Project ICP News

from the Integrated Crop Pollination project

January 2015
Issue 3

www.projecticp.org

Main Articles

Project ICP is a Coordinated Agricultural Project, funded by the Specialty Crops Research Initiative of the USDA's National Institute of Food and Agriculture.

United States Department of Agriculture
National Institute of Food and Agriculture

Project ICP is a collaboration between:
AgPollen LLC
Franklin & Marshall College
Loyola University
Michigan State University
Oregon State University
Pennsylvania State University
Rutgers University
St. Mary-of-the-Woods Coll.
Simon Fraser University
The Xerces Society
UC Davis
UC Berkeley
University of Florida
University of Vermont
USDA Pollinating Insects Lab

Increasing Interest in Integrated Crop Pollination

Since our project started in 2012, concerns about the long-term health of bee populations has grown, and it continues to grow. The Presidential Memorandum (article on page 5) brought this into sharp focus in the spring of 2014, and there has been a flurry of activity since then to provide input to the development of the federal action plan that will be released in early 2015.

Our USDA-ARS colleagues have been heavily involved in crafting parts of the action plan, and others on this project have also given technical advice, guidance, and the benefit of our experience gained through participation in Project ICP. During this planning process in the U.S., during discussions with colleagues in Europe and elsewhere this year, as well as in discussions with farmers, there has been growing attention to the idea that combining sources of pollination is a useful approach to explore.

Learning where and when it makes economic sense is of paramount importance to fruit and vegetable growers, who need reliable and cost-effective strategies to pollination just as for all other parts of their farming. As we continue to explore Integrated Crop Pollination in this project, it is exciting to see it being embraced by others. Since the beginning of our proposal development and the early thinking about this project, we wanted to have a definition to encapsulate this idea.

Here is our current working definition of Integrated Crop Pollination:

The combined use of different pollinator species and pollination strategies to support, protect, and augment pollinator populations that provide reliable and economical pollination of crops.

A definition such as this provides clarity for what ICP is, and is not. It also lays out the components that should be considered when developing or studying integrated crop pollination. It starts with the combination of pollinators, which highlights that we are interested in whether there are benefits to using more than one species for crop pollination. This redundancy could be beneficial if one species is unable to sufficiently pollinate the crop. This may occur when there is reduced pollinator activity due to inclement weather, decline due to disease, or loss of managed bees due to lack of availability. With multiple species in the system, there is still capacity in to provide pollination.

We also mention different pollination strategies to indicate that in addition to thinking about which pollinators to use, ICP considers how to use them, how to augment them with forage and/or nesting sites, and how to protect them. The final aspect of considering reliability and economics is also essential. Effective strategies have little chance of being adopted widely if they do not provide some return on investment, so we are working to evaluate this for the different pollination approaches being investigated in the various systems where Project ICP is active.

Currently, a review article is being developed to describe these ideas and their application, and we plan to have that published in 2015. Over the next few years these ideas will also be tested for the specialty crops in our project. This will inform our extension and outreach activities and the development of decision-aids to help facilitate ICP adoption. Ultimately, we will see how widely the Integrated Crop Pollination approach is adopted by growers, and that will be the true test of whether integrated crop pollination helps address the long-term pollination needs of specialty crop producers

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Year 3 Snapshots

- In 2014, a total of 142 crop fields and orchards were sampled in: almond (CA), apple (MI, PA), blueberry (FL, MI, OR, BC), cherry (MI, WA), pumpkin (PA), raspberry (OR), and watermelon (CA, FL).
- Twenty almond orchards across three counties in California (Kern, Stanislaus, and Merced) were sampled for bee visitation, fruit set and yield. Only honeybees and blue orchard bees were observed visiting blossoms.
- Four Bing cherry orchards in Washington, and 15 tart cherry orchards in Michigan were sampled in 2014. Pollinator exclusion drastically reduced cherry yield in orchards.
- 56 blueberry fields were sampled from Florida (10), Michigan (17), Oregon (12) and British Columbia (17). Initial analysis shows a strong influence of native habitat on wild bee abundance.
- Wildflower enhancements have been planted in Pennsylvania apple and pumpkin, Michigan blueberry and cherry, and in California almond and watermelon. Sites for additional plantings are being prepared in the other regions and crops.
- Mason bees or bumble bees were used as alternative managed pollinators in almonds, apples, blueberries, canefruit, cherries, and watermelon.
- Almost 150,000 blue orchard bees were released in almond orchards. Yield from these sites will be compared to orchards that used only honey bees for pollination.
- Farms have been chosen in each region where project team members will establish demonstrations of ICP tactics.
- Twenty five pollinator workshops, 62 extension presentations and10 extension publications were produced by the ICP team.
- In conjunction with USDA-NASS, 3500 surveys were distributed to assess the current and future use of ICP methods among specialty crop growers in the regions where ICP research is ongoing.
- The ICP economics and modeling team is developing a nationwide analysis of the supply of wild pollinators and suitability of different habitats for wild pollinators. Preliminary results suggest 6% of US counties may have a pollination service deficit.

Clockwise from top left: Habitat planting in almond. Wildflower strip next to watermelon. Bumble bee worker ready to emerge. Pollinator exclusion bags in blueberry. Bumble bee visiting blueberry. Dave Biddinger tells growers about wild bees. Pumpkin harvest measurements.Collecting bees during cherry bloom. Weighing bumble bee colonies in the field.

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Where do Honey Bees fit into Project ICP?

Honey bees (*Apis mellifera*) are without a doubt the most recognized and relied upon pollinator in the world. Between one-quarter and one-third of food consumed in the U.S. relies on animal pollination, and honey bees are attributed with providing about 85% of those pollination services. The USDA recently announced plans to provide an additional $4 million for honey bee habitat, building on $3 million that was previously announced. Meanwhile Project Integrated Crop Pollination (ICP) aims to maximize sustainable pollination of specialty crops, but does not explicitly focus on honey bees. So, where do honey bees fit into Project ICP?

Despite not focusing directly on honey bees, the activities of Project ICP do help honey bees. Anything that benefits wild bees will benefit honey bees as well. As we examine factors that affect the abundance of wild bees and develop habitat management practices that improve crop pollination, we learn more about what harms and benefits honey bees.

Honey bee visiting a wildflower.

Honey bee at a watermelon flower.

Project ICP is monitoring current farm management practices, so that we can see if particular practices boost or depress bee populations. Are there more bees observed at farms that allow flowering weeds to persist for longer times? Among those farms that do more to control weeds, does the method of weed control affect bee abundance? How do pesticide choices and application schedules impact the presence of bees? The answers to these questions are important, because practices that affect wild bee populations are likely to impact honey bee health and influence crop yield.

Allowing more flowering weeds might prove to be important because they may be providing food resources for both wild and honey bees. Not only is the amount of food available to bees increased, but nutrition, and therefore, health are improved. Would you feel very good after eating nothing but almonds for a month? Neither would bees.

Taking one additional step toward the goal of optimizing forage for bees, Project ICP is adding wildflower plantings alongside some farms. This will allow us to determine if enhancement of habitat through adding bee forage can economically increase the abundance of bees, including honey bees, pollinating crop flowers. Enhancing the habitat in this way is important because often farms are not surrounded by wildlands that can provide nutritional diversity to bees.

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Honey Bees and ICP

But why is this important to honey bees, when they can be fed artificial diets? Artificial diets are often lacking key nutrients and as recently presented by Dr. Gloria DeGrandi-Hoffman at the 2014 Annual Meeting of the Entomological Society of America, are often not metabolized as well as natural forage. In fact, under some circumstances, the supplementary diets fed to honey bees may be toxic, as has been found in the case of high-fructose corn syrup held at high temperatures for extended periods. The best food for bees is natural and diverse forage, and if we can find a way to sustainably provide that while increasing specialty crop pollination, then everybody wins.

Pollen substitute is placed on top of the hive (top). Workers gathering pollen substitute (bottom).

Colonies being fed nectar substitute. Note the clear jars on top of the hives.

Project ICP is not only identifying and developing best management practices, but we are working on the best methods for conveying this information to stakeholders. Honey beekeepers are among the stakeholders that we are educating. Many of the beekeeping associations in Florida have invited me to speak about Project ICP. I am also approached by beekeepers while I'm out working in the field. They are particularly interested in learning what flowers they can plant to provide bee forage throughout the year. I am always pleased that my work with Project ICP enables me to give them recommendations for plant species that are particularly suited for our area. In addition, I can tell them the best methods for successfully sowing the seeds and establishing the wildflower plots.

Growers, beekeepers, and the general public recognize the value of this research and are genuinely interested in the outcomes. As Project ICP enters its third research season, I am struck by just how beneficial the work we are doing is for all of the pollinators, including the honey bees. As I said earlier, anything that benefits wild bees will benefit honey bees as well. In fact, it benefits all of us.

Cory Stanley-Stahr
University of Florida

For more information:
http://www.usda.gov/wps/portal/usda/usdahome?contentid=2014/10/0241.xml
http://edis.ifas.ufl.edu/in1027
https://esa.confex.com/esa/2014/webprogram/Paper84880.html

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New Federal Attention and Initiatives for Bees

This has been a big year for federal attention to honey bees and native bees. In June, President Obama released the Presidential Memorandum on Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. This directs a wide range of US government executive departments and agencies to consider how they can adjust their policies and investments to improve the health of this nation's bee populations. These agencies are being led by co-chairs of the Pollinator Health Task Force, one from USDA and one from EPA, to develop a Pollinator Research Action Plan which was to be developed in a 180 day timeline. This is a tall order, and meant release around the holidays, so we are eagerly awaiting the release of the Action Plan in early 2015. We are expecting some new initiatives that will support bees, butterflies, and other pollinators. This may also include some new funding opportunities as well as new investment in bee conservation programs, but we will need to wait for the details.

Some action has already been taken, such as Executive Order 13514 that has provided Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes and Supporting Pollinators on Federal Landscapes. There have also been new programs announced and established quickly by the USDA-NRCS to support honey bees in five Midwestern states. On October 29, Secretary Vilsack announced an additional $4 million for honey bee forage in this region that is home to a majority of the migratory honey bee colonies for summer forage. Members of Project ICP have been involved in advising the development and rollout of this program, and may also be part of the efforts to evaluate the support of managed and wild bees over the next few years as the plantings supported by this program become part of the farm landscapes.

Project ICP members were also involved in the Honey Bee Forage and Nutrition Summit, sponsored by USDA, in October 20-21, in Alexandria, VA. This was led by Dr. David Epstein of USDA's Office of Pest Management Policy who worked with a planning committee to bring together researchers, beekeepers, government agencies, industry partners, and non-profit groups to provide input on the interactions between honeybees and forage, from the physiological level to the landscape level.

On the first day, the group heard beekeeper Zack Browning who is also a board member of the American Beekeeping Federation, describe the many challenges of modern beekeeping. His stark warning about the lack of available forage and the cascading effects on honey bee health, honey production, the economics of beekeeping, and long term projections for the industry provided a clear focus for the task at hand, and why it is so important to develop programs that will help bring more clean forage onto the landscape that bee keepers can have access to. This was followed by presentations about honey bee forage and nutrition as well as the benefits of forage plantings for crop production and how best to design and implement these plantings. Project ICP members Neal Williams, Rufus Isaacs, and Mace Vaughan all presented at the meeting, and our advisory committee member Marla Spivak was involved in the discussions too. On Day 2, the meeting broke into assigned teams to discuss four main topics. From the reporting back to the large group, there were some common themes in how to move forward, lively discussions about the value of some excellent honey bee forage plants that are also considered invasive, and some clear action items that the agencies could take back to discuss. The results of this workshop are expected to be brought together into a report, which we also expect will inform the Federal Action Plan mentioned above.

Workshop organizer Dr. David Epstein presenting an overview at the honey bee forage and nutrition summit.

Much of what we are learning in Project ICP, especially in Objective 2, relates to the discussions at the forage summit, and we can expect that there will be great interest in our results to help inform the policies and programs that might develop from the input provided at this workshop.

Rufus Isaacs
Michigan State University

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Creating Habitat for Wild and Managed Bees

The connection between availability of floral resources and wild bee abundance and diversity, as well as between resource diversity and honey bee health, has motivated widespread action to diversify agricultural landscapes through planting of wildflower forage for bees. Recent work in California, Michigan, New Jersey and Florida shows dramatic increases in wild pollinator abundance and diversity at wildflower plantings on farms compared to un-enhanced field margins. Similar benefits are seen for honey bees in California, Michigan and New Jersey. A major goal of Project ICP is to plant habitat on farms near pollinator-dependent crops to measure its ability to increase crop yields through support of wild bee communities. We are measuring these effects at blueberry farms in Oregon, Michigan, Florida and British Columbia, watermelon and pumpkin farms in California, Florida, and Pennsylvania, apple and cherry orchards in Michigan and Washington and almond orchards in California.


Great valley phacelia
Phacelia ciliata


Baby blue eyes
Nemophila menziesii


California poppy
Eschscholzia californica


California blue bell
Phacelia campanularia


Five spot
Nemophila maculata


Chinese houses
Collinsia heterophylla

Wildflowers used in the seed mix for the almond system in California

In all regions we have planted regionally-appropriate native wildflowers and shrubs previously shown to attract wild bees and honey bees. We use native plants because they are adapted to local environmental conditions and are less likely to require inputs like irrigation or fertilizer. We also chose species that are compatible with crop-specific farm management practices. For example, in almonds system in California, we use short-lived, short-statured annual wildflowers that flower early enough to precede crop bloom in early February; that finish flowering by March when growers begin insecticide applications on the crop; and that leave no residual organic matter that could interfere with almond sweeping from the orchard floor in fall.

Plot preparation and seeding equipment. (Top) Chain harrow pulled behind an ATV. (Bottom left) Drop seeder and rolling culti-packer. (Bottom right) "Belly grinder" hand-operated broadcast seeder.

Such novel actions come with substantial challenges. In some areas plant lists and native plant materials are lacking. For example British Columbia does not have a developed network of native plant suppliers. In addition novel weed management issues arose with the extreme drought in California in 2014. These are an expected part of pioneering new approaches to sustainable agriculture and the regional ICP teams have met them head on.

Successful establishment and persistence of pollinator habitat depends on proper site preparation, well-timed planting and attention to weed control in the first year. A full year of weed control prior to sowing native seed is essential to give wildflowers a foothold and the ability to persist and reseed themselves with low ongoing maintenance. Typically this involves tilling to prepare a good seed bed the fall before planting, then flushing out and controlling weeds that germinate in fall, spring and summer. Ideally fall and spring rains stimulate weed germination, but in some regions and years irrigation may be required. We spray each flush of weeds with glyphosate to control weeds without further ground disturbance. It is critical to avoid further tilling after initial bed preparation and weed control because soil disturbance stirs up additional un-germinated weed seeds.

After controlling winter and summer weeds the site is sprayed a final time and seeded in the second fall. In most regions, fall timing can be important for two reasons. Many wildflower species require cold treatment to germinate. Others germinate immediately and can crowd out weeds remaining in the seed bank.

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Bee Habitat (con't)

No matter what time of year it is critical to achieve good seed-soil contact while minimizing ground disturbance. A chain harrow can be used to loosen the top1-2 inches of soil, then immediately sow seed and follow with a culti-packer or other ring-roller to press the seed into the soil. Seed mixes can be sown using typical farm drills but broadcast-seeding is most effective because unlike most crop seeds, wildflower seeds are often small and require light to stimulate germination. We have found no-till drills (to avoid ground disturbance), drop-seeders or belly-grinders to be most effective. It is important to use a bulking agent with seed mixtures to disperse small and large seeds at a similar rate. The California team uses polenta as a bulking agent – because polenta is also a seed material it is the right density to suspend seeds ranging in size from a poppy seed to lupine seeds (about the size of a lentil) without dropping the heavy seed to the bottom of the seed hopper. Other bulking agents commonly used include sand, rice, wheat or barley hulls, and sawdust.

Wildflower seed mixed with polenta as a bulking agent.

Vigilant weed control throughout the first year of establishment is essential for long term persistence and cost-effectiveness of habitat installations. Good native cover can shade out weeds in the long run and allow perennials to persist and annuals to reseed themselves for many years. It is most economical to control weeds in the early growing season before they flower and set seed. Grasses should be sprayed with a grass-specific herbicide when they are only 2" tall to minimize the amount of herbicide used and prevent crowding out germinating wildflowers.

Wildflower strip in its first (above) and fourth (below) growing seasons. Planted fall 2010. Bottom photo by Jessa Kay Cruz, Xerces Society, April 2014.

We are monitoring pollinator habitat for its ability to support bees through provision of both forage and nesting habitat. Every month during the bloom season of the wildflower enhancement we quantify floral resources and conduct timed samples of the number and diversity of bees visiting wildflowers in the habitat compared to nearby unenhanced areas. This allows us to capture shifts in the bee community use of plantings with seasonal shifts of wildflower bloom, and to identify key wildflower species that provide the most benefit. We monitor pollination and yield of adjacent crops to assess whether support of wild and managed bees through habitat provision can improve pollination services.

Monitoring floral abundance (left) and sampling bees after harvest (right).

Bee Habitat (con't)

Most research on bee habitat focuses on floral resources, but in many farming systems tillage and other weed management practices also limit nesting resources. Thus, habitat enhancement, including those focused on wildflower plantings, may support native ground-nesting bees, such as bumble bees and squash bees, by providing undisturbed nesting substrate. In addition, reduced tillage represents a low cost option available to many growers of diverse fruit and vegetable farms to promote nesting opportunities for native bees. It may be especially effective for bees that are closely tied to one crop species and thus nest within the crop itself. We have been quantifying the ability of wildflower plantings and low-till management to promote nesting of bees on farms using direct field assessment of nest densities. In the coming year, work will begin in some regions using molecular-based methods to estimate densities of bumble bee colonies.

Kimiora Ward
University of California - Davis

Figure 6. Emergence trap used to sample ground-nesting bees in a wildflower strip in CA

Upcoming Workshop will Spread Molecular Techniques through Project ICP

In mid-February, a dozen researchers will gather in Logan, Utah for the first Bee Molecular Ecology Workshop. This Project ICP-supported event will provide in-depth training in the molecular methods that can be used to analyze bumble bees and determine the number of bee nests in an area or how many bee nests are providing foragers to pollinate a particular crop field. Dr. Jamie Strange and his team at the Pollinating Insects Research Unit of the USDA-ARS and of Utah State University will host the group for a week, and they have lined up a detailed agenda of hands-on training, lectures, and discussion. The attendees will be able to take the techniques back to their institutions, and the organizers hope this will help enhance the capacity of the junior and established researchers in our project to answer some of the important current and future research questions. The workshop has been affectionately dubbed the “Bee & Ski” workshop, so we hope to have some photos of researchers on the mountains for our next edition.

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Graduate Students and Project ICP

Project ICP is helping to produce young scientists who by participating in the project's research in California, Utah, Michigan, Vermont, Florida, Pennsylvania, and Oregon are developing skills to become the next generation of crop pollination ecologists. Here is a little about them and how they each fit into the team

Kyle Bobiwash

Simon Fraser University

My research interests are focused on establishing methodologies to enhance habitat within and around agricultural fields to both increase the presence of beneficial arthropods and the ecosystem services they provide. This will be essential going forward to mediate threats such as pollinator loss, climate change and anthropogenic landscape disturbances. Through a better understanding of the pest predators, wild and managed pollinators present in British Columbia agriculture, we can maintain and potentially increase the effectiveness of pollination and pest predator services by adapting our farming practices to accommodate the needs and behaviour of these insects. My research project aims to determine the key features in farm landscapes that supply beneficial arthropods with resources in order to ultimately provide farmers with field trialed techniques that optimize crop production while maintaining biodiversity and ecosystem services.

Chase Kimmel

University of Florida

I am a second year PhD student at the University of Florida studying how land management practices impact pollinator habitat and pollinator diversity. For Project ICP, I am part of the team developing habitat management practices to improve crop pollination to blueberry and watermelon crops (objective two). My dissertation research identifies key floral resources being utilized by pollinators in upland sandhill pine communities and investigates how fire management practices (prescribed burn frequency and timing) impact pollinator diversity.

Before joining UF's Honey Bee Research and Extension Laboratory, I worked as an environmental scientist on wetland and waterway permitting, mitigation planning, and monitoring throughout the Midwest. In my spare time, I love spending time with my family, scuba diving, hiking, photography, and travelling.

ICP Grad Students (con't)

Corey Androkoupolis

Utah State University

I received my BS in Biology and Zoology from Humboldt State University in December 2013. I am currently a graduate research assistant with Dr. Jim Cane at the USDA-ARS Pollinating Insect Research Unit and pursuing a Master's degree in Ecology at Utah State University. For my part in Project ICP I am studying raspberry pollination. In May 2014 I helped to collect data on the abundance and distribution of bees in commercial raspberry orchards in northern Oregon. My future research as part of the ICP project will focus on determining the relative pollination efficiencies, on raspberry, for several genera of bees including *Apis, Bombus, Osmia*, and *Ceratina.* I will also be studying various aspects of the behavior and biology of *Osmia aglaia*, which has shown promise as a manageable pollinator of cane fruits in the Pacific Northwest.

Katharina Ullmann

UC Davis

I was recently hired by the Xerces Society for Invertebrate Conservation to help manage the outreach and extension component of Project Integrated Crop Pollination. In this capacity I'm working with project partners to develop materials and tools that growers can use to inform pollination management strategies on their farms. These include fact sheets, guides, and videos – all of which will be posted on the project website (www.icpbees.org). In addition, I am coordinating the project's demonstration sites where I'll be working with project partners and farmers to show integrated crop pollination in action. I am very excited to be working with a team of research partners and growers that represents different specialty crops and regions from around North America.

Prior to starting with Xerces I conducted research and extension as part of my PhD in Entomology at the University of California, Davis where I was advised by Neal Williams. My dissertation explored how crop rotation and tillage practices impact the squash bee (*Peponapis pruiniosa*) a pollinator of squash and pumpkin. I've also participated in research projects developing pollinator friendly wildflower mixes, evaluating a citizen science pollinator training guide, and testing the impact of urban development and farm hedgerows on pollinators. I have eleven years of experience conducting outreach, extension and educational programs and four seasons of experience working on mixed vegetable and livestock farms.

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Annual Meeting Notes

Since the time of our last newsletter, our project team held its second annual meeting in January of 2014. The delayed passage of the Farm Bill in 2013-14 imposed budget constraints on our project, and in addition to limiting the research we could accomplish, we were obligated to have last year's meeting in a virtual setting. Despite this limitation, we organized and ran a successful meeting, complete with project updates, mini-workshops, concurrent breakout sessions and interactive planning discussions, all using Adobe Connect. Although this meeting achieved its goals of providing progress updates, getting valuable feedback from our advisory committee and planning for the coming field season, the one-on-one interactions of in-person meetings cannot be duplicated using online conferences.

Another year has passed, and we will have our third meeting at UC Davis, January 20-21, 2015. The project team is excited to meet in person again, and from this we expect our project to continue to flourish. The agenda for the meeting in Davis includes considerable time to discuss the future direction of our work as we prepare to apply for funding for the remaining two years of Project ICP. Our advisory committee will also have an opportunity to provide valuable input on our project's direction. Thanks to our colleagues at UC Davis for hosting this meeting. Look for a report of this meeting in the next edition of Project ICP News!

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Participating Institutions and Organizations

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Franklin and Marshall College
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Oregon State University
Pennsylvania State University
Rutgers University
Simon Fraser University
University of California, Berkeley
University of California, Davis
University of Florida
University of Vermont
USDA-ARS Pollinating Insects Lab
Wenatchee Valley College
The Xerces Society

The information in this newsletter is the result of our excellent team of people who contribute their time and energy to the goals of Project ICP. I want to provide a personal word of thanks to all Project ICP team members, our advisory board, the grower collaborators, and our supporters, and to wish you all a productive 2015. We are almost half way through the five year span of this project, and it is clear that there is a lot of great work underway within this effort. We have much more to do in the second half of the project, with a growing emphasis on extension and outreach activities, and the development of crop pollination decision-aids. Check back for our next edition to learn more!

Rufus Isaacs
Project Director