Project News

from the Integrated Crop Pollination Project

November 2017
Issue 5

In this issue:

Project ICP is a collaboration between:

Michigan State University
AgPollen LLC
Point Blue Conservation
University of Minnesota
Oregon State University
Pennsylvania State University
Rutgers University
Simon Fraser University
The Xerces Society
UC-Davis
UC-Berkeley
University of Florida
University of Vermont
USDA-ARS Pollinating Insects Lab
Wenatchee Valley College

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USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

Integrating pollinators, project goals, and people

Five years goes by *very* quickly. That's one lesson I learned while having the privilege of guiding Project ICP as the Project Director. I also learned that it takes a lot of committed people working together to reach ambitious goals. Our team was funded by the Specialty Crop Research Initiative of USDA-NIFA in 2012 to improve sustainability of pollination in US specialty crops. To do this, we counted thousands of bees, worked on over a hundred farms (see inside for an interview with one collaborator in Pennsylvania), talked to a lot of growers, gained new insights into crop pollination, helped train the next generation of agricultural scientists, and delivered our project results to thousands of growers, applied researchers, and policy-makers.

None of this would be possible without great people. This is the essential element that has made Project ICP so rewarding, whether they served on our advisory board, were a research or extension colleague, a farm collaborator, or one of our excellent support staff. They all worked to help this project succeed, and we couldn't have done it without them. My thanks go out to them all.

While we were working together under this project umbrella, people's lives moved on, with new babies, different jobs, graduations, promotions, and retirements. In this last project newsletter we highlight the new directions that some team members are taking in their life after this project.

Bringing this team together for our annual meetings in Florida, California, or Michigan was the highlight of the year, providing a chance to chart our progress. As the account on the last page shows, there was great energy put into discussions, debates, and arguments about our progress and plans, eventually agreeing on the next steps. These are passionate people, and I am sure our project was made better by the diversity of opinions and by the guidance of our expert advisory board. As this project wraps up, it is heartening to see new research projects and extension programs developing out of Project ICP, many of which will focus on similar goals.

Though our funding is complete, our website and Facebook page will remain in place, so please visit or 'Like' us to see news of the publications and other updates that will continue to flow from Project ICP.

Best wishes for your holiday season!

Rufus Isaacs
Project ICP Director
Michigan State University


Sampling bees with Katherine Odanaka, Gabriela Quinlan, and Julia Brokaw

Action Shots!

Calliopsis andreniformis on watermelon © J. Gibbs

Pollinator exclusion in Washington sweet cherry © K.Allen

Osmia cornifrons on apple © D. Biddinger

Pollination field day in sunny Florida © M. Bammer

Collecting bees in blueberry © J. Brokaw

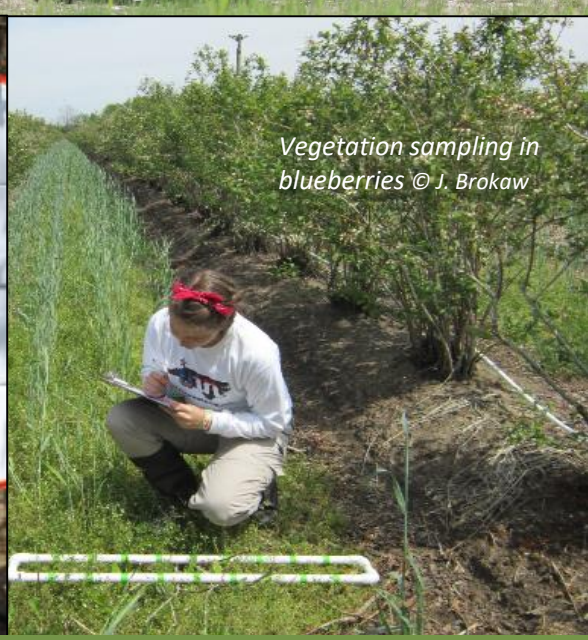
Penn State treefruit field crew © D. Biddinger

Full bloom in Michigan tart cherry © K. Ullmann

Bumble bee colony in Florida blueberry © M. Bammer

Floral enhancement in California almond © K. Ullmann

Osmia lignaria release In almonds © D. Artz



Vegetation sampling in blueberries © J. Brokaw

Bob Curtis

Almond Board of California

Bob Curtis administers the Almond Board of California (ABC) production research program. The ABC funds research in horticulture, entomology, plant pathology and nematology, aflatoxin and almond quality field studies, integrated pest management, and pollination and honey bee health issues. This long term commitment to research has resulted in increased production efficiency, improved quality, and environmentally responsible orchard and pest management practices. He works to assure research addresses both production and production-related issues and to assure implementation of research findings. As such, Bob interacts closely with the University of California (UC), other universities, and the US Department of Agriculture, Cooperative Extension, ag and ag-related organizations, as well as state and federal agencies. Bob rejoined the Almond Board in 2006, where he began his career 39 years ago. In 2013, Bob was awarded the UC Davis College of Agricultural and Environmental Sciences (CA&ES) Award of Distinction, which recognized his work as a liaison for the betterment of partnerships between the almond industry and the agricultural research community. Bob has also worked for the California Strawberry Advisory Board and Campbell Soup Company in the areas of technical and research program administration and implementation. He received his Bachelor's degree (*cum laude*) in Zoology from UC Los Angeles and his Master's degree in agricultural entomology from UC Riverside. His thesis research was published in peer reviewed publications.

Estimating Bumble Bee Colony Density on Farms

Historically, growers have relied heavily on managed honey bees to pollinate a variety of crops and insure a profitable yield. However, recent research highlights the pollination activity of wild bees that are naturally occurring in agricultural landscapes. In Pennsylvania, some pumpkin growers no longer stock honey bee hives and rely entirely upon native pollinators to get the job done.

Several research teams throughout the mid-Atlantic region have identified the common eastern bumble bee as a very active native pollinator in pumpkin agroecosystems. Yet questions remain: just how reliable are these bumble bee populations? Are they abundant? Are they stable year after year? Typically, scientists answer these types of questions for other species by counting the number of individuals living in a given area. However, because bumble bees live in colonies where only the queen reproduces, it is necessary to count the number of colonies, not just the number of individual bees.

Capturing a bumble bee for DNA analysis.
Photo: Carley McGrady

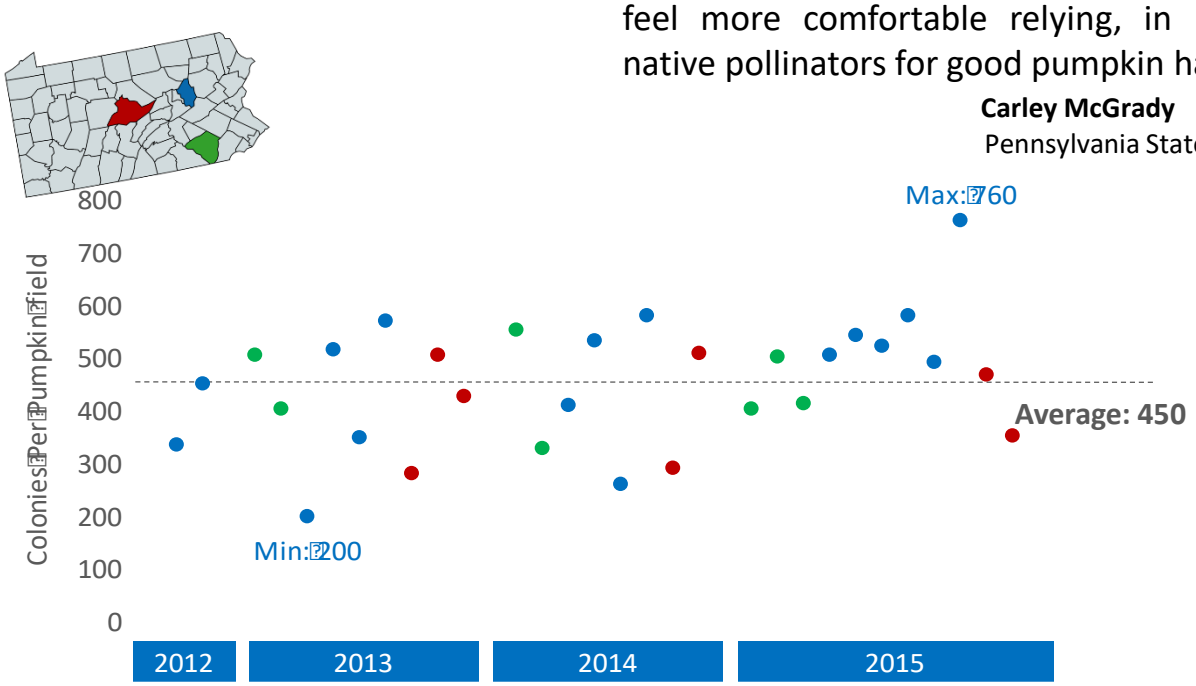
Penn State grad student Carley McGrady pipetting bumble bee DNA samples. ***Photo: Michelle Bixby***

But colonies are very tricky to find – bumble bees are very secretive about their nests and can fly far distances in search for food. This means any bumble bees seen in a pumpkin field may be several kilometers from home. Therefore, researchers have turned to genetic analysis to understand bumble bee populations. First, bumble bees were collected from pumpkin fields over the course of 4 years (2012 – 2015) in 3 different regions (Columbia, Lancaster, Centre). Then, each bee's DNA was examined. If two bees have similar DNA, then they likely come from the same colony. By matching bees with similar DNA, researchers can calculate the number of unique colonies from a sample of collected bees. Because it is impossible to collect bees from every single colony, statistics are used to estimate the total number of bumble bee colonies visiting a single pumpkin field. And the numbers of total colonies are BIG: on average, foragers from 544 bumble bee colonies are visiting a single pumpkin field!

Estimating Bumble Bee Colony Density on Farms

That may seem like a lot – especially when you look around the pumpkin fields and can't seem to locate any of the colonies. However, if you look in the pumpkin flowers during peak bloom, you can see lots and *lots* of bumble bees – even throughout large pumpkin fields stretching over 30 acres. So now it appears that the bumble bee populations are indeed abundant – but are they stable? Will bumble bees show up year after year across Pennsylvania? Further analysis revealed that YES, the number of bumble bee colonies remains consistent from year to year and from region to region. Furthermore, additional genetic testing shows that there is gene flow across the 3 regions, indicating a randomly-mating and well connected population of bumble bees. Populations that are genetically well-connected tend to be resilient and can withstand environmental stressors year after year. Researchers feel pretty confident that the Common Eastern Bumble Bee is a reliable pollinator that will show up in Pennsylvania pumpkin fields in large numbers. Does this mean that growers never need to rent honey bees again? Not necessarily – disease, weather, management practices and other factors could impact bumble bees in a given area for a season or two. Honey bees can insure pollination in the face of unforeseen circumstances. Researchers are working on updated recommendations for honey bee stocking rates in Pennsylvania based on recent research results, but hopefully growers can feel more comfortable relying, in part, on native pollinators for good pumpkin harvests.

Carley McGrady
Pennsylvania State University



Each point represents the number of bumble bee colonies visiting a pumpkin field. The number of colonies is along the y-axis. Our results show a minimum of 200 colonies visiting a single field and a maximum of 760. The overall average was 450 colonies per field, represented by the horizontal dotted line. The points are arranged along the x-axis by year, starting with 2012 and ending with 2015. Blue dots indicate fields from Columbia County, green dots indicate Lancaster County and red dots indicate Centre County.

Grower Spotlight

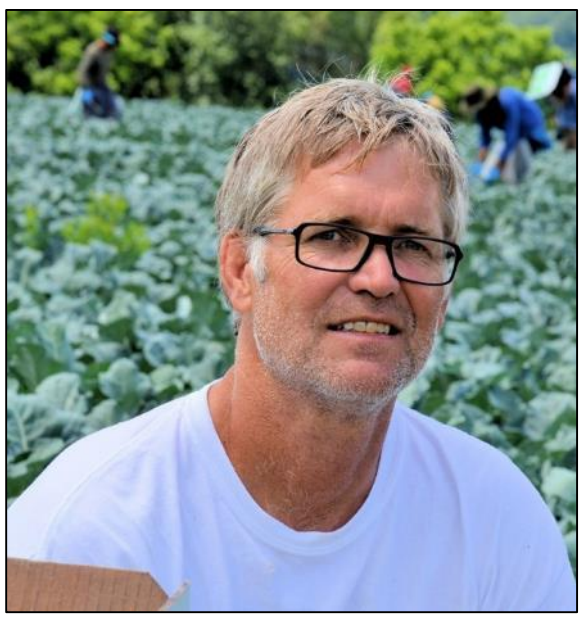
Over the past four years, Project ICP has partnered with growers across the country to carry out on-farm research on the pollination and yield of fruit, nut, and vegetable crops. Many of these growers, including Brian Campbell of Brian Campbell Farms in central Pennsylvania, are going beyond the scope of Project ICP's research to test and implement innovative practices to improve crop pollination – and their bottom line.

Brian Campbell began farming at a young age; at age 14, he started a popular produce stand selling sweet corn and vegetables in Berwick, PA. After attending college at Penn State University, he returned home, rented 200 neighboring acres, and began farming and marketing vegetables. Since then, his farm has expanded to a 2,000-acre diversified operation growing pumpkins, sweet corn, broccoli, and other vegetables. His 400 acres of pumpkins are sold in Walmarts across the northeastern US.

"I love what I do," says Brian. "I wrestled in college, and farming comes with that same never quit attitude."

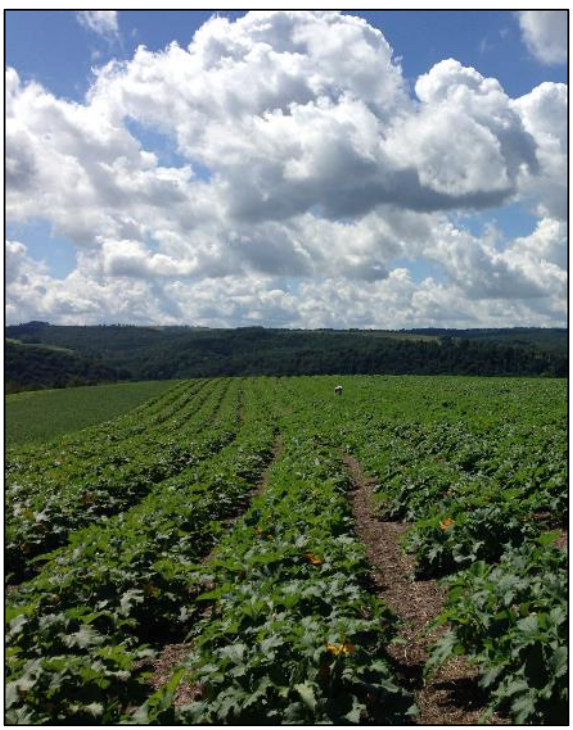
Five years ago, Brian began working with Penn State University researchers interested in native bee populations in central Pennsylvania. Students in the lab of Dr. Shelby Fleischer, a research partner on Project ICP, captured bumble bees in several of Brian's fields and analyzed the DNA of captured specimens to determine how many colonies were present in the area.

"I didn't know much about bees when they started collecting bees here," Brian explains, "but I wanted to learn more about the life cycle of different native pollinators and how that impacts everything." He began to pay more attention to the bees he was seeing in his fields and the surrounding natural areas, and how the practices he was using in his fields might affect those pollinators. "Some bees are ground-nesting, so we may have a pumpkin field where they're nesting and overwintering. The disking I do for crop management might be hurting those bees. That led me to look at other practices I can use to support native pollinators."



Project ICP grower-collaborator Brian Campbell in one of his fields at harvest. Photo: www.americanagriculturist.com/

As Brian began to pay more attention to the pollinators in his fields, he realized that he had strong native bee populations in fields surrounded by good habitat. At the time, he was bringing in one hive of managed honey bees per acre for pumpkin pollination, the standard stocking rate. “Since I became more aware of the native pollinators, I cut back my honey bee rentals to ½ hive per acre,” Brian says. “At $135/hive, that is a substantial cost savings.” He says the relationships he had with the Penn State researchers and his beekeeper allowed him to feel comfortable cutting back on hives in all fields except those where he sees low bee activity in early spring. Four years later, he has no regrets.



A scenic view of a Campbell Farm pumpkin field.
Photo: Carley McGrady

In addition to cutting back on managed hives, Brian is now testing and implementing a variety of practices to support his native bee populations, including switching to no-till management for his pumpkin fields, planting floral provisioning strips on field edges, allowing flowering cover crops to bloom before termination, and cutting back on insecticide use. “We’ve really changed a lot of our spraying so that we’re not spraying when bees are active,” says Brian. “Turns out you can wipe out a lot of native pollinators if you spray them in the field.” Researchers on Project ICP are monitoring the early spring and late summer flowering cover crop strips to see whether they benefit wild bumble bee populations and pumpkin pollination in Brian’s fields.

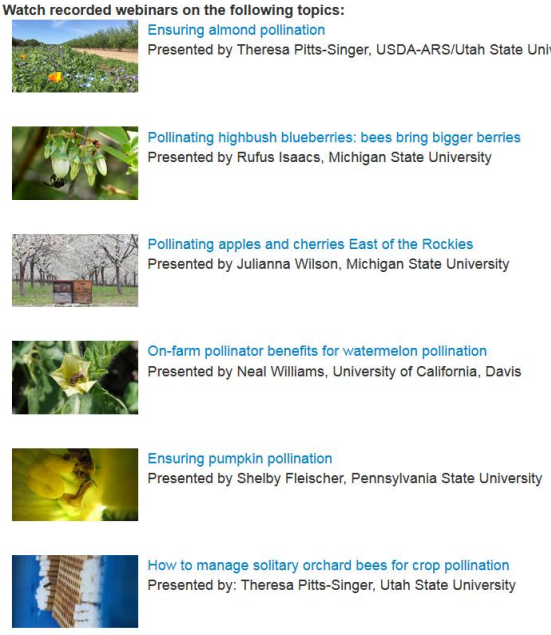
Brian continues to enjoy learning more and testing new practices to improve his crop pollination and yields, despite the constant demands of farming 2,000 diversified acres. “You get into the season and there’s so much to do,” he says, “but there’s also still so much to learn about pollination and pollinators.”

Emily May
Xerces Society

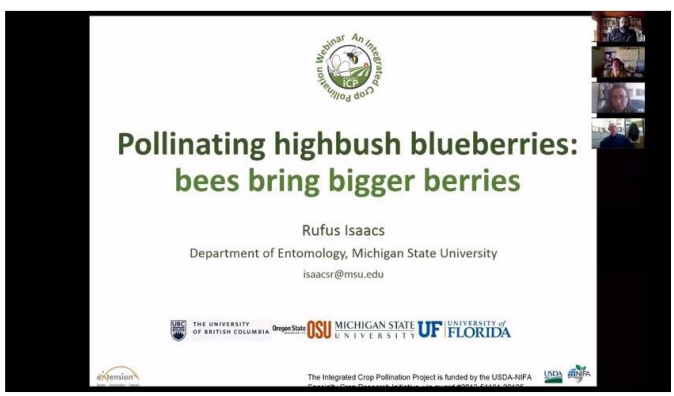
Spreading the word to specialty crop growers in the US and beyond

Over the past five years, researchers with the Integrated Crop Pollination Project have investigated which bees are pollinating which specialty crops and how farmers can best support those crop pollinators. During this time Project ICP research partners also shared their preliminary findings at local grower field days, workshops, and Extension meetings. In order to reach a wider audience, Project ICP launched a webinar series in January 2017 in collaboration with eXtension.org, the online arm of Cooperative Extension. This six part webinar series explored integrated crop pollination for almonds, blueberries, tree fruit, and cucurbits, provided practical guidance on crop pollination using alternative managed bees, planting wildflowers for bees, and created an opportunity for participants to ask questions about specialty crop pollination. On average, over 150 people registered for each webinar, including growers, extension agents, crop consultants, government agency staff, and researchers.

The majority of participants were based in the United States, but people from 18 additional countries sat in on the first four webinars. All participants responding to post webinar surveys said that they thought the webinar they attended was useful and that they learned something new. In addition, more than half of the participants said that they'd use the information they acquired to help future crop pollination decisions on their farm or with farmers they advise. To watch the webinars, visit the ICP website video page.



Screen capture showing the webinars that were presented in 2017 by the ICP Team. These webinars can be accessed by clicking on this link: ICP webinars.



Screen shot of Rufus Isaacs' blueberry pollination webinar.

Katharina Ullmann
Xerces Society

After five years of research, the ICP team has worked to provide a way to deliver the insights and knowledge we've learned to growers and their crop advisors. Our immediate goal in developing Pollination Mapper was to create a decision support tool (DST) that could be used to augment the ongoing interactions specialty crop growers have with their technical advisors, e.g. Extension educators and farm conservation advisors that help growers make informed decisions about applying integrated crop pollination strategies. Specific pollination strategies would include accounting for the supply of wild bees and augmenting pollination with a combination of managed honey bees and the creation of habitat to support additional wild bees. Our long-term goal is to have the DST broaden the access to such decision-making approaches and would facilitate making this process more quantitative, improve the ability of farmers and technical advisors to explore the effects of potential alternative pollination strategies on their farming goals, provide a process to evaluate the efficacy of the recommendations in terms of bee abundance and yield effects, and ultimately improve them over time.

Background on Pollination Service Tools - The development of *Pollination Mapper* was co-led by Eric Lonsdorf and Taylor Ricketts, who worked with the software company Azavea to produce the tool. *Pollination Mapper* builds off of the InVEST model that predicts bee abundance and pollination services across landscapes. InVEST had some limitations with respect to our goals such as users needing a working knowledge of GIS in order to load a land cover layer and provide lookup tables indicating nesting and floral resources. In order to explore changes to the land cover, the user

would also have to modify land cover on their own and load alternative maps. Also, the InVEST model focuses on wild pollinator abundance at the landscape scale, rather than focusing on individual fields. It also has no information on honeybees. Finally, users are not able to correct land cover around them or access their results online.

Pollination mapper - We had four main objectives in creating a pollination support tool that improves upon the InVEST platform for integrating pollination services into specialty crop management. First, we wanted a tool that is relevant to the individual grower so that they can focus on a specific field. Second, it should be interactive, easy to use and provide real-time responses to management changes. Third, the tool should reflect and illustrate the concept of ICP - using managed and wild bees interactively to support pollination. Finally, the tool must be trustworthy, so its predictions must be believable and accurate.

Ease of use and relevancy - To improve upon the past tools, we've worked to have the DST function on the web making it accessible nearly everywhere. Each user can create a password protected account, create different projects and share them if they like. Once connected, the user identifies the location of the farm by zooming in to a location on a map or entering the address of their farm. To designate the specific crop field for analysis, a user is asked to draw an outline of the field of interest, and the tool then evaluates quality of the landscape for wild bees specific to the field of interest. Aerial imagery, land cover data and the translation of land cover to nesting and floral resources are stored on a central server and based on validated expert judgement of the ICP team so the user does not have to provide this information.

Land cover information generated through the remote sensing is sometimes misclassified, so the tool allows the user to edit land cover on and around the field of interest. In the image on page 11, one can see the underlying mistakes in land cover upon the aerial imagery. The tool is designed to be used to evaluate crops from Project ICP (almonds, apples, blueberries, cherries, pumpkins, raspberries and watermelon), and the tool facilitates correcting land cover for those types.

Applying ICP principles - Once the user has identified the field of interest and is satisfied with the depiction of the land cover, the user can develop new scenarios of management by adding wild bee enhancements and/or managed honey bee hives. The tool allows the user to select from three types of wild bee enhancements (Wildflower, Woody, and Woody-Wildflower Mix), and then the user can draw the enhancements upon the landscape and view the potential impact on the relative yield of the crop. The user may also modify the density of honey bee hives. The predicted impact of pollination enhancements varies

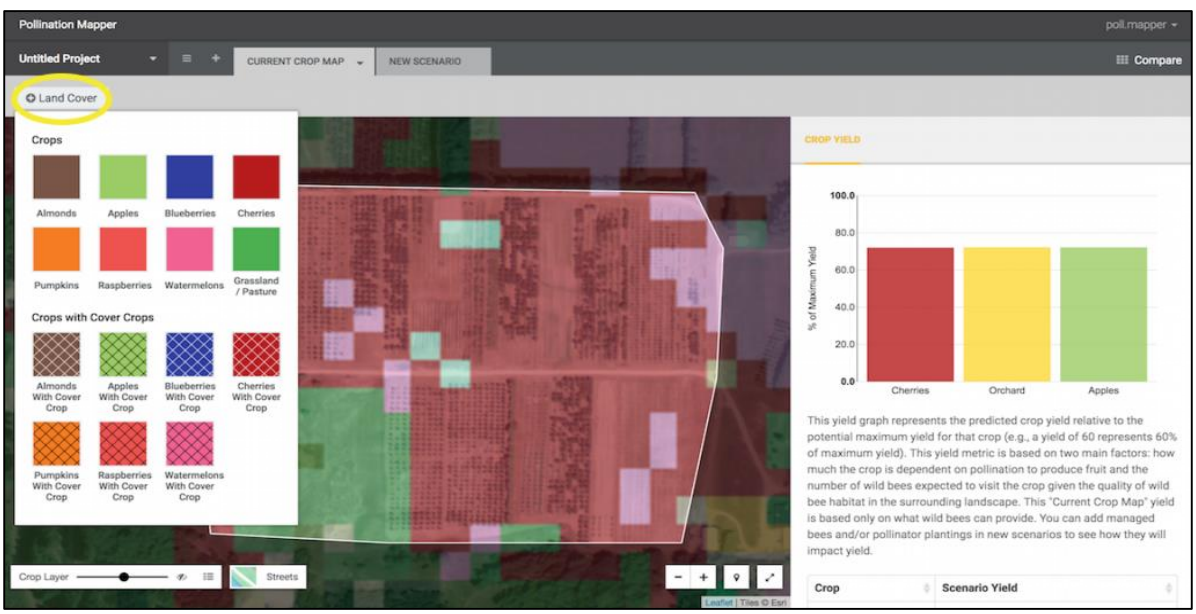
from crop to crop depending on the known dependence of the crop on pollination and the recommended hive stocking rates in the literature. In other words the impact of management on relative yield depends on the current landscape and crop type, and the tool can illustrate the different and interactive effects of using wild and managed bees. Finally, the user can develop several scenarios and compare the results easily.

Building confidence in the results – The vision and usability of the tool is currently a bit ahead of the underlying data analysis, unfortunately. The conceptual relationships between managed bees, the landscape quality for wild bees and yield are accurate, but we are still working on analyzing the data for more quantitative estimates relating landscape to yield for the ICP study crops. So at this point, the tool is in beta testing for feedback, and we are using place-holder functions.

Once we have more confidence in the tool, we will update the underlying predictions, remove the beta label, and share the tool more widely.

Next steps - We feel that Pollination Mapper will be a huge leap forward for providing a central hub for making predictions about yield and ultimately to provide a site to gather observed data. It is the first step at potentially creating an adaptive management program that would allow us to keep track of people's management decisions, the outcomes for yield of those decisions and improve the predictive ability over time. While there is still work to be done, Pollination Mapper is a big improvement on past tools and creates excellent opportunities for future development.

More information on the tool and links to the tool itself can be found at www.pollinationmapper.org



Eric Lonsdorf, Taylor Ricketts, Insu Koh and Katharina Ullmann
Project ICP Modeling and Economics Group

Team members moving on

Many of the team are moving on to new challenges. Here are updates on some new directions for members of our Project ICP team…..

Sujaya Rao, University of Minnesota

Sujaya was the lead researcher on Project ICP's work in Oregon, where she and postdoc George Hoffman investigated blueberry pollination. This summer Sujaya accepted a position as the Department Head of Entomology at The University of Minnesota and she moved there this fall. This is a homecoming of sorts, as Sujaya studied at UMN for her Ph.D. Sujaya has been awarded various IPM, extension, teaching, and mentoring awards, and will be exploring new opportunities to get engaged in these areas of activity in her new position.

Katharina Ullmann, U. California, Davis

Katharina was the National Crop Pollination Specialist at The Xerces Society and she led the Extension-Outreach aspects of Project ICP. In this role she guided the development of the online and printed materials as well as the ICP workshops that were held across the country. This fall, Katharina became the Director of the UC Davis Student Farm, a working farm that produces vegetables, fruit, and flowers as well as developing campus food security efforts, and diverse learning opportunities.

Neelendra Joshi, University of Arkansas

Neelendra worked as a postdoctoral researcher on Project ICP in Pennsylvania, working with David Biddinger. His main focus was leading field trials to evaluate Japanes orchard bees in cherry orchards. He is now an Assistant Professor of Entomology at the University of Arkansas, where his program will focus on ecotoxicology and pesticide risk assessment, native and alternative pollinators, pollinator health, management and conservation, and integration of pollinator health into IPM programs and crop production.

Jason Gibbs, University of Manitoba

As a bee taxonomist, working on Project ICP in blueberry farms was a new experience for Jason. He adapted to it quickly, leading the Michigan blueberry research and also coordinating the other regions working on this crop. In spring 2017, Jason returned to his native Canada to start a faculty position as Assistant Professor and Curator of the Wallis/Roughley Museum of Entomology in the University of Manitoba. Jason remains a collaborator with many members of Project ICP, lending his unique taxonomic expertise to wild bee research projects.

Erin Treanore, Penn State University

Graduate training in crop pollination was one goal of our project, and multiple graduate students were supported by Project ICP. Erin completed her MS degree with Shelby Fleisher at Penn State University in 2017, studying flowering cover crops that can be rotated into annual pumpkin crop systems to provide food for bees. Erin also attended the recent BOMBUSS conference with support from Project ICP. She is starting a Ph.D program, still at PSU, with Etya Amsalem with a focus on bumble bee physiology.

Eric Lonsdorf, University of Minnesota

Eric led the Objective 6 synthesis aspects of Project ICP, with one of the main goals being to develop a decision support tool to help growers plan their crop pollination. See his article on Pollination Mapper starting on page 9. Eric is now the Lead Scientist on the Natural Capital Project, based at the University of Minnesota. Here, he leads a group focused on developing ecological models for natural resource decision-makers operating with considerable uncertainty and with limited resources. Eric continues to collaborate with many of the ICP team members and is leading a group to develop a second phase of Project ICP.

Annual Meeting Notes

Project ICP Team at the final annual meeting at Michigan State University

The Project ICP Team met as a group twice in 2016. The first meeting was our 4th annual project meeting, held at the University of California, Davis in late January. This two day meeting was filled with reviews of the 2015 field season, and planning for the last full year of Project ICP research and education activities. Smaller breakout groups were used to focus on how to best assess habitat enhancements, and generated new ideas for synthesis and analysis of data across our research objectives. We spent considerable time discussing and planning for the deliverables to be produced by this project. In particular, the Economics and Modeling group of ICP discussed progress and future plans for The Pollination Mapper, a pollination decision support tool that is built on data from the ICP project (see the article on page 9 for more information). As always, the Project ICP Advisory Committee provided thoughtful and useful feedback to the group on how they see the project's progress, and future directions.

The final Project ICP annual meeting was held at Michigan State University. We met in November 2016, at the project's lead institution. This also allowed us to hold a large public pollination outreach event before the annual meeting began, featuring lightning talks, posters and a keynote presentation by Dr. Marla Spivak from the University of Minnesota. Approximately 350 people were in attendance and this included researchers, extension educators, beekeepers, master gardeners and backyard bee enthusiasts; and after the presentations, everyone was invited to a reception to discuss (mostly) all things pollination.

In lieu of the progress reporting that dominated previous project meetings, the final meeting focused on how we planned to meet our project goals, and how we will continue the work of integrated crop pollination. Major themes of this meeting were to emphasize the importance of honey bees and wild bees for crop pollination, interacting with Azavea (the software firm developing The Pollination Mapper), and planning for the completion of research and extension publications. All in all, we had great meetings to cap off an excellent and productive project.

Keith Mason
Project ICP Manager
Michigan State University

Project ICP Overview

Project ICP team, by the numbers

5 years

10 states and 1 province

15 institutions

27 full time faculty scientist equivalents

28 staff members

44 undergraduate trainees

17 graduate students

22 postdoctoral researchers

USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

The list below is a selection of publications, videos, and fact sheets from our six project objectives that you can easily access by clicking on the titles.

Objective 1. Identify economically-valuable pollinators and the factors affecting their abundance.

Gibbs et al. (2015) Contrasting pollinators and pollination in native and non-native regions of highbush blueberry production.

Isaacs et al. (2017) Integrated Crop Pollination: Combining strategies to ensure stable and sustainable yields of pollination-dependent crops.

Objective 2. Develop habitat management practices to improve pollination.

May et al. (2017) Establishing wildflower habitat to support pollinators of Michigan fruit crops.

May et al. (2017) Establishing wildflower habitat to support pollinators of California row crops.

Objective 3. Determine performance of alternative managed bees as specialty crop pollinators.

Lundin et al. (2017). Wildflower plantings do not compete with neighboring almond orchards for pollinator visits.

Campbell et al. (2017) Managed bumble bees caged with blueberry bushes at high density did not increase fruit set or fruit weight compared to open pollination.

Objective 4. Demonstrate and deliver ICP practices for specialty crops.

Project ICP Resources for growers – fact sheets, websites, and planting guides.

Project ICP You Tube channel, containing 14 videos.

The eXtension page containing the Project ICP webinars.

Objective 5. Determine optimal methods for ICP information delivery and measure ICP adoption.

Garbach & Morgan (2017). Grower networks support adoption of innovations in pollination management: the roles of social learning, technical learning, and personal experience.

Objective 6. Data syntheses on pollinators and Integrated Crop Pollination.

Koh et al. (2016) Modeling the status, trends, and impacts of wild bee abundance in the United States.