mngmt type	Mngmt 2	Site dist ≥ 1km	Site selection	Spatial replication	Bias level	Landscape	Threat	Study length	Sample year	# of sample occasions	Page/source	Type of organism	Order	Family	Type	Genus	Species	Status	Type of variable	Variable	Nt	meant	SEt	vart	Nc	meanc	SEc	varc	t statistic	t-test result	t-test p	chi-squared	chi-sq p	df	Z-score	Z p	Ncorrected	Hedge's d	var of d	Notes
gs_055_001	GS0055	Kaul and Wilsey	2019	Journal article	USA	CI	road side	prairie restoration	conservation planting	prairie restoration	restoration	seeding	n/a	YES	YES	Low	NO	n/a	2 years			Table 1	Plants			Plants		all milkweeds		amount	stem density per hectare	46	3260	664		47	920.7	226										93			
gs_055_002	GS0055	Kaul and Wilsey	2019	Journal article	USA	CI	road side	prairie restoration	conservation planting	prairie restoration	restoration	seeding	n/a	YES	YES	Low	NO	n/a	2 years			Table 1	Plants			Plants		seeded milkweeds		amount	stem density per hectare	37	3127	734		20	845.3	369										57			
gs_055_003	GS0055	Kaul and Wilsey	2019	Journal article	USA	CI	road side	prairie restoration	conservation planting	prairie restoration	restoration	seeding	n/a	YES	YES	Low	NO	n/a	2 years			Table 1	Plants			Plants		unseeded milkweeds		amount	stem density per hectare	2	1805	1380		7	1391	856										9			
gs_055_004	GS0055	Kaul and Wilsey	2019	Journal article	USA	CI	road side	prairie restoration	conservation planting	prairie restoration	restoration	seeding	n/a	YES	YES	Low	NO	n/a	2 years			Table 1	Plants			Plants		seeded common milkweed		amount	stem density per hectare	2	424.6	425		1	0	0										3			
gs_055_005	GS0055	Kaul and Wilsey	2019	Journal article	USA	CI	road side	prairie restoration	conservation planting	prairie restoration	restoration	seeding	n/a	YES	YES	Low	NO	n/a	2 years			Table 1	Plants			Plants		unseeded common milkweed		amount	stem density per hectare	37	2330	572		26	850.3	338										63			
gs_073_001	GS0073	Haan and Landis	2019	Journal article	USA	CI	road side, railway, lawn, old field, field margin	mowed	roadside, railway, lawn, old field, field margin	unmowed	mowing	n/a	n/a	NO	YES	Medium	NO	mowing	2 years		weekly for 2-3 mos	Section 3.3, pg 188	Pollinators			Butterflies		Monarch	Eggs/1st instar	amount	survival, June	22	34.17%	6		22	25%	5.38													
gs_073_002	GS0073	Haan and Landis	2019	Journal article	USA	CI	road side, railway, lawn, old field, field margin	mowed	roadside, railway, lawn, old field, field margin	unmowed	mowing	n/a	n/a	NO	YES	Medium	NO	mowing	2 years		weekly for 2-3 mos	Section 3.3, pg 189	Pollinators			Butterflies		Monarch	Eggs/1st instar	amount	survival, July	22	40.00%	7		22	36%	6.86													
gs_086_001	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	1 mowing regime; plot size	roadside	unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_002	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	2 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.003	0.02		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control

gs_086_003	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	3 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.001	0.01		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_004	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	4 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.031	0.12		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_005	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	5 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_006	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	6 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_007	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	7 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control

gs_086_008	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	8 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	1	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	n/a	n/a	n/a		n/a	0.001	0.01													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_009	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	1 mowing regime; plot size	roadside	unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	n/a	n/a	n/a		n/a	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_010	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	2 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.044	0.14		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_011	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	3 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.06	0.11		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_012	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	4 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.082	0.2		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control

Appendix E3

gs_086_013	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	5 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.14	0.28		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_014	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	6 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.006	0.03		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_015	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	7 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0.095	0.28		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_016	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	8 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	2	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.015	0.09													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_017	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	1 mowing regime; plot size	roadside	unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control

gs_086_018	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	2 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	14	0.022	0.1		14	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_019	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	3 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	14	0.032	0.08		14	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_020	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	4 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	14	0.058	0.17		14	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_021	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	5 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	14	0.074	0.21		14	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_022	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	6 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	14	0.004	0.02		14	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control

gs_086_023	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	7 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	14	0.049	0.21		14	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control
gs_086_024	GS0086	Knight et al	2019	Journal article	Canada	CI	road side	8 mowing regime; plot size		unmowed	mowing	n/a	n/a	NO	NO	Medium	NO	mowing	2 years	all	wkly for 2 mo	Table 5, Table 1	Pollinators			Butterflies		Monarch	EGGS	amount	abundance per milkweed plant	7	0	0		7	0.007	0.06													Paired plots; half was mowed, half was control. Overall mean for all control
ex_1	init0001	Keilsohn et al.	2018	Journal article	USA	CI	road side	lawn with median	roadside	lawn no median	n/a	n/a	NO	n/a	n/a	HIGH	n/a	traffic volume	one year	n/a	5	Table 1; Figure 4	Pollinator	Insecta	Hymenoptera	Bees				amount	mortality	20	19.3	3.66	0.82	20	5.6	1.73	0.39												Site numbers totally unclear: had to count dots on Figure 4 to obtain
ex_2	init0001	Keilsohn et al.	2018	Journal article	USA	CI	road side	meadow with median	roadside	meadow no median	n/a	n/a	NO	n/a	n/a	HIGH	n/a	traffic volume	one year	n/a	5	Table 1; Figure 4	Pollinator	Insecta	Hymenoptera	Bees				amount	mortality	20	11.25	2.2	0.49	19	11.9	3.99	0.91												Site numbers totally unclear: had to count dots on Figure 4 to obtain
ex_3	init0001	Keilsohn et al.	2018	Journal article	USA	CI	road side	wooded with median	roadside	wooded no median	n/a	n/a	NO	n/a	n/a	HIGH	n/a	traffic volume	one year	n/a	5	Table 1; Figure 4	Pollinator	Insecta	Hymenoptera	Bees				amount	mortality	20	1.1	0.32	0.07	20	2	0.81	0.18												Site numbers totally unclear: had to count dots on Figure 4 to obtain

ex_4	init0001	Keilsohn et al.	2018	Journal article	USA	CI	road side	lawn with median	roadside	lawn no median	n/a	n/a	NO	n/a	n/a	HIGH	n/a	traffic volume	one year	n/a	5	Table 1; Figure 3	Pollinator	Insecta	Lepidoptera	Butterflies				amount	mortality	20	3.9	1.26	0.28	20	0.95	0.41	0.09												Site numbers totally unclear: had to count dots on Figure 3 to obtain
ex_5	init0001	Keilsohn et al.	2018	Journal article	USA	CI	road side	meadow with median	roadside	meadow no median	n/a	n/a	NO	n/a	n/a	HIGH	n/a	traffic volume	one year	n/a	5	Table 1; Figure 3	Pollinator	Insecta	Lepidoptera	Butterflies				amount	mortality	19	9.95	2.54	0.58	19	2.9	1.25	0.28												Site numbers totally unclear: had to count dots on Figure 3 to obtain
ex_6	init0001	Keilsohn et al.	2018	Journal article	USA	CI	road side	wooded with median	roadside	wooded no median	n/a	n/a	NO	n/a	n/a	HIGH	n/a	traffic volume	one year	n/a	5	Table 1; Figure 3	Pollinator	Insecta	Lepidoptera	Butterflies				amount	mortality	19	0.75	0.27	0.06	19	0.25	0.12	0.03												Site numbers totally unclear: had to count dots on Figure 3 to obtain
i_008_001	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native forb				amount	percent coverage	5	7.8	1.53		5	49.64	7.94										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_002	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Nonnative forb				amount	percent coverage	5	2.54	0.54		5	2.22	0.46										5			This study reports paired Means and SEs at the beginning and end of treat

i_008_003	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native grass				amount	percent coverage	5	1.84	0.47		5	4.93	0.94										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_004	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Nonnative grass				amount	percent coverage	5	134.5	8.77		5	115.6	9.01										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_005	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native rush				amount	percent coverage	5	0.03	0.03		5	3.11	1.06										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_006	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native legume				amount	percent coverage	5	0.02	0.02		5	5.62	2.57										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_007	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Nonnative legume				amount	percent coverage	5	6.79	2.87		5	7.16	4.17										5			This study reports paired Means and SEs at the beginning and end of treat

i_008_008	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native sedge				amount	percent coverage	5	0.33	0.11		5	0.89	0.25										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_009	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Nonnative sedge				amount	percent coverage	5	0.21	0.17		5	0.91	0.36										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_010	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native shrub				amount	percent coverage	5	0.52	0.4		5	0.34	0.11										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_011	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native tree				amount	percent coverage	5	0.69	0.23		5	1.88	0.48										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_012	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Native vine				amount	percent coverage	5	12.02	4.09		5	2.49	0.76										5			This study reports paired Means and SEs at the beginning and end of treat

i_008_013	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	1	n/a	Table 2	Plants			Nonnative vine				amount	percent coverage	5	2.1	1.03		5	0.92	0.48										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_014	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native forb				amount	percent coverage	5	20.1	2.72		5	47.45	7.21										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_015	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Nonnative forb				amount	percent coverage	5	3.83	0.96		5	8.07	1.52										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_016	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native grass				amount	percent coverage	5	2.08	0.75		5	5.87	1.27										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_017	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Nonnative grass				amount	percent coverage	5	159.1	9.81		5	127.5	7.42										5			This study reports paired Means and SEs at the beginning and end of treat

i_008_018	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native rush				amount	percent coverage	5	0.21	0.09		5	10.68	1.94										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_019	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native legume				amount	percent coverage	5	0	0		5	4.12	1.94										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_020	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Nonnative legume				amount	percent coverage	5	84.02	7.43		5	42.31	5.25										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_021	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native sedge				amount	percent coverage	5	1.51	0.47		5	7.17	1.3										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_022	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Nonnative sedge				amount	percent coverage	5	0	0		5	0	0										5			This study reports paired Means and SEs at the beginning and end of treat

i_008_023	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native shrub				amount	percent coverage	5	0.19	0.13		5	0.66	0.29										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_024	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native tree				amount	percent coverage	5	1.3	0.39		5	5.13	1.7										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_025	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Native vine				amount	percent coverage	5	5.92	1.48		5	5.02	1.42										5			This study reports paired Means and SEs at the beginning and end of treat
i_008_026	init0008	Entsminger et al	2017	Journal article	USA	CI	road side	upland	roadside	riparian lowland	n/a	n/a	YES	YES	NO	Medium	YES	n/a	2 years	2	n/a	Table 2	Plants			Nonnative vine				amount	percent coverage	5	2.39	1.03		5	1.02	0.37										5			This study reports paired Means and SEs at the beginning and end of treat
i_011_001	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 3 wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	13	Figure 1a	Pollinator			Live butterflies				amount	abundance																				Calculated from time series
i_011_002	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 6 wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	13	Figure 1a	Pollinator			Live butterflies				amount	abundance																				Calculated from time series
i_011_003	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 6* wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	13	Figure 1a	Pollinator			Live butterflies				amount	abundance																				Calculated from time series
i_011_004	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 3 wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	27	Figure 1b	Pollinator			Dead butterflies				amount	abundance																				Calculated from time series

Appendix E3

i_011_005	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 6 wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	27	Figure 1b	Pollinator			Dead butterflies				amount	abundance																				Calculated from time series
i_011_006	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 6* wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	27	Figure 1b	Pollinator			Dead butterflies				amount	abundance																				Calculated from time series
i_011_007	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 3 wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	9	Figure 1c	Pollinator			Butterflies				amount	mortality																				Calculated from time series
i_011_008	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 6 wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	9	Figure 1c	Pollinator			Butterflies				amount	mortality																				Calculated from time series
i_011_009	init0011	Halbritter et al	2015	Journal article	USA	CI	road side	mowed 6* wk	roadside	no-mow	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	9	Figure 1c	Pollinator			Butterflies				amount	mortality																				Calculated from time series
i_013_001	init0013	Hanley and Wilkins	2015	Journal article	UK	CI	hedgerow	roadside	hedgerow	arable field	n/a	n/a	YES	NO	YES	Medium	NO	n/a	1 year	1	1	Table 1	Pollinator			Bumblebee	Bombus	terrestris		amount	abundance	30	7.11	1.02		30	3.22	1.04										30			**Could scrape from Figures 1 and 2 if more data is needed
i_013_002	init0013	Hanley and Wilkins	2015	Journal article	UK	CI	hedgerow	roadside	hedgerow	arable field	n/a	n/a	YES	NO	YES	Medium	NO	n/a	1 year	1	1	Table 1	Pollinator			Bumblebee	Bombus	hortorum		amount	abundance	30	3.33	0.71		30	0.56	0.24										30			**Could scrape from Figures 1 and 2 if more data is needed
i_013_003	init0013	Hanley and Wilkins	2015	Journal article	UK	CI	hedgerow	roadside	hedgerow	arable field	n/a	n/a	YES	NO	YES	Medium	NO	n/a	1 year	1	1	Table 1	Pollinator			Bumblebee	Bombus	pascuorum		amount	abundance	30	2.44	0.6		30	1.44	0.47										30			**Could scrape from Figures 1 and 2 if more data is needed
i_013_004	init0013	Hanley and Wilkins	2015	Journal article	UK	CI	hedgerow	roadside	hedgerow	arable field	n/a	n/a	YES	NO	YES	Medium	NO	n/a	1 year	1	1	Table 1	Pollinator			Bumblebee	Bombus	lapidarus		amount	abundance	30	1.56	0.18		30	1.11	0.31										30			**Could scrape from Figures 1 and 2 if more data is needed

i_013_005	init0013	Hanley and Wilkins	2015	Journal article	UK	CI	hedgerow	roadside	hedgerow	arable field	n/a	n/a	YES	NO	YES	Medium	NO	n/a	1 year	1	1	Table 1	Pollinator			Bumblebee	Bombus	pratorum		amount	abundance	30	1.78	0.52		30	0.33	0.17										30			**Could scrape from Figures 1 and 2 if more data is needed
i_025_001	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 1x	roadside	unmanaged	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	3	Figure 1c	Pollinator			Insects				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_002	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 2x	roadside	unmanaged	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	4	Figure 1c	Pollinator			Insects				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_003	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 1x + hay removal	roadside	unmanaged	mowing	hay removal	NO	NO	NO	Medium	NO	n/a	1 year	1	3	Figure 1c	Pollinator			Insects				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_004	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 2x + hay removal	roadside	unmanaged	mowing	hay removal	NO	NO	NO	Medium	NO	n/a	1 year	1	4	Figure 1c	Pollinator			Insects				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_005	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 1x	roadside	unmanaged	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	3	Figure 1b	Plants			Flower				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_006	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 2x	roadside	unmanaged	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	4	Figure 1b	Plants			Flower				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_007	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 1x + hay removal	roadside	unmanaged	mowing	hay removal	NO	NO	NO	Medium	NO	n/a	1 year	1	3	Figure 1b	Plants			Flower				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_008	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 2x + hay removal	roadside	unmanaged	mowing	hay removal	NO	NO	NO	Medium	NO	n/a	1 year	1	4	Figure 1b	Plants			Flower				amount	abundance	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments

i_025_009	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 1x	roadside	unmanaged	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	3	Figure 1a	Plants			Flower				diversity	diversity	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_010	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 2x	roadside	unmanaged	mowing	n/a	NO	NO	NO	Medium	NO	n/a	1 year	1	4	Figure 1a	Plants			Flower				diversity	diversity	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_011	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 1x + hay removal	roadside	unmanaged	mowing	hay removal	NO	NO	NO	Medium	NO	n/a	1 year	1	3	Figure 1a	Plants			Flower				diversity	diversity	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_025_012	init0025	Noordijk et al	2009	Journal article	Netherlands	CI	road side	mowed 2x + hay removal	roadside	unmanaged	mowing	hay removal	NO	NO	NO	Medium	NO	n/a	1 year	1	4	Figure 1a	Plants			Flower				diversity	diversity	25	TBD (log scale)	TBD (log scale)		25	TBD (log scale)	TBD (log scale)										25			Same control plot for all four treatments
i_028_001	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	arable	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 3	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				1.149	t>c	0.26						12			Outer Hebrides sampled once in year 1 of this study
i_028_002	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	fallow	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 3	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				0.315	t>c	0.76						12			Outer Hebrides sampled once in year 1 of this study
i_028_003	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	pasture	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 3	Pollinator			Long-tongued bumblebees				amount	abundance	6				5				1.871	t>c	0.07						11			Outer Hebrides sampled once in year 1 of this study
i_028_004	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	winter grazed	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 3	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				0.657	t<c	0.52						12			Outer Hebrides sampled once in year 1 of this study

i_028_005	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	arable	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 5	Plants			Forage plants				amount	abundance	6				6				3.079	t>c	0.01						12			Outer Hebrides sampled once in year 1 of this study
i_028_006	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	fallow	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 5	Plants			Forage plants				amount	abundance	6				6				2.486	t>c	0.02						12			Outer Hebrides sampled once in year 1 of this study
i_028_007	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	pasture	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 5	Plants			Forage plants				amount	abundance	6				5				3.2	t>c	0						11			Outer Hebrides sampled once in year 1 of this study
i_028_008	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	winter grazed	n/a	n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	1	1	Table 5	Plants			Forage plants				amount	abundance	6				6				-0.811	t>c	0.43						12			Outer Hebrides sampled once in year 1 of this study
i_028_009	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	cattle grazed		n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	2	2	Table 4	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				2.63	t>c	0.02						12			July sample; Somerset Levels sampled twice in year two of this study
i_028_010	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	silage		n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	2	2	Table 4	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				-3.81	t>c	0						12			July sample; Somerset Levels sampled twice in year two of this study
i_028_011	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	cattle grazed		n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	2	2	Table 4	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				1.06	t>c	0.3						12			August sample; Somerset Levels sampled twice in year two of this study

i_028_012	init0028	Osgathorpe et al	2012	Journal article	UK	CI	road side	n/a	silage		n/a	n/a	NO	YES	YES	Low	YES	n/a	2 years (each site sampled in one year only)	2	2	Table 4	Pollinator			Long-tongued bumblebees				amount	abundance	6				6				-2.09	t>c	0.05						12			August sample; Somerset Levels sampled twice in year two of this study
i_031_001	init0031	Skorka	2016	Journal article	Poland	CI	road side	with traffic	roadside	no traffic	n/a	n/a	NO	NO	YES	Medium	NO	traffic volume	3 years	1, 2, 3	1	Section 3.2	Pollinator			Dead butterflies				amount	persistence	4	0.249	0.02		4	0.548	0.02										8			
i_037_001	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	4	Table 1	Plants			Plants				diversity	species richness	3	16.67	0.88		3	17.16	0.88													Same control sites
i_037_002	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	4	Table 1	Plants			Plants				diversity	species richness	3	12.33	2.96		3	17.16	0.88													Same control sites
i_037_003	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	2	4	Figure 8	Plants			Plants				diversity	species richness	3	6.5	1		3	18	3.25													Same control sites
i_037_004	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	2	4	Figure 8	Plants			Plants				diversity	species richness	3	8.5	0.1		3	18	3.25													Same control sites
i_037_005	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	1	4	Figure 8	Plants			Plants				diversity	species richness	3	12	1.5		3	14	3													Same control sites
i_037_006	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	1	4	Figure 8	Plants			Plants				diversity	species richness	3	11	0.75		3	14	3													Same control sites
i_037_007	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	4	Table 1	Plants			Plants				amount	abundance	3	399	1		3	400	0.58													Same control sites
i_037_008	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	4	Table 1	Plants			Plants				amount	abundance	3	399.3	0.67		3	400	0.58													Same control sites
i_037_009	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	8	Table 2	Pollinator			Butterflies				diversity	species richness	3	15	2.08		3	13.67	0.88													Same control sites
i_037_010	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	8	Table 2	Pollinator			Butterflies				diversity	species richness	3	16	1.53		3	13.67	0.88													Same control sites
i_037_011	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	8	Figure 9	Pollinator			Butterflies				amount	abundance	3	23	2.1		3	26	0.5													Same control sites
i_037_012	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	3	8	Figure 9	Pollinator			Butterflies				amount	abundance	3	20	2		3	26	0.5													Same control sites
i_037_013	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	2	8	Figure 10	Pollinator			Butterflies				diversity	species richness	3	7	0.65		3	7	0.6													Same control sites
i_037_014	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	2	8	Figure 10	Pollinator			Butterflies				diversity	species richness	3	4.25	0.3		3	7	0.6													Same control sites
i_037_015	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	2	8	Figure 9	Pollinator			Butterflies				amount	abundance	3	13	1.75		3	16	2.5													Same control sites
i_037_016	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	2	8	Figure 9	Pollinator			Butterflies				amount	abundance	3	10	2.5		3	16	2.5													Same control sites
i_037_017	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	1	8	Figure 10	Pollinator			Butterflies				diversity	species richness	3	7	1		3	7.5	0.8													Same control sites
i_037_018	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	1	8	Figure 10	Pollinator			Butterflies				diversity	species richness	3	7	0.6		3	7.5	0.8													Same control sites
i_037_019	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	spray	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	1	8	Figure 9	Pollinator			Butterflies				amount	abundance	3	26	1.5		3	12.5	2													Same control sites

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i_037_020	init0037	Zinnecker and Larsen	2011	Grey literature	USA	BACI	road side	organic	roadside	mowed	herbicide	planting	n/a	NO	YES	Medium	NO	n/a	3 years	1	8	Figure 9	Pollinator			Butterflies				amount	abundance	3	19.5	7.5		3	12.5	2													Same control sites
wos_013_001	WOS0013	Garbuzov et al	2015	Journal article	UK	CI	linear strips	mowing every 2 wks	linear strip	mowing til July	mowing	n/a	NO	NO	YES	Medium	NO	n/a	1 year	1	weekly for 4 months	Table 1	Pollinator			Insects on flowers				amount	abundance	4	1.4	0.2		4	3.1	0.5													
wos_013_002	WOS0013	Garbuzov et al	2015	Journal article	UK	CI	linear strips	mowing every 2 wks		mowing til June	mowing	n/a	NO	NO	YES	Medium	NO	n/a	1 year	1	weekly for 4 months	Table 1	Pollinator			Insects on flowers				amount	abundance	4	1.4	0.2		4	4.6	0.6													
wos_013_003	WOS0013	Garbuzov et al	2015	Journal article	UK	CI	linear strips	mowing every 2 wks		no mowing	mowing	n/a	NO	NO	YES	Medium	NO	n/a	1 year	1	weekly for 4 months	Table 1	Pollinator			Insects on flowers				amount	abundance	4	1.4	0.2		4	7	1.1													
wos_013_004	WOS0013	Garbuzov et al	2015	Journal article	UK	CI	linear strips	mowing til July		mowing til June	mowing	n/a	NO	NO	YES	Medium	NO	n/a	1 year	1	weekly for 4 months	Table 1	Pollinator			Insects on flowers				amount	abundance	4	3.1	0.5		4	4.6	0.6													
wos_013_005	WOS0013	Garbuzov et al	2015	Journal article	UK	CI	linear strips	mowing til July		no mowing	mowing	n/a	NO	NO	YES	Medium	NO	n/a	1 year	1	weekly for 4 months	Table 1	Pollinator			Insects on flowers				amount	abundance	4	3.1	0.5		4	7	1.1													
wos_013_006	WOS0013	Garbuzov et al	2015	Journal article	UK	CI	linear strips	mowing til June		no mowing	mowing	n/a	NO	NO	YES	Medium	NO	n/a	1 year	1	weekly for 4 months	Table 1	Pollinator			Insects on flowers				amount	abundance	4	4.6	0.6		4	7	1.1													
wos_051_001	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	n/a	roadside	n/a	n/a	n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	middle of page 5	Plants			bee forage				diversity	species richness	60	75.4		SD=35.2	60	25		SD=5.4												
wos_051_002	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	n/a	roadside	n/a	n/a	n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	top of page 7	Plants			bee forage				amount	% cover (abundance)	60	75%			60	41%									8.69					
wos_051_003	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	<50 m from forest	roadside	<50 m from forest		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 1	Plants			bee forage				diversity	species richness		105.2		SD=36.5		26		SD=3.6												Not sure on number of sites that meet these criteria
wos_051_004	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	51-300 m from forest	roadside	51-300 m from forest		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 1	Plants			bee forage				diversity	species richness		85.5		SD=32.5		35.8		SD=6.2												Not sure on number of sites that meet these criteria
wos_051_005	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	>301 m from forest	roadside	>301 m from forest		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 1	Plants			bee forage				diversity	species richness		63.2		SD=31.5		24.2		SD=5.5												Not sure on number of sites that meet these criteria
wos_051_006	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	<50 m from meadow	roadside	<50 m from meadow		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 1	Plants			bee forage				diversity	species richness		74.1		SD=15.4		23.6		SD=1.3												Not sure on number of sites that meet these criteria
wos_051_007	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	51-300 m from meadow	roadside	51-300 m from meadow		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 1	Plants			bee forage				diversity	species richness		57.8		SD=16.2		21.2		SD=2.1												Not sure on number of sites that meet these criteria

wos_051_008	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	>301 m from meadow	roadside	>301 m from meadow		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 1	Plants			bee forage				diversity	species richness		59.5		SD=11.7		24.6		SD=1.4												Not sure on number of sites that meet these criteria
wos_051_009	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	low intensity	roadside	low intensity		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 2	Plants			bee forage				diversity	species richness	20	76.5		SD=27.2	20	40.3		SD=5.8												
wos_051_010	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	mid intensity	roadside	mid intensity		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 2	Plants			bee forage				diversity	species richness	20	103.7		SD=3.5	20	32.8		SD=2.9												
wos_051_011	WOS0051	Wrzesien and Denisow	2016	Journal article	Poland	CI	railway	high intensity	roadside	high intensity		n/a	YES	YES	NO	Medium	YES	traffic intensity	3 years	all	n/a	Table 2	Plants			bee forage				diversity	species richness	20	49.6		SD=20.5	20	29.4		SD=2.9												
wos_064_001	WOS0064	Valtonen et al	2007	Journal article	Finland	CI	road side	intersections	grassland	n/a	mowing	n/a	NO	NO	NO	Medium	YES	n/a	1 year	1	13	Figure 2	Pollinator			Butterflies				diversity	species richness	17				17												18? (9 of each?)			Pull data from figures
wos_064_002	WOS0064	Valtonen et al	2007	Journal article	Finland	CI	road side	intersections	grassland	n/a	mowing	n/a	NO	NO	NO	Medium	YES	n/a	1 year	1	13	Figure 2	Pollinator			Butterflies				amount	abundance	17				17												18? (9 of each?)			Pull data from figures
wos_065_001	WOS0065	Valtonen et al	2006	Journal article	Finland	CI	road side	with lupine	roadside	w/out lupine	n/a	n/a	n/a	NO	NO	Medium	NO	n/a	1 year	1	1	Table 1	Plants			Plants				diversity	species richness	15	26.9		SD=6.1	15	34.7		SD=11									15			Same treatment and control sites
wos_099_001	WOS0099	Berg et al	2011	Journal article	Sweden	CI	forest road	n/a	powerline	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				amount	abundance	24	63.29	11.7		24	101.8	14.3													
wos_099_002	WOS0099	Berg et al	2011	Journal article	Sweden	CI	forest road	n/a	clearcut	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				amount	abundance	24	63.29	11.7		24	59.46	8.88													
wos_099_003	WOS0099	Berg et al	2011	Journal article	Sweden	CI	forest road	n/a	pasture	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				amount	abundance	24	63.29	11.7		24	70.42	10.9													
wos_099_004	WOS0099	Berg et al	2011	Journal article	Sweden	CI	powerline	n/a	clearcut	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				amount	abundance	24	101.8	14.3		24	59.46	8.88													
wos_099_005	WOS0099	Berg et al	2011	Journal article	Sweden	CI	powerline	n/a	pasture	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				amount	abundance	24	101.8	14.3		24	70.42	10.9													
wos_099_006	WOS0099	Berg et al	2011	Journal article	Sweden	CI	clear cut	n/a	pasture	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				amount	abundance	24	59.46	8.88		24	70.42	10.9													
wos_099_007	WOS0099	Berg et al	2011	Journal article	Sweden	CI	forest road	n/a	powerline	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				diversity	species richness	24	16.88	1.66		24	21.46	1.44													
wos_099_008	WOS0099	Berg et al	2011	Journal article	Sweden	CI	forest road	n/a	clearcut	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				diversity	species richness	24	16.88	1.66		24	15.83	1.38													
wos_099_009	WOS0099	Berg et al	2011	Journal article	Sweden	CI	forest road	n/a	pasture	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				diversity	species richness	24	16.88	1.66		24	15.88	1.25													
wos_099_010	WOS0099	Berg et al	2011	Journal article	Sweden	CI	powerline	n/a	clearcut	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				diversity	species richness	24	21.46	1.44		24	15.83	1.38													
wos_099_011	WOS0099	Berg et al	2011	Journal article	Sweden	CI	powerline	n/a	pasture	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				diversity	species richness	24	21.46	1.44		24	15.88	1.25													
wos_099_012	WOS0099	Berg et al	2011	Journal article	Sweden	CI	clear cut	n/a	pasture	n/a	logging	n/a	YES	NO	NO	Medium	YES	n/a	1 year	1	7	Appendix B	Pollinator			Butterflies				diversity	species richness	24	15.83	1.38		24	15.88	1.25													
wos_109_001	WOS0109	Moron et al	2014	Journal article	Poland	CI	railway	n/a	grassland	n/a	n/a	n/a	NO	YES	YES	Medium	NO	n/a	1 year	1	3	Figure 2b	Pollinator			wild bees				amount	abundance	25				19															Pull data from figures
wos_109_002	WOS0109	Moron et al	2014	Journal article	Poland	CI	railway	n/a	grassland	n/a	n/a	n/a	NO	YES	YES	Medium	NO	n/a	1 year	1	3	Figure 2b	Pollinator			Butterflies				amount	abundance	25				19															Pull data from figures
wos_109_003	WOS0109	Moron et al	2014	Journal article	Poland	CI	railway	n/a	grassland	n/a	n/a	n/a	NO	YES	YES	Medium	NO	n/a	1 year	1	3	Figure 2b	Pollinator			hoverflies				amount	abundance	25				19															Pull data from figures
wos_109_004	WOS0109	Moron et al	2014	Journal article	Poland	CI	railway	n/a	grassland	n/a	n/a	n/a	NO	YES	YES	Medium	NO	n/a	1 year	1	3	Figure 2a	Pollinator			wild bees				diversity	species richness	25				19															Pull data from figures
wos_109_005	WOS0109	Moron et al	2014	Journal article	Poland	CI	railway	n/a	grassland	n/a	n/a	n/a	NO	YES	YES	Medium	NO	n/a	1 year	1	3	Figure 2a	Pollinator			Butterflies				diversity	species richness	25				19															Pull data from figures

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wos_109_006	WOS0109	Moron et al	2014	Journal article	Poland	CI	railway	n/a	grassland	n/a	n/a	n/a	NO	YES	YES	Medium	NO	n/a	1 year	1	3	Figure 2a	Pollinators			hoverflies				diversity	species richness	25				19															Pull data from figures
wos_137_001	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	highway	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Butterflies				amount	abundance	17	131		SD=67																No control in this study
wos_137_002	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	urban	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Butterflies				amount	abundance	17	79		SD=37																No control in this study
wos_137_003	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	rural	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Butterflies				amount	abundance	17	141		SD=62																No control in this study
wos_137_004	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	highway	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Diurnal moths				amount	abundance	17	117		SD=56																No control in this study
wos_137_005	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	urban	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Diurnal moths				amount	abundance	17	105		SD=87																No control in this study
wos_137_006	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	rural	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Diurnal moths				amount	abundance	17	50		SD=52																No control in this study
wos_137_007	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	highway	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Butterflies				diversity	species richness	17	18		SD=5																No control in this study
wos_137_008	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	urban	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Butterflies				diversity	species richness	17	14		SD=3																No control in this study
wos_137_009	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	rural	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Butterflies				diversity	species richness	17	17		SD=6																No control in this study
wos_137_010	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	highway	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Diurnal moths				diversity	species richness	17	12		SD=3																No control in this study
wos_137_011	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	urban	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Diurnal moths				diversity	species richness	17	11		SD=4																No control in this study
wos_137_012	WOS0137	Saarinen et al	2005	Journal article	Finland	CI	road side	rural	n/a	n/a	n/a	n/a	NO	NO	NO	Medium	YES	traffic intensity	2 years	all	12	Table 2	Pollinators			Diurnal moths				diversity	species richness	17	10		SD=4																No control in this study
wos_145_001	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-0.97	0.34		19									55	-3.12	0.02				
wos_145_002	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge hedge verge facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-2.29	0.32		19									55	-7.17	< 0.0001				
wos_145_003	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-1.42	0.31		19									55	-4.54	0				
wos_145_004	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	1.08	0.31		19									55	3.46	0.01				
wos_145_005	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-1.63	0.32		19									55	-5.16	< 0.0001				
wos_145_006	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	verge hedge verge facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-1.32	0.32		19									55	-4.14	0				
wos_145_007	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-0.45	0.31		19									55	-1.44	0.71				
wos_145_008	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	2.06	0.31		19									55	6.55	< 0.0001				

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wos_145_009	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-0.65	0.31		19									55	-2.09	0.3				
wos_145_010	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	0.87	0.31		19									55	2.77	0.06				
wos_145_011	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	3.37	0.33		19									55	10.4	< 0.0001				
wos_145_012	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	0.66	0.31		19									55	2.12	0.28				
wos_145_013	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge field facing side	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	2.5	0.32		19									55	7.9	< 0.0001				
wos_145_014	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge field facing side	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-0.21	0.31		19									55	-0.67	0.99				
wos_145_015	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	field center	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	1	Appendix H	Pollinators			Pollinating insects				amount	abundance	19	-2.71	0.32		19									55	-8.45	< 0.0001				
wos_145_016	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	0.01	0.36		19									55	0.04	1				
wos_145_017	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge hedge verge facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-1.1	0.35		19									55	-3.1	0.02				
wos_145_018	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-0.71	0.35		19									55	-1.99	0.35				
wos_145_019	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	1.51	0.39		19									55	3.87	0				
wos_145_020	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-0.65	0.36		19									55	-1.86	0.45				
wos_145_021	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	verge hedge verge facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-1.11	0.36		19									55	-3.12	0.02				
wos_145_022	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-0.72	0.36		19									55	-2.02	0.33				
wos_145_023	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	1.49	0.39		19									55	3.86	0				
wos_145_024	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-0.66	0.36		19									55	-1.86	0.43				
wos_145_025	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	0.39	0.35		19									55	1.11	0.88				
wos_145_026	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	2.6	0.39		19									55	6.6	<0.0001				
wos_145_027	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	0.45	0.35		19									55	1.26	0.8				
wos_145_028	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge field facing side	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	2.21	0.4		19									55	5.61	<0.0001				
wos_145_029	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge field facing side	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	0.06	0.35		19									55	0.16	1				
wos_145_030	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	field center	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							amount	abundance	19	-2.16	0.39		19									55	-5.55	<0.0001				
wos_145_031	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	-0.08	0.12		19									55	-0.67	0.99				
wos_145_032	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge hedge verge facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	-0.35	0.11		19									55	-3.11	0.02				
wos_145_033	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	-0.06	0.12		19									55	-0.48	1				

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wos_145_034	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	1.46	0.16		19									55	9.23	<0.0001				
wos_145_035	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge edge	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	-0.01	0.12		19									55	-0.07	1				
wos_145_036	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	verge hedge verge facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	-0.27	0.11		19									55	-2.45	0.14				
wos_145_037	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	0.02	0.12		19									55	0.18	0.99				
wos_145_038	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	1.54	0.16		19									55	9.77	<0.0001				
wos_145_039	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge center	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	0.07	0.12		19									55	0.59	0.99				
wos_145_040	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	verge hedge field facing side	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	0.3	0.11		19									55	2.64	0.09				
wos_145_041	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	1.82	0.16		19									55	11.7	<0.0001				
wos_145_042	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge verge facing side	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	0.34	0.11		19									55	3.04	0.03				
wos_145_043	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge field facing side	fields	field center	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	1.52	0.16		19									55	9.62	<0.0001				
wos_145_044	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	verge hedge field facing side	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	0.05	0.12		19									55	0.41	1				
wos_145_045	WOS0145	Phillips et al	2019	Journal article	UK	CI	road side	field center	fields	field hedge	mowing	n/a	YES	NO	NO	Medium	YES	traffic, mowing	1 year	1	3	Appendix H	Plants							diversity	species richness	19	-1.47	0.16		19									55	-9.29	<0.0001				
wos_147_001	WOS0147	Seitz et al	2019	Journal article	USA	CI	Road side	n/a	sand mine	n/a	n/a	n/a	YES	NO			NO	n/a	1 year	1	10	text around Fig 3	Pollinators			Wild bees				amount	abundance	3	24		SD=24.8	3	59		SD=56.6									6			
wos_147_002	WOS0147	Seitz et al	2019	Journal article	USA	CI	Road side	n/a	sand mine	n/a	n/a	n/a	YES	NO			NO	n/a	1 year	1	10	text around Fig 3	Pollinators			Wild bees				diversity	species richness	3	9		SD=5.2	3	14		SD=6.5									6			
wos_148_001	WOS0148	Dee and Baum	2019	Journal article	USA	CI	road side	n/a	grassland	n/a	n/a	n/a	n/a	NO	NO	Medium	NO	n/a	1 year	1	111	bottom of pg 30; beginning of Results section	Plants			Milk weed	Asclepias	viridis		amount	# of stems	2	1.96		SD = 1.518	2	2.24		SD = 1.676												