Assessing Pollinator Habitat Value of Managed Plant Communities using Pollinator Site Value Indices (PSVI) and Implications for Infrastructure Investment

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A. EXECUTIVE SUMMARY

A Presidential memorandum created a federal strategy on pollinators in 2014 due to the decline of honey bees, native bees, birds, bats, and butterflies. Sixty million acres of existing energy and transportation service rights-of-way (ROW) criss-cross private, public and tribal nations lands, an acreage on par with the national park system. As America upgrades its infrastructure, pollinator and bird habitat can simultaneously be restored on a massive scale simply by upgrading ROW vegetation maintenance practices from mowing to integrated vegetation management (IVM).

Traditional mechanical mowing maintenance hinders climate resiliency efforts and environmental enhancements by increasing greenhouse gas emissions and spreading nonnative invasive plants. IVM can reduce a carbon footprint by managing for native prairie meadow habitat, requiring less maintenance and lower costs. Documentation of habitat improvement has already been established through research by IVM Partners, a nonprofit organization, on energy and highway ROW.

No index existed to measure the relative benefits of the studied plant communities to pollinators until a nectar and pollen quality ranking for Mid-Atlantic plants was published in the 2014 book, "Garden Plants for Honey Bees." This ranking provided a legitimate means to develop a pollinator site value index (PSVI), which measures the quality of habitat from the perspective of the pollinators, beginning with *Apis* (honey bee) and expanding to *Bombus* (bumblebee).

A complementary ranking compiled by University of Delaware researchers lists Mid-Atlantic plants that serve as food for *Lepidoptera* (moth and butterfly) larvae, a ranking which has since been expanded to plants across the entire United States. A PSVI measure of these larval host food plants ranks the vegetative community benefit for lepidopterans, as well as for song and game birds, since these same insects are a vital food source for birds. By applying these two PSVI indices with ROW plant community documentation over time, one can accurately assess the success of integrated vegetation management (IVM) methods to not only meet the primary objectives of energy and transportation services to the public, but also to restore prime habitat for pollinators and birds.

Plant identification training by community colleges can develop skilled workers and regional botany technicians necessary to apply and assess IVM best practices on ROW. IVM Partners, as a non-profit organization and current liaison for federal, state, and tribal governments, utilities, universities, and community colleges, is uniquely positioned to help develop the curriculum and coordinate implementation. As we rebuild our nation's infrastructure, we must invest in the education and training necessary to restore habitat for insects and birds that pollinate our crops and feed a hungry world.

INTRODUCTION – BACKGROUND

Integrated Vegetation Management Partners, Inc. (IVM Partners), a 501-c-3 non-profit organization, was incorporated in the State of Delaware in August 2003 to develop, educate and apply best integrated vegetation management (IVM) practices. IVM Partners continued a twenty year collaboration between its founder and president R. A. Johnstone and board member M. R. Haggie, who met when Johnstone was a forester for Delmarva Power and Haggie a botanist for Chesapeake Wildlife Heritage. Together they had documented habitat changes on high voltage electric transmission rights-of-way (ROW) in Delaware, Maryland and New Jersey as vegetation transitioned from routine mowing to IVM.

IVM Partners formed partnerships with utilities, agencies, conservationists and universities to document plant community changes across an additional 22 states, 2 Tribal Nations and 4 national wildlife refuges; accumulating considerable botanical and photographic data on electric, natural gas and highway ROW, wind farms, solar arrays, golf courses, parks and natural areas, landfills, farms and rangeland.

With the backing of over 35 years of research data, IVM Partners stresses that the common practice of indiscriminate and untimely mowing decreases biodiversity and raises long term costs, since it spreads non-native, invasive plants and encourages continued growth of species incompatible with the intended services of a ROW and other lands. IVM Partners' significant botanical and photographic data has influenced the American National Standard Institute ANSI-A300 part 7-IVM, the ROW Stewardship Accreditation Program, the Federal Strategy on Pollinators, and a Candidate Conservation Agreement with Assurances for the monarch butterfly.

According to the latest ANSI IVM standard; "IVM is used to create, promote, and conserve sustainable plant communities that are compatible with the intended use of the site, and manage incompatible plants that may conflict with the intended use. Chemical methods should be used to transition the plant community to sustainable, compatible species by facilitating biological controls."[1] Properly applied IVM techniques will allow growth of necessary and some cases rare native grasses, wildflowers and shrubs to proliferate and once again occupy their vital niche. Safe, reliable and economical utility and transportation services are upheld while converting ROW into biological greenways. IVM management reduces erosion, water pollution, and ecosystem degradation while improving habitat for pollinators, birds and other wildlife.

B. THE NEED FOR A POLLINATOR HABITAT INDEX

Increased awareness over the last decade in the decline of pollinators - such as colony collapse disorder in honey bees - prompted many conservationists to recommend the planting of pollinator gardens and a wholesale restriction of pesticides. IVM Partners research showed, however, that native pollinator plants could be restored from the dormant native seed bank under an IVM regime that included judicious use of selective herbicide applications to control problem species and facilitate biological controls.

To quantify the benefits of IVM for pollinators, a legitimate measurement of the nectar and pollen values of plants documented in case study surveys was necessary. Despite substantial web and library searches, a comprehensive list of qualitative nectar and pollen values for bees could not be found. Initially the possi-

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[1]ANSI A300 PART 7, 2018 Edition, 2018 - Tree Care Operations - Tree, Shrub, and other Woody Plant Maintenance - Standard Practices (Integrated Vegetation Management A. Utility Rights-of-Way)

bility of incorporating the pollen percent protein data table explored by Ralston and others in 2000 [2] was investigated. Their work on pollen protein average percent is a nutritional value by plant species 'family' but does not include nectar, and many of the plant species analyzed are tropical and not native to North America, so for our purpose their data was incomplete.

In 2014 however, Peter Lindtner, a horticulturalist at the Hagley Museum and a lifelong apiculturist, published the book "Garden Plants for Honey Bees" [3]. His book gives a star (*) rating of 1-5 to measure the nectar and pollen values of horticultural and some native plants of North America for European honey bees (*Apis mellifera* L.). With Lindtner's proficiency, expertise and empirical evaluations of the nectar and pollen values of many botanical genera for honey bees, his star (*) rating represented the beginning of a long sought-after goal of creating a pollinator site value index (PSVI).

C. RESOLVING A BASIC FORMULA FOR THE PSVI

IVM Partners and Lindtner started a close collaboration to expand the star (*) *Apis* rating to include all the plants encountered in Mid-Atlantic ROW case study surveys (Table 1). Subsequently a regional star (*) rating was developed for bumble bees (*Bombus sp.)* with the only changes being the nectar and pollen star (*) values more specific for the genus *Bombus* (Table 2). A *Bombus* PSVI is a better measure of natural habitat restoration than an *Apis* PSVI, as a Bombus PSVI reflects the need of dead vegetation and open ground nesting areas (70% of native bees are ground nesting)[4] instead of colony hive dwelling by honey bees.

Following collaboration with Peter Lindtner, and biostatistic analysis by Hubert Allen & Assocs., a firm in Albuquerque, NM, the framework of an initial PSVI was produced that included a biodiversity index (BDI) and adjacent land usage. Recognizing that ROW plant communities must be compatible with the ROW objectives of safe and reliable transport of services, a BDI measurement of diversity and richness is not applicable. ROW managers are also restrained by easement restrictions and have no control over shifting adjacent land usage, making that evaluation impossible. The final native bee *Bombus* PSVI index consists of the following five parameters:

1. Percent cover of plant species found in field site documentation
2. Nectar * rating of each species core food value
3. Pollen * rating of each species core food value
4. Number of regional flowering months per plant species
5. Percent cover of dead vegetation, leaf litter and bare soil (Maximum 10%)[5]

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[2]Roulston T.H, Cane J.H, Buchmann S.L. 2000. What governs protein content of pollen: Pollinator preferences, pollen-pistil interactions, or phylogeny? Ecological Monographs 70(4): 617-643.

[3]Lindtner, Peter. Garden Plants for Honey Bees. 2014. (ISBN: 978-1-878075-37-6) Wicwas Press, MI., USA. 396 pp.

[4]https://xerces.org/pollinator-conservation/nesting-resources

[5] Johnstone, Richard A. Personal Communication with Sam Droege, USGS Native Bee Inventory and Monitoring Lab, Patuxent Wildlife Research Center, Laurel, MD 2021.

The *Bombus* nectar and pollen star (*) ratings (Table 2) are relevant to all states east of the Rocky Mountain front range, excluding southern Florida, with specific application to the Mid-Atlantic states. It includes the importance of having consistent flowering months to feed migrating pollinators and bare soil or dead plant material for ground and cavity nesting habitat for native bees. The PSVI is designed to be scientifically accurate yet approachable, practical and easy to use for multiple audiences. The PSVI data helps capture and compare the baseline documented plant community present with existing vegetation management practices, to the more diverse native plant community that emerges in the pollinator habitat transition after IVM is implemented. It is an accurate indicator of vegetation being managed for the primary ROW objectives of safe and reliable transport of services to the public, and functionality as a successful pollinator wildlife corridor.

Apis and *Bombus* compilations (Tables 1 and 2) respectively list 30 plant orders with 660 species of the Mid-Atlantic region. Where nectar and pollen star (*) values were absent for certain species in a data set, averages were necessarily made by genus, family or order, whichever lower level on the taxonomic hierarchy had the most data, thus creating a truly workable comprehensive list. Further research into nectar and pollen values can fill any gaps and expand to species of other geographic regions.

D. ASSIGNING NECTAR AND POLLEN VALUES FOR UNLISTED SPECIES

Where *Bombus* nectar and pollen values are not listed in Table 2 for a plant, either by species or genus, a search for that species at https://plants.sc.egov.usda.gov/java/ by “Scientific Name”, “Common Name”, or “Symbol Code” is necessary. At the USDA.NRCS PLANTS website, under “Classification” at the bottom of the "General" page, the family or order is given according to USDA/NRCS taxonomic criteria, which uses the International Plant Name Index (IPNI) www.ipni.org. Crosschecking the family or order given against existing data (Table 2) will give the average nectar/pollen star (*) value to the lowest taxonomic level achievable. A more concise and easier reference is provided in Table 3 (*Bombus* N&P Star Ratings Sequenced by Order). As an example, Eastern blue star, (*Amsonia tabernaemontana*) which has no Lindtner nectar/pollen star (*) rating but is in the family *Apocynaceae*, the lowest taxonomic level in this case, receives that family (*) rating of 1 for pollen and 1.5 for nectar. Additional examples are provided in Table 4 (Order Gentianales Unlisted Species Nectar-Pollen Computation).

When searching the USDA/NRCS website under ‘Classification’ and using Table 2, there are two taxonomic systems referenced; Cronquist and APG III. Example: Rough Buttonweed (*Diodea teres)* is placed in the Cronquist taxonomic system in the Order Rubiales, but in the APG III system it is placed in the Order Gentianales. The PSVI tables use the Cronquist system that was developed in 1968, with the APG system (developed as APG I in 1998) referenced for modern updates. In the Cronquist system nectar/pollen values for the family Rubiaceae are 1:1, and under the APG III system nectar/pollen values for the Order Rubiales/Gentianales are 1:1. Thus Rough Buttonweed (*Diodea teres)* is assigned the same values for nectar/pollen of 1:1, with priority assignment of values at the family level. In the absence of *Bombus* nectar and pollen (*) data, the default is the Lindtner *Apis* (*) ratings.

Though there are situations when statistical differences can be found between the two, the pollen and nectar source values for *Apis* and *Bombus* are very similar. Where data for *Bombus* is not available, *Apis* pollen and nectar star (*) values can provide a good measurement.

E. PSVI FIELD RESULT ASSESSMENT

IVM Partners' case studies are normally performed on 10 x 30 meter managed areas that have a mix of plant species representative of the majority of the ROW conditions. Where possible, both upland and wetland sites are chosen and replicated to discern the ecosystem differences. Sampling the same sites in both spring and fall months is preferred, but if only one annual sample is conducted it is performed during the same annual season.

A skilled botanist is required to discern the plant species since 100% of the case study vegetative cover is documented and the majority of plant species cover less than 1% of the community. We sort our field data by 20 living plant categories (VT-Vegetation Type) and 2 non-living categories (DEVE (Dead Vegetation) and BASO (Bare Soil), see example (Table 5). From this table we can note and graph the percent ground cover of various plant types (incompatible trees, grasses, herbs), assess whether invasive plants are being controlled by the IVM methods employed, and track the amount of potential nesting sites for native bees.

The core food values of each plant species involve the multiplication of percent vegetative cover by pollen (P) and nectar (N) source star (*) values to create an index with a maximum of 5,000 for nectar and 5,000 for pollen (seasonal cumulative totals). The maximum value of any of our plots never exceeded 40% of the total possible (10,000 N+P) and no site measured zero.

To gauge the success of the IVM program to meet the ROW primary objectives of safety, access and reliability, plant species that are incompatible with those objectives receive a zero value, as do non-native invasive plant species that should be selected against. Thus a case study documentation that has a high accumulative PSVI score will substantiate that the IVM program has selected for a plant community that is compatible with its operational needs, while at the same time producing quality pollinator habitat. This quality pollinator habitat also equates with an ecosystem restoration to provide natural habitat for birds and other wildlife.

We note that fifteen (15) plant taxonomic orders consistently dominate in providing pollinator food, namely: Asterales, which includes the family Asteraceae (asters); Caryophyllales, which includes the family Polygonaceae (smartweeds); Fabales, which includes the family Fabaceae (legumes); Lamiales, which includes the family Lamiaceae (mints); Gentianales, which includes the family Asclepiadaceae (milkweeds); Myrtales, which includes the family Onagraceae (evening primroses) and Sapindales, which includes the family Anarcardiaceae (sumacs). We predict that it may be possible in the future to use satellite imagery or a smartphone camera APP to analyze the infrared or ultraviolet signature from a photograph of a site, and capture the plant community to discern the important pollinator species.

F. COMPUTATION OF METRICS USED for PSVI-LEP *(Lepidoptera*)

Another measure of habitat quality of an IVM program is taken from work on *Lepidoptera* by researchers at the University of Delaware, Douglas L. Tallamy and Kimberley J. Shropshire, summarized in the abstract of their 2009 publication "Ranking Lepidopteran Use of Native Versus Introduced Plants"[6]:

Abstract: In light of the wide-scale replacement of native plants in North America with introduced, invasive species and noninvasive ornamental plants that evolved elsewhere, we compared the value of native and introduced plants in terms of their ability to serve as host plants for Lepidoptera. Insect herbivores such as Lepidoptera larvae are critically important components of terrestrial food webs and any reduction in their biomass or diversity due to the loss of acceptable host plants is predicted to reduce the production of the many insectivores in higher trophic levels. We conducted an exhaustive search of host records in the literature. We used the data we gathered to rank all 1385 plant genera that occur in the

[6]Tallamy, Douglas W., and Kimberley J. Shropshire. 2009 "Ranking lepidopteran use of native versus introduced plants." Conservation Biology 23, no. 4: 941-947.

mid-Atlantic states of the United States by their ability to support Lepidoptera richness. Statistical comparisons were made with Welch's test for equality of means. Woody plants supported more species of moths and butterflies than herbaceous plants, native plants supported more species than introduced plants, and native woody plants with ornamental value supported more Lepidoptera species than introduced woody ornamentals. All these differences were highly significant. Our rankings provide a relative measure that will be useful for restoration ecologists, landscape architects and designers, land managers, and landowners who wish to raise the carrying capacity of particular areas by selecting plants with the greatest capacity for supporting biodiversity.

Similar to our PSVI for *Bombus*, we take the percent cover of each plant specie multiplied by the *Lepidopteran* numerical ranking as a larval host food plant and sum them for that year. Again, plants that are incompatible with the ROW objective, such as tall growing trees on an electric ROW, receive a zero value to validate the relative success of the IVM program in managing desirable species that meet the operating goals of safe access and reliability while also improving habitat for *Lepidoptera* pollinators (Table 6).

G. EDUCATION AND LIAISON

IVM Partners' PSVI indices for *Bombus* and *Lepidoptera* provide a good measure of the success of an IVM program to meet the operational objectives of the ROW or lands by documenting the botanical community of any section of land, have it monitored over a period of time as to the suitability of the management procedures in place, and rank the benefits obtained for native *Bombus* and/or *Lepidopteran* pollinator insects.

The potential of ROW to restore habitat critical to the survival of pollinators is immense. Roughly 60 million acres of the United States are contained in linear ROW, according to research at Purdue University[7]. These corridors crisscross every ecosystem in our country, covering more land than is presently protected by the National Park System in the lower 48 states! If these lands are managed with IVM best practices, we are well on our way to protecting 30% of our country by 2030, a goal of the Biden Administration's Conserving and Restoring America the Beautiful[8].

Our research shows that IVM best practices will improve pollinator habitat while also improving the functionality of the ROW, and will do so through more economical and environmentally acceptable means than conventional practices. We provide 3 documented case study examples where the past practice of mechanical cutting was replaced with IVM techniques that restored native habitat beneficial to pollinators while meeting the operational needs of the ROW corridors:

- Case Study 1 Electric Transmission ROW (Patuxent National Wildlife Refuge, Maryland) Tables 7, AB
- Case Study 2 Highway ROW (RT 275, Alabama) Tables 8, AB
- Case Study 3 Natural Gas Transmission ROW (J. Percy Priest, Tennessee) Tables 9 AB.

[7]Holt, H.A. 2016. Purdue University, College of Agriculture, Dept. Forestry & Natural Resources, West Lafayette, IN. pers. comm.

[8]https://www.doi.gov/sites/doi.gov/files/report-conserving-and-restoring-america-the-beautiful-2021.pdf

H. RECOMMENDATIONS

Our research also substantiates that a ROW should be divided into vegetation management zones as recommended in the consensus standard ANSI A300 Part 7-IVM. The reliability standard FAC-003 enforced by NERC (North American Electric Reliability Corporation)[9] requires high voltage electric transmission vegetation to be managed on the ROW to prevent height growth that risks a contact outage that could cause a cascading loss of power. Many utilities obtain this clearance by periodically mowing everything down within the entire ROW. The Wire Zone - Border Zone concept recognizes that low vegetation types, such as prairie grass and wildflowers, should be managed for directly under the electrical conductors (Wire Zone) where clearance is most important, while allowing shrubs and low stature trees to grow outside the conductor area to the ROW corridor edge (Border Zone) to improve habitat for pollinators, birds and other wildlife. This type of management requires selective treatment and is not a one-size-fits-all program.

Similarly, the majority of natural gas and oil pipeline ROW are routinely mowed across their entire ROW width to maintain sight distance between pipe markers and to allow periodic leak detection maintenance. But those needs can be accomplished by managing for low growing grass on a narrow swath directly over the pipes while allowing wildflowers and shrubs to grow in between pipelines and to the ROW edge, a Pipe Zone - Border Zone concept.

Highway ROW recognize 3 Zones; (Zone 1) needs to be managed for grass in the area directly adjacent to the road surface to enable sight distance and vehicle escape, but unfortunately most departments of transportation routinely mow not only this critical area, but the entire highway ROW back to the boundary fence which could be several hundred feet wide. The area next to Zone 1 contains the road drainage area consisting of a swale/ditch designated (Zone 2). Behind the swale/ditch to the road boundary fence is termed the back-slope or (Zone 3). Both Zone 2 and 3 do not need to be populated with only grasses but should be managed for wildflowers, shrubs and low stature trees that do not threaten vehicle safety but do provide food and nesting habitat for pollinators and birds.

Routine mechanical mowing is the most common vegetation maintenance practice that is destructive to habitat and wildlife and is contrary to the climate resiliency focus of reducing greenhouse gases and use of fossil fuels. Federal land management agencies, such as the U S Forest Service, often require an extensive environmental assessment before a ROW can change from routine maintenance mowing to IVM, siting NEPA (National Environmental Policy Act)[10]. This process can hold up the implementation of habitat management using IVM best practices for years. Since knowledge and use of selective herbicide chemistry is necessary to control problem and invasive plant species, IVM Partners can help facilitate this transition by reviewing the unique characteristics of each ecosystem and recommending suitable chemistry and application techniques. If America is going to upgrade its infrastructure, obstructive regulations and permits need to be fast-tracked as well to enable pollinator and wildlife habitat upgrades.

CAPITAL CONSTRUCTION

Case studies are also established to capture the existing plant community where a new ROW is proposed. This baseline documentation is then compared with the plant community that germinates after the existing vegetative cover has been cleared. These studies document that native early successional plants - some of

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[9] https://www.nerc.com/pa/Stand/Reliability%20Standards/FAC-003-4.pdf

[10] https://ceq.doe.gov/laws-regulations/regulations.html

which are classified as rare or endangered species - will germinate from dormancy when the established vegetative cover is removed. Subsequent IVM treatments can remove any germinating incompatible or invasive plants to retain this critical habitat. Tribal Nations recognized this natural plant succession and often used fire, an IVM method, to burn off vegetative cover and regenerate native prairie habitat.

Today American native prairie and meadow habitats are rare but ROW offer a restoration opportunity if properly constructed and managed. Our studies substantiate the importance of the top soil layer as the source for the dormant native seed bank and the need for protection and separation of top soil during ROW construction, rather than wholesale mixing of all soil profiles. Case in point: IVM Partners negotiated a partnership for a natural gas pipeline replacement project crossing a wetland in Canaan Valley NWR in West Virginia that contained a rare plant, Dewey Hayden's sedge (*Carex haydenii*). The agreed upon plan consisted of the gas company contractor removing the sedges and transplanting them adjacent to the ROW; FWS interns harvesting the sedge seeds and storing them; topsoil being isolated and stored separately from mineral soil profiles; the pipeline being replaced followed by mineral soil being spread back over to original contours, followed by topsoil being similarly spread. No artificial seeding or mulching was used. The result was the rare plant habitat being restored to its original health (Table 10). This type of construction practice, and a reassessment of mandated mitigation landscape planting of aggressive introduced grass species to control erosion, could effectively restore native plant communities.

The common construction practice of "deep clearing" (removing tree stumps and roots after felling) should be restricted to the footprint of tower sites and access routes for high voltage electric transmission or wind turbines, or the road and pipeline routes of highways and natural gas/oil utilities. The majority of the proposed ROW footprint should have the top soil, which stores the native seed bank population and symbiotic fungi, scraped off and stored separately while the other soil layers are mixed and compacted during construction. This rich top soil layer should then be spread back across the disturbed soils after construction is complete and mulched and seeded where necessary with only an annual grain to stabilize soils, while allowing the dormant native seeds lying in the top soil time to germinate. IVM techniques can then eliminate any incompatible and invasive plant species that may germinate.

These recommended changes in constructions practices are extremely important for infrastructure improvements to accommodate wind turbine generation of electric power. Consistent land wind speed for turbine generation occurs in our country's plains states and on mountain ridges, areas presently lacking electric transmission infrastructure. Wind farms do not consist of stand alone turbines, instead multiple windmills generate power that is downloaded to a substation and then transported as high voltage along a generator lead line to an existing substation tied in to the electrical grid. These new electric transmission line ROW should be established as recommended with IVM as the accepted best practice for new green energy constructions and their transportation access pathways. Facility construction to offset climate change should not be conducted in a fashion that is deleterious to other areas of our environment.

Utility and highway departments already employ biologists for siting and permitting new construction projects, yet neglect to use workers trained in IVM techniques nor employ scientists trained to assess the habitat quality of those completed projects. Certification and training in regional plant identification would create a green jobs pathway for vegetation application jobs to become professional careers. Skilled workers with the knowledge and expertise to discern species to retain for pollinator benefit as well as treatment of target species are necessary for the restoration of habitat beneficial to pollinators and wildlife. IVM Partners is uniquely positioned as a liaison to assist universities and community colleges to develop an IVM curriculum for training botany technicians to monitor the successful management of ROW using *Bombus* and *Lepidoptera* PSVI indices.

I. CONCLUSION

Multi-year case studies using a PSVI metric provide ample evidence for the value of IVM programs for both pollinator and social functions (Tables 7,8,9) . The *Lepidoptera* indices have been developed and are ready for use across the country, while *Bombus* PSVI is established for the eastern half of America. We look forward to working with university partners in the western states and tropical Florida in determining nectar and pollen benefits of their regions' plant species to expand our *Bombus* PSVI.

As our country upgrades and expands its infrastructure to better meet the needs of society and a changing climate, we have an opportunity to simultaneously upgrade and expand vegetation management practices of the ROW infrastructure. Integrated vegetation management (IVM) provides effective and economical practices to improve 30% of our country's ecosystems for our pollinators and other wildlife. Plant identification training by community colleges can develop skilled workers and regional botany technicians necessary to apply and assess IVM best practices on ROW. IVM Partners remains available to work with agency, industry, conservation, university and community college experts for the necessary education and training of workers. As we rebuild our nation's infrastructure, we must invest in the education and training necessary to restore habitat for insects and birds, and in turn pollinate the crops to feed a hungry world.

J. REFERENCED TABLES

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