NSERC-CANPOLIN
CANADIAN POLLINATION INITIATIVE

POLLINATION & LAND REHABILITATION

WORKSHOP REPORT

COLUMBUS, OHIO, SEPTEMBER 29 & 30, 2012

CONTENTS

INTRODUCTION & OVERVIEW: It is has become increasingly common to incorporate pollinator and pollination considerations into land rehabilitation and restoration activities. By fostering mutualistic ecological associations, such as pollination, fruit/seed dispersal, and soil interactions, regeneration of degraded sites can be accelerated and become self-sustaining more rapidly than by conventional landscape horticulture. Moreover, current and future restoration activities can also play an important role in pollinator conservation – a growing concern given the global decline of both managed and wild pollinators.

On September 29 & 30, 2012, the Canadian Pollination Initiative (NSERC-CANPOLIN) hosted a workshop in Columbus, Ohio, dedicated to exploring the role of pollination in land rehabilitation. This event provided a timely and valuable opportunity to assess the current state of knowledge and to identify research priorities. Approximately 30 pollination biologists, conservationists, and restoration ecologists from academia and non-governmental organizations participated. After a day of presentations on a range of topics, the group split into three breakout groups, each focused on pollination and restoration in a different type of environment: **agricultural**, **natural** and **urban**. Each group was charged with identifying key knowledge gaps and, where appropriate, making recommendations to address these gaps. The workshop wrapped up following brief presentations by each working group.

This report provides a written summary of the breakout group discussions (abstracts from the presentations are also included, as are links to several of the Powerpoint presentations for which authors have granted permission to share). These summaries highlight the knowledge gaps that are common in restoration research across all environments as well as important research questions specific to different types of environment. Participants brought a range of expertise to the workshop, and the ensuing discussion and brainstorming led to a valuable exchange of information and ideas.

A common theme that emerged from the workshop is the need to define goals in enhancement and restoration projects, encouraging biodiversity generally and pollination service specifically. Ecosystem function is an important overarching consideration. Goals of specific projects could be many, from conservation of wild lands to inner-city food production, with an equally wide variety of public priorities and perceptions to contend with. Tools are needed to quantify and justify particular biodiversity targets. Workshop participants also identified a number of basic ecological issues surrounding pollinator populations and pollination service that require study. These include the role of resources (food, nest sites, other materials) in regulating pollinator populations, the role of enhancements in the population dynamics of pollinators in the broader landscape, and the habitat required to support viable populations of pollinators in the long term, including such considerations as genetic issues and metapopulation

structure. Baseline ecological data on pollinator populations and communities are needed in many types of landscapes, together with replicable protocols to evaluate and monitor them and the resources that support them. Effects of common agricultural and urban practices on pollinators require investigation, in particular the effects of exposure to pesticides and other toxins, and best practices and decision tools established for planning.

On behalf of NSERC-CANPOLIN, I would like to thank all of our workshop participants for making the event such a great success, and the NSERCs Strategic Network Enhancement Initiative for their support.

Peter Kevan, FRS
Scientific Director, NSERC-CANPOLIN

Presentations (left) and a breakout group session (right) at the Pollination and Land Rehabilitation Workshop in Columbus, Ohio.

1) AgroEcosystems Breakout Group Summary

Participants: Elizabeth Elle, Mace Vaughan, Mary Harris, Teja Tscharntke, Andony Melathopoulos, Lora Morandin, Emily May, Brett Blaauw, Neal Williams, Valerie Fournier

Knowledge/Research gaps (action items are underlined):

1. **True estimates of yield** (not just seed set) when comparing landscape enhancements and controls (i.e., Brett Blauw and Rufus Isaac's work in blueberry; Morandin and Kremen using canola phytometers; Harris work in corn, where restorations affect soil retention). We should all make an effort to do this.
   - Do enhancements serve as net pollinator concentrators or exporters? Determine by measuring abundance on the crop. Keep in mind that prime function is not only to increase pollinators in edges when we are interested in ecosystem service of yield; we need to consider this both within a year and across years. Do we have enough enhanced fields that we can do a good comparison of yield? Where do we measure yield? Where do we assess pollinators? Considering within-field spatial scale is important. Do we have good data on how abundance of bees is related to yield? Not clear what is needed to address this, but Kremen lab seems to be doing it with population occupancy modelling.
   - Note: The group agreed that pollinators should be identified to species as evenness and turnover are important.

2. **What are the other benefits of landscape enhancements** (e.g.**,** nest habitat, both ground and above-ground; beneficial insects; other ecosystem services)? How does this vary with types of enhancements (woody vs not, cover crops) and how does enhancement efficacy differ given the crop in question?
   - For ground nesting bees, use emergence tents ($50-100 per tent) to assess bare ground, cracks, etc. Put out ca. 30 traps in an evening at a site, this will yield perhaps three traps with a bee. Some investigators are already looking at how packed or tilled the soil is, or other soil conditions. Building a sandy mound (at a demonstration location) will result in colonization. South-facing ditches are one possible option for assessment; what are other types of directed searching would be effective? What about assessments of above-ground nesters; does this depend on which species pollinates the crop? Plan to use a coordinated approach so that we can later compare data and do a review.
   - Above-ground nesters: only some species will nest in wood blocks. What about buried canes? Several in this group may try to do this. All that is needed are canes will small holes started, and bees will utilize. This approach will work for *Ceratina*, *Osmia*, etc. These bees may be more 'sentinels' than pollinators of the crop.
   - To asses other beneficial, add sweep netting to sampling regime to determine presence of both antagonists and beneficial.

3. **If we are enhancing for crops, which species are important for crop yield?** This approach fits within an optimization framework but will differ among regions. Once species are identified, one can consider the nesting needs of those species. We should all make an effort to do this.

4. **How do enhancements work?** Are enhancements "sinks" because of use of **pesticides** (insecticides and fungicides)? (*Apis* is not necessarily a good surrogate for non-apis bees as responses can vary.)
   - Sentinel bees: One approach is to encourage a grower to use *Megachile rotundata* and then determine if there is residue in the pollen balls and any impacts on population growth. In this situation the goal is to evaluate a bee that is active after the crop bloom, which is when the enhancements are supposed to be working. (Emily may initiate and once she has a method others can also assess in a similar manner).
   - Should we be cautious about our results? If there is a profound effect, the result could be a fight to remove pollinator habitat (i.e., chemical companies don't want the liability).
   - Could this information be used to push for better IPM strategies? Will there be labelling issues? Is there a way to not spray pesticides on field margins to protect pollinators using those margins (there will be yield loss)?

5. **Scale issues: how to consider landscape scale?** Does this differ with type of crop (i.e., ground crops vs berry or tree fruit)? How large should an enhancement be to act as a significant source of bees? The hedgerow is not independent of the landscape within which it is embedded. We know yield effect of hedgerow is greater in depauperate landscapes. A modelling/meta-analysis exercise could elucidate effects of configuration, size, etc., and impacts on yield and economics in different landscapes.

6. **How do cropping techniques like row covers affect pollinators?** How can we measure factors such as irrigation, pesticide use, etc?

7. **Social science issues**: Need surveys to gather information regarding willingness to pay, attitudes of men vs women, aesthetic value of enhancements, and barriers to adoption. Demonstration farms are important, as are growers that are engaged.

8. **Education:** Education regarding using native bees for bet-hedging, reducing costs, because native bee phenology is more likely to be synchronized with local weather than imported managed bees. (Does this assume that honeybee prices are going to keep increasing?

9. **Policy:** Is there a way to lobby Agriculture and AgriFood Canada and Environment Canada to make biodiversity in agriculture a priority in Canada? Can we work with the provinces to get this integrated at the provincial level? Can we create opportunities for farmers to receive financial support to implement biodiversity strategies and reduce pesticide use?

2) Natural Habitats Breakout Group

Participants: Ralph Cartar, Karen Goodell, Diane Larson, Peter Kevan, Sheila Colla, Jane Ogilvie, Alana Taylor-Pindar

a) Ecological principles and new directions

What properties might natural communities have, against which to judge the success of restoration or reclamation efforts?

- Log-normal distribution of species abundances in communities seems typical, and is simple to measure deviations from (although it's unclear what a "disturbed" community would look like).
- Natural disturbance regimes, which could be simulated in restored/reclaimed (RR) habitats. For many temperate North American habitats, time since major natural disturbance and disturbance size (disturbance is usually fire) at a site typically follow a negative exponential distribution. This suggests that risk of disturbance is independent of site age, and that most disturbances are small in space, but the fires that structure the landscape are rare and of broad scale. Periodic climate cycles (e.g., Atlantic oscillation, El Nino-Southern Oscillation) and directional climate change will adjust the predicted distribution. Managed lands rarely follow this distribution, however; prescribed fires typically are applied on a regular rotation.
    - Within a natural disturbance regime, we often expect species diversity to increase and then decrease following a natural disturbance, as encapsulated in the Intermediate Disturbance Hypothesis.
- Landscape context matters for locating RR habitats.
    - If RR habitats are too small to support viable populations of pollinators or plants (i.e., they're demographic sinks, not sources), then they should be located near existing natural habitats, or linked with corridors (e.g., as shown experimentally for butterflies). But we note that corridors are pollinator-specific, and therefore problematic if individual species, rather than communities, are targeted in management.
    - But if RR habitats are sources, then separating them from existing sources seems desirable, to produce a metapopulation structure where diseases & predators can be experienced somewhat independently in separate communities.
- Native flowers, rather than introduced flowers. But the presence of introduced flower species in a restored community is not unequivocally harmful. Are they valuable forage that facilitates pollinator visitation to natives and extends the foraging season of pollinators? Competitors? Both? Removing invasive flowers from a community risks disrupting pollination networks that support native species, so should be undertaken with caution.
    - Centrality of invasive flowers increases with their relative abundance.

Other Issues potentially related to successful RR:

- In re-constructing communities, should the focus be on particular species, or the whole community?
- Using percentiles for guilds as a proxy to determine "healthy" pollinator populations (with recommendations on monitoring to use this proxy) (scale of landscape issues, sample size issues, species interactions).
- Using pollination deficit rates to determine pollinator population status (recognizing that when flowers compete for pollinators, pollination deficits are one natural outcome).
- What regulates natural bee populations (nesting sites, floral resources, social and micro-parasites, diseases)?
- Comparison of RR communities with those predicted from species area curves may allow inference of impact.
- Recommendations for R&R will differ depending on condition of original habitat and its location relative to other RR and relict areas.
- How many potential colonists come from remnant versus other restorations?

b) Assessment Tools:

- Measuring traits of pollination networks (e.g., connectance, nestedness, complexity, etc.) and their sensitivity to incomplete sampling of the pollinator community.
- Proportions of functional groups that can only be supported in diverse communities (e.g., nest kleptoparasites).
- Ideal free distribution (IFD) is expected when pollinators distribute themselves across floral resources, and deviations from an IFD potentially signal a disrupted RR community.
- Log-normal species abundance of community (see above, pattern of deviation for disrupted community is unclear).
- Measuring pollination deficit, seed set or low availability of pollen among selected plant species while accounting for other reasons for such deficits (e.g., resource availability).
- Long-term monitoring of population density and nest boxs (i.e. demographic, parasitism levels, resource usage) allow for estimation of population performance, particularly whether a place or time is a demographic source or sink.
- A desired part of any R&R project would be to treat it as a "BACI" design, with relevant spatial and temporal comparisons.

c) Plans and Recommendations for Management

Identify problem: Determine whether goal is to restore landscape for pollinator diversity/ abundance or for the ecosystem service of pollination. The former is preferable, but the latter might be a requirement of economic payoff for investment in R&R.

- Plan disturbance regimes to maximize pollinator diversity considering different successional stages. Regimes should be informed by natural disturbance levels. Implementation would involve determining frequency and size of disturbance that promotes diversity while reducing extinction risk from disturbances that exceed the size of managed areas, a consideration which constrains the desired scale of variation in natural disturbances. Goal is to maximize Gamma diversity.
- Extend remnant habitat instead of starting new areas? (*a knowledge gap*)
- Determine quality of habitat and quality of surrounding habitat (spatial context)

3) Urban and Peri-Urban Environments Breakout Group

Participants: Lisa Novick, Arlene Hopkins, Ashley Bennett, David Goulson, Soliman Kamel, Gretchen LeBuhn, Scott MacIvor, Scott Prajzner, Thomas Woodcock, Olubayo Oluduro

Knowledge/Research gaps

a) Pollinator habitat and resources

- Public (including low income sector) has interest in home gardening, which requires pollinators. Is bee diversity important in those circumstances, are unmanaged bees sufficient in cities or should we manage pollination (i.e., use honey bees) in pollination deficient areas?
- What are limiting factors for pollinators in built environments? (Floral resources may not be limiting with the availability of home gardens, street trees, etc. Are nesting habitat and materials [such as suitable leaf material and resins] limiting? In some areas, nesting sites may be abundant, but food limiting, perhaps due to plant choice in landscaping [e.g., areas with lots of junipers].)
- How does urbanization isolate populations spatially? Genetically? What does this mean for local extirpation?
- What is the value of urban pollinator populations as refugia for surrounding ecosystems and agricultulture? Are there metapopulation/corridor considerations?
- Can pollinator requirements be integrated into other ecological engineering technologies (e.g. there is a decrease in diversity and nesting success with height of green roofs, which are increasingly common in cities and frequented by bees).
- Standardized assessment methods for nesting habitat – there is a need to develop these methods for urban environments (similar to what has been done for some agroecosystems).

- Native plants should be encouraged, not necessarily for pollinators but for other (invertebrate) wildlife, particularly those that require food plants.
- Biodiversity considerations for urban planning. In Toronto, for example, there is a mandate that new planning include biodiversity considerations. This is a biological and ecological knowledge gap. How can pollinator biodiversity be practically incorporated by architects and engineers into urban plans? At what spatial scale is this valuable (or un-valuable)?
- How to encouragement entomophilous plants most effectively (anemophilous plants and invasive plants can take over at the expense of entomophilous plants if not managed, although many bees readily collect pollen from wind-pollinated plant).

b) Range Dependence

- What is the minimum amount of space required to support a population of a given pollinator species in an urban environment?
- Need to provide evidence to regulators to justify biodiversity targets (X% of pollinators provisioned by Y% of green or gardened area).
- How does length of life cycle of pollinator species impact range requirements in an urban setting, given transitory nature of resource availability?

c) Pesticides

- What is the exposure of urban bees to toxins? (Can test pollen provisions for metals, organics, pesticides, etc.)
- Does injection of neonics into trees expose pollinators during flowering? Detritivores?
- What is public perception of aesthetic pesticide use (golf courses, urban trees, parks, appearance of food) as it relates to impacts on pollinator populations?

Considerations for Extending Information and Creating Public Awareness

- Role of citizen science (bottom up approach can indirectly influence policy makers).
- Integrate food production and home gardens as part of multiple-use pollinator conservation efforts.
- Certification programs for pollinator or wildlife-friendly gardens.
- Create emotional and economic “hook”, entertain, tease, persuade, inform. Use of charismatic minifauna.
- Be conscious of cognitive frames of people (cultural biases against bees, etc.)
- Theory of change, aesthetic and behavioural transition of public perceptions. What is a ‘good’ garden? What is the purpose of the garden or park? Is it just an aesthetic endeavour, or can it be something more?

- Science leads (ideally) to policy, laws and treaties; programs and projects follow from the legislative goals of those entities. Develop goals at various scales, and develop evaluation protocols and standards before programs and policies are implemented.
- Industry has forces that promote their interests; scientists need to organize opposition when these interests are not in the public or environment's interests.

Priority Knowledge Gaps and Suggested Time Frames to Address			
	Short-term (i.e., 5 years)	**Long term (i.e., 10 years)**	**Very long term (i.e., 20 years)**
What toxins and pesticides are urban bees exposed to?	X		
What is the effect of exposure? (Could also include pathogens.		X	
Is there pollinator limitation to urban crop production?	X		
How do we improve or optimize this urban pollination?		X	
Who is doing the pollinating, managed honey bees or wild bees?		X	
What is the economic value of pollination services delivered in urban areas, and how might it be improved? (more crops, more pollinators)		X	
Quantify the baseline biodiversity of urban pollinators, nesting resources, nest site availability, etc.	X		
General effects of city practices on pollinators, such as soil compaction and coverage for ground-nesters.	X		
How might biodiversity be improved/conserved in the cities, based on the previous question?		X	X
How can urban areas conserve species and provide pollinators to agricultural and wild areas for plant sustainability?			X
Improvement of nesting habitat, other resources. What are novel nesting analogs available to urban bees & are they beneficial to the populations?		X	
Novel foraging resources (i.e., rooftops, three dimensional novel habitat).		X	
Land use, density, intensity, building forms and materials, age and maturity of sites.		X	X

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Presentation Abstracts

(PDFS of some presentations are available for download at www.uoguelph.ca/canpolin/Publications/talks.html)

Pollination of typical species in disturbed sites in the extreme north-east of Asia

E. A. Tikhmenev

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In the far North-East of Russia, harsh climatic conditions result in very slow natural restoration of disturbed lands. Reclamation of technogenic formations and cultivation of productive plant (floral) communities is possible only with careful selection of pioneer species adapted to the region. Ongoing research has examined the reproductive biology of several species of native plants for potential use in reclamation. At early stages of succession when vegetation is sparse, anemophily easily occurs. Disturbed sites are actively reseeded with grasses, sedges and other wind pollinated species. Anthecological research has shown that regular and thick seeding is typical for species in the Poaceae family and many are highly valuable for revegetation. Regular and thick seeding on disturbed sites is also characteristic for some members of Salicaceae family, which are also important anemophilous plants in boreal Russia. Plenty of free-flowing pollen enriching ground-level air for 24 hours, close-growing trees and shrubs and extended periods of fertility contribute greatly to successful pollination and seeding at different succession stages. A high level of adaptation to harsh environments is typical for a number of entomophilous species as well. Growth in clumps and dense groups also favours “efficiency” of insect pollination in disturbed environments. Revegetating floral communities usually include members of the Fabaceae, Scrophulariaceae and some Salicaceae; these are characterized as entomophilous plants with obligate xenogamy. These plants are rare in rehabilitated plant communities and have limited use in revegetation.

Restoring and augmenting habitat for insect pollinators in agricultural landscapes

Neal M. Williams & Kimiora Ward

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Agricultural intensification is among the primary drivers of bee declines worldwide. Recent research, however, suggests that native bees can persist and contribute to crop pollination where their resource needs are met. Wildflower plantings within agricultural landscapes offer a means to provide

critical forage and nesting resources to support wild and managed pollinators and to bolster pollination services to crops. In a three phase study we have (1) developed a framework for identifying native plants to include in mixes; (2) we have tested annual and perennial plant mixes ability to support native pollinators; (3) we are testing best mixes ability to attract native species and increase pollination to target crops.

All mixes increased bee abundance and diversity over control plots. Perennial plants flowered well in the first season and contributed most strongly to support pollinators. Less diverse plant mixes performed equally to more diverse mixes; however, seasonal variation in plant flowering phenology highlight the importance of including multiple plants to fully support pollinators. This effort is part of a collaboration between Michigan State University, University of Florida supported under the umbrella of Operation Pollinator. Comparisons between California and other regions show a consistent benefit of wildflower strips to bees in agricultural landscapes.

Re-establishing pollinator communities and pollination services with hedgerow restoration in intensive agricultural landscapes

Lora A. Morandin

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Declines of managed and native pollinators are causing concern world-wide. Restoration of small habitat areas, such as hedgerows, in intense agricultural landscapes is being increasingly encouraged and is a feasible method for growers to implement conservation on their lands. However, little is known about whether small-scale restoration in intensive agricultural landscapes will benefit native pollinator populations. In the Central Valley of California, we are comparing native bee populations and pollination services on sites with and without native perennial plant hedgerows. We questioned whether hedgerows were increasing abundance of native bees and if they differentially impact common and less common species. We assessed whether hedgerows are net exporters or concentrators of pollinators and how hedgerows impact pollination services to adjacent crops. We found that hedgerows did not increase overall bee abundance but did increase abundance of all but the most common species. Hedgerows also increased species richness and acted as net exporters of native bees to adjacent fields. We also are assessing economic costs and benefits of hedgerow restoration to agricultural production.

Harnessing leviathan: Can the conservation of wild pollinator habitat be motivated by the value of ecosystem services delivered to a massive commodity crop like canola (*Brassica napus*)?

Andony Melathopoulos[1], Stephen Pernal[2] Chris Cutler[3] and Peter Tyedmers[1]

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The spectrum of pollinator-dependent crops encompasses numerous species of vegetables, fruits and spices. In spite of this diversity, the majority of the value associated with pollination is derived disproportionately from a handful of commodity crops, predominantly oilseeds, that are grown intensively, across a vast geographic scale and with moderate to low dependency on pollination. In Canada, for example, over half of the value attributable to insect pollination is accounted for by one such crop, canola. Given the extent to which these crops dominate agro-ecological landscapes and agri-business they potentially pose both the greatest challenge and opportunity for motivating pollinator habitat conservation and rehabilitation. This paper describes our initial efforts to estimate the current level of ecosystem pollination services being delivered to canola in Western Canada. The goal of this work is to better understand the extent to which an ecosystem service approach to pollinator habitat conservation and rehabilitation will confront trade-offs that will limit their impact in practice.

Assembly of plant-pollinator relationships and measurement of pollination service using seed set phytometry on regenerating lands

Thomas S. Woodcock

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Sustainable re-establishment of vegetation on degraded lands depends in part on available pollination service, and in turn pollinator populations depend on the presence of appropriate resources. Three former corn-soybean fields of different ages (cultivation ceased in autumn 2003, 2006, and 2009 respectively) have been monitored for floral coverages, pollinator assemblages (pan and Malaise trap catches), and observations of floral visits for three years (2010, 2011, 2012). Sites show progressively higher floral richness and more floral visits with age, although continuity of floral resource availability is slower to increase. Development of a Pollination Service Monitoring system has been ongoing at these and other sites, to allow accurate, direct measurement of pollination service. In 2011 seed set in three species of potted *Symphyotrichum* plants was related to pollinator assemblage characteristics

(abundance, richness, diversity). *S. puniceum* seed set per inflorescence showed highest correlation with pollinator assemblage descriptive metrics (r^2=0.67 to 0.92), although cultural issues reduced utility of the other species. In 2012, a broader functional range of plants are being evaluated at an increased number of sites, and a citizen science pilot program using *S. puniceum* is underway. Rehabilitation of sites must include considerations of both habitat and resource continuity for pollinators.

Some efforts to conserve and restore leafcutting bees in Egypt

Soliman M. Kamel

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This work is a preliminary study to establish a leafcutting bees industry in Egypt. Agriculture development in Egypt has progressed rapidly in recent years. Particular interest is being focused in new lands scattered all over the country. Production in new lands is being limited by lack of pollination. One of the major problems that face most of the newly reclaimed areas is the relatively low production of crops due to lack of insect pollinators. In addition to the negative impact of the loose old cultivated land due to reconstruct new buildings and cities, many concrete houses had been moved quickly to replace the old mud houses in the villages. Many natural nests of *Megachile* spp had been discovered in many villages in El Tel Kebber and efforts were carried out to conserve these bees. Most *Megachile* species collected from the natural mud wall nests are similar in shape and size to *Megachile rotundata*. Therefore, it was a good point of view to manage these bees and use it for alfalfa, *Medicago sativa*, pollination. The main effort focused on using different models of polystyrene foams to encourage bees to renest in these artificial nests. Observations were also made to determine if bees will emerge and renest again in same artificial nests. The results revealed that nesting rates were high but varied from area to another. Moreover, experiments were carried out using these bees for alfalfa pollination in experimental fields. The results revealed that these bees are promising pollinators for alfalfa in Egypt especially in new reclaimed lands and old cultivate area of Suez Canal region.

Pollinator Habitat Restoration from Coast to Coast: Lessons Learned from the Field

Mace Vaughan

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With funding from a USDA NRCS Conservation Innovation Grant (CIG), Xerces Society conservationists and partners created more than 20 pollinator habitat demonstration projects on farms across the United States. We targeted six major regions of the country where pollinator dependent crops are concentrated, planting hedgerows or pollinator meadows using a variety of site preparation

and planting techniques. Demonstration sites also were monitored for the success of establishment and bloom time of plants.

In this presentation, Mace Vaughan will provide an overview of this project, discuss lessons learned, and share case studies from these CIG-funded field trials. He also will share new technical guides developed by the Xerces Society, including region-specific habitat restoration guidelines. Finally, he will discuss next steps and the latest questions coming from the field to Xerces Society restoration specialists.

Integrating Pollinators into Large-Scale Landscape Restorations

Victoria Wojcik

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Tools and guidelines for pollinator conservation, inclusive of planting lists and habitat management techniques, are available to a wide range of audiences, ranging from home gardeners, to farmers and ranchers, to public and private land managers. This presentation will examine the strategy behind scaling up pollinator conservation practices and as well as determining how they can be fit and adapted into standard larger-scale restoration practices and programs.

Challenges and opportunities when working large multi-stakeholder landscapes will be addressed as they represent a new and growing opportunity for pollinator habitat restoration and creation. This presentation will focus on the novel work being conducted at a Southern California restoration site where Pollinator Partnership is working with The Boeing Company, NASA, Wildlife Habitat Council, Padre Associates, and MWH Global to integration pollinator habitat restoration into a multi-facetted program. Unique opportunities to assess the impacts that large-scale restoration presents for threatened and rare species on disturbed lands will also be addressed. Case studies from other regions where large-scale restoration partnerships are underway will also be presented to highlight successes and lessons learned.