This presentation summarizes the progress made on two inter-related competitive grants, one from the USDA-NIFA Crop Protection & Pest Management, Applied Research & Development Program (ARDP) and the other from the Monsanto Insect Knowledge Management Program (IKMP). The ARDP is completing its first year in this Extension-led project. The IKMP is completing its 1st quarter.

All PIs present except Palumbo, and including the graduate student assigned to the project and funded through the IKMP, Naomi Pier.

These 3 objectives represent our commitments to these two grants and the overall project. We will teach landscape principles of resistance; test and establish relationships between local/regional pesticide use patterns and resistances measured in this project; and then measure changes attributable to these project activities and project impacts made possible.

In any complex project, there is an imperative to make sure all project leaders are made current on the progress made. Each of us is responsible for a building block of this project; this permits us to see and respect the entirety of the undertaking and identify any constraints, issues or problems that we can avoid or mitigate.

So this is meant to be a discussion within the confines of time today. More detailed technical issues can be addressed in subsequent meetings by smaller groups, as needed.

Let's make sure that everyone's questions are answered today or that there are plans to do so as we move forward.

When speaking to growers, we consider this imagery. Sitting in the center of an agroecosystem, how does information change one's perception of risk? With no information, decisions are made entirely based on the personal qualities of the decision-maker. Is he/she risk averse or risk prone with their decisions or practices?

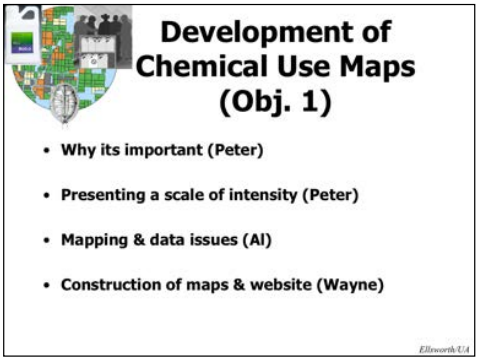
However, if the system is flooded with pesticide purple all around a farm that does not use this pesticide, they are subject to the evolutionary outcomes and resistances possible even without using that pesticide. With this knowledge in place, a decision-maker might make very different choices in pesticide selection.

[2007 FF#47]

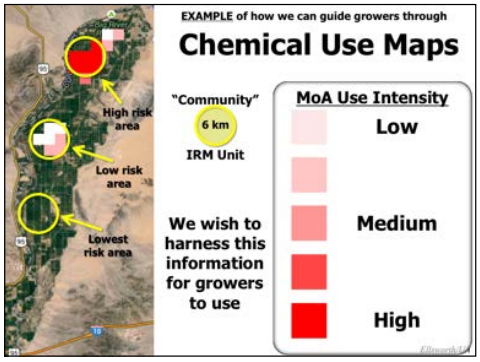
The world more likely looks like this. But either way, our central thesis is this. Good information can lead to good or better decisions.

This project is designed specifically to place information in the hands of stakeholders and give science-based guidance to them in their pesticide use decisions, specifically in the control of whiteflies in multiple crops.

[2007 FF#47]



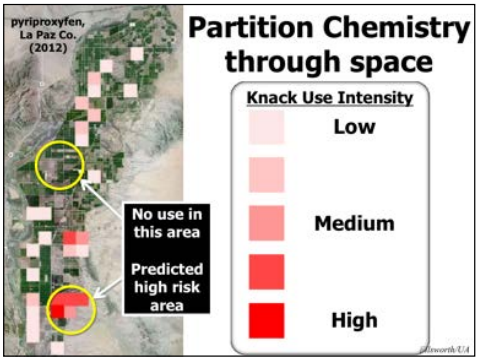
Our 1st objective centers around development of chemical use maps from pesticide use reports that the APMC captures.



Why is this important?

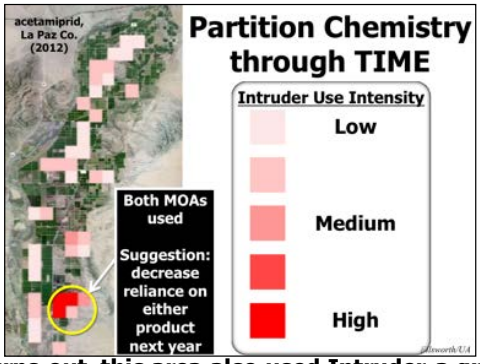
In this fictional example, the APMC would publish maps like this showing the distribution of usage of different whitefly products. Just by inspection, a grower and PCA could discuss which areas nearby are at higher or lower risks for future resistance development. They would not have to depend on hearsay or conjecture on what was used by neighbors. We have this capability and could publish these maps annually prior to each whitefly season, which typically is July–September.

Note we only have the capacity at present to publish last year's chemical use patterns. If successful in this project, we could spur more interest in near real-time deliveries of this information.

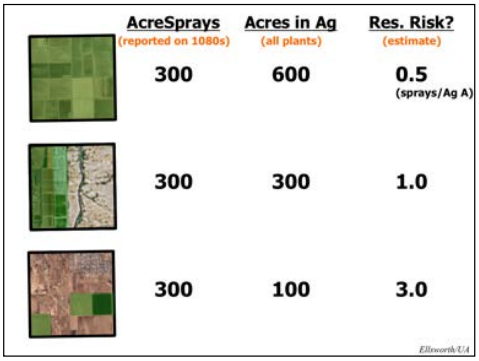


We can produce chemical use maps that show recent trends of use such as this one of Parker Valley for pyriproxyfen (Knack IGR) usage in 2012. So now, we can begin to arm growers with information that permits them to partition chemistry, locally, through space. In this example, growers in the south of the valley used pyriproxyfen sometimes intensively in some areas. But growers in the other parts of the valley, for whatever reason, did not use pyriproxyfen. This effectively has partitioned the chemistry over space & could become a directed management practice by these growers in the future.

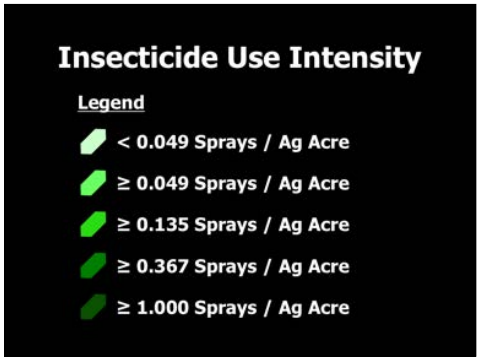
This helps provide refuges for whiteflies that are needed to reduce selection pressures for resistance.



As it turns out, this area also used Intruder a great deal; perhaps pressure was extreme and both compounds were needed. But also perhaps because they mixed Knack with Intruder. While this practice has been popular at times with the intention of "knocking down" adults with Intruder and getting long-lasting control of eggs and immatures with Knack, this practice risks the simultaneous selection for resistance to BOTH compounds. So this grower should carefully consider whether Oberon and/or Courier can better meet their needs in 2013 and avoid usage of both Knack and Intruder for a time. In fact, the grower was thankful for this perspective, not realizing his relationship to the balance of the valley, and elected to use Oberon in the next year. Bear in mind that he was not having problems before or after this change. This defines proactive practice.



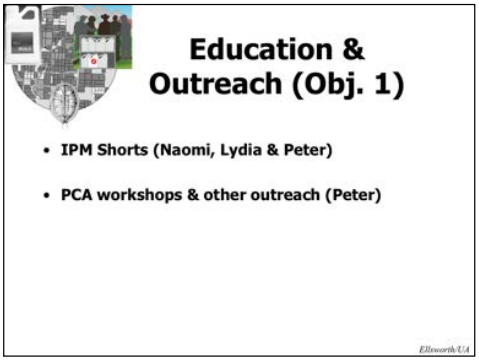
Our existing data has always been limited, because we lacked information about the array of potential sprayed and unsprayed hosts in any section. We have excellent information on the acres sprayed in each section (AcreSprays). Now, however, in collaboration with ACRPC, we have information from their annual host surveys. This tells us how much agriculture is in each section (with some uncertainty) as well as crop identities for many fields. So now we can form a quotient that describes the proportion of agricultural acres (limited to whitefly host crops) sprayed with whitefly chemistry. This can be thought of as a resistance risk. Our research on this question will likely tell us more about which crops are included and over what spatial scale.



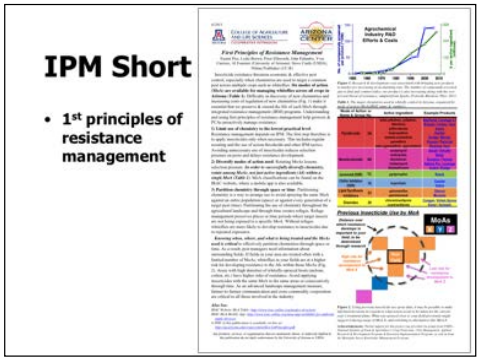
Presenting and communicating a scale of insecticide use intensity for each MoA can be challenging. The human brain can only process so much information. We chose to aggregate the insecticide use information into 5 bins (6, if you consider empty space as untreated in the maps). These levels were selected in order to show the diversity of practice in any landscape and is non-linear.

The last bin can represent numbers that are very, very high 5, 10 or more sprays per agricultural acre on a section level basis.

The resulting maps communicate a great deal of information.



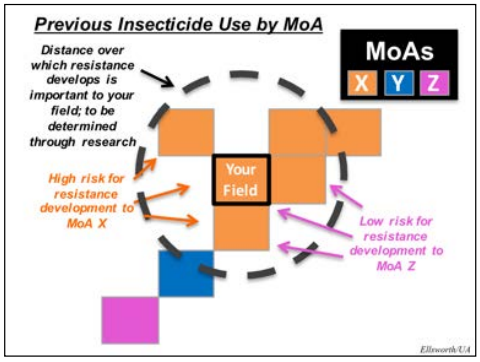
Objective 1 contains our education and outreach activities. Naomi and Lydia took the lead on drafting a short piece on the 1st principles of resistance management that each of you had the opportunity to review before its release.



This one-page presentation of information has been effective in communicating to our stakeholders. The responses have been positive. Cotton Incorporated saw the release and believed it very appropriate to share with their marketing groups who interact with buyers, with the stated purpose of a real-world demonstration of the science-based sustainability activities that our growers are engaged in. So this local "IPM Short" has already been put to use in unexpected ways.

Mode of Action or Name & Group Number		Active Ingredient	Example Products
Pyrethroids	3A	beta-cyfluthrin, cyfluthrin, bifenthrin, esfenvalerate fenpropathrin lambda-cyhalothrin permethrin zeta-cypermethrin, cypermethrin	Baythroid, Leverage 2.7 Brigade, Fanfare, Hero Asana Danitol Endigo, Warrior Pounce / Perm-Up Mustang, Hero
Neonicotinoids	4A	acetamiprid clothianidin dinotefuran imidacloprid thiamethoxam	Assail / Intruder Belay Scorpion / Venom Admire Pro, Leverage Actara, Endigo
Juvenoid (IGR)	7C	pyriproxyfen	Knack
Chitin Inhibitor (IGR)	16	buprofezin	Courier, Vetica
Lipid Synthesis Inhibitors	23	spiromesifen spirotetramat	Oberon Movento
Diamides	28	chlorantraniliprole cyantraniliprole	Coragen, Voliam Xpress Exirel / Verimark

The PDF online contains links directly to product labels for each active ingredient. This is a convenience to our growers who are not as familiar with the common chemical names. Some groups are far too large to show every product, but the most popular ones are shown here. Naomi developed this table based on our key MoA under study in this project.



The Short also contains this simplified graphic of a very complex system. But we have found from comments from stakeholders that it has helped them understand the nature of what we are trying to develop and do.

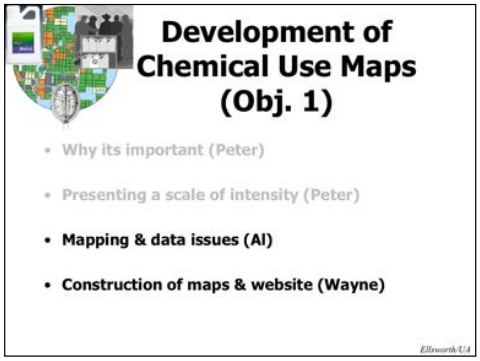
PCA Workshops & Other Outreach

Date	Location	CEUs
18-Nov	Portland OR (ESA)	0
4-Feb	Avondale	1
16-Feb	Marana	0.6
17-Feb	Casa Grande	0.5
18-Feb	Yuma (Helena PCA Training)	0
31-Mar	Parker	1
1-Apr	Yuma	1
6-May	Chandler (Desert Ag Conference)	1
3-Jun	Maricopa	0.75
9-Jun	ACRPC Board	0
10-Jun	Yuma	3
11-Jun	Mexicali Mex.	0
25-Jun	Casa Grande	3
1-Jul	Avondale	1
1-Jul	Avondale	3
2-Jul	Blythe (incl. Parker area PCAs)	3
9-Jul	Ak-chin Indian Community	0.75
12-Aug	Yuma	3
27-Aug	Phoenix	1.5

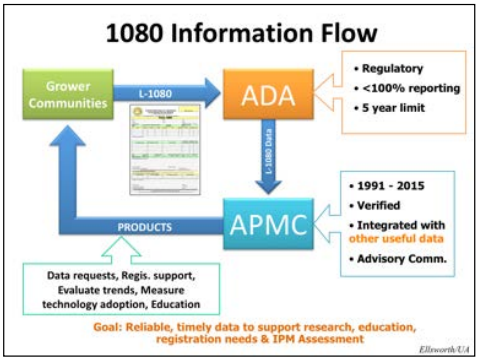
Ellsworth/UA

None of these efforts and innovations can reach the public through passive processes only. We actively teach these principles and about our scientific approach to this project in a series of stakeholder sessions, meetings, focus groups, and presentations over the last year. A total of 19 of these were made in a diversity of formats. Some were sessions dedicated to this project; others were part of larger sessions.

Starting in June and very early July, we did invitee-only PCA sessions so that they could be introduced to the website and maps that we were producing.

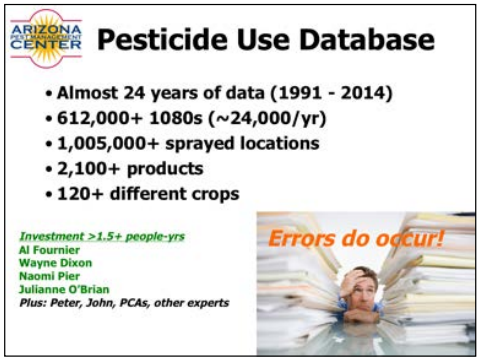


Our 1st objective centers around development of chemical use maps by 1 July of each year from pesticide use reports that the APMC captures.

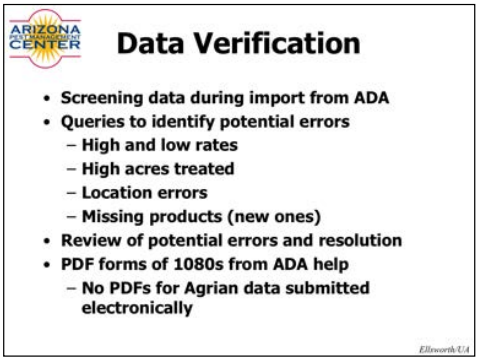


Al reviewed the process by which we collect, correct, and verify data in this session.

After grower communities submit the data to ADA, it gets entered into their local 5-year database, used for regulatory purposes. Data older than 5 years is not maintained by ADA. We have tapped into their data and expanded it with historical 1080 data back to 1991. We verify their data, correct errors and integrate other data sources, including tables from EPA. We use the data to produce products that bring information back to grower communities.



The stats on this slide give you an idea of the size of the pesticide use database. Errors do occur and we invest a lot of personnel time into identifying and correcting these errors.



Verification and correction of data are critical to the success of this project as well as any products produced from these data.

These are some of the errors we routinely screen data for. PDFs of 1080 forms provided by ADA facilitate data correction.

Data Issues (1)

- Data entry errors (ADA)
- Rates
  - Decimal errors, math errors, product or crop errors
- Duplicated records
  - Faxed twice, faxed and mailed
  - Agrian electronic records, also mailed or faxed
  - Sprays over multiple days, resubmitted
- Post-processing errors
  - Invalid data insertions
    - Crops, locations or chemistries from multiple 1080s merged

Ellsworth/UA

More examples of data errors we find and correct.

Data Issues (2)

- Location errors
  - Data entry
  - Wrong on 1080, often repeated
  - Additional field notes and site information important to resolving these issues

Ellsworth/UA

Our study is particularly sensitive to location errors. There are many. Though reflecting a small percentage of the entire dataset, placing a pesticide report in non-agricultural acreage would skew our analyses in two ways, expanding the spatial dimension over which pesticides are used and diluting the actual use in agricultural sections.

Our team led by Al and Wayne has painstakingly worked through these errors one-by-one to relocate the data to its proper location in agriculture.

Location Issues

This map is of the Yuma area as an example of how dislocated some reports are. Anything shaded brown or green represents a section that received a reported pesticide use. Most are truly and properly reported. However, there are many sections in the middle of the desert on in mountain ranges that are clearly improperly formed in the database. Each of these was corrected.

ADA 1080 Process Improvement

- Duplicate 1080's found and removed from database.
  - Worked with ADA to improve the process used to find duplicated 1080s.
- Valid TRS file incorporated into ADA registration process to limit the number of invalid TRS locations.
  - Provided ADA with complete list of valid ag locations.
- Working on a fix for invalid data insertions into the ADAs database.

Ellsworth/UA

There are many arcane reasons why a 1080 report might be incorrectly coded. Our team works with ADA directly to improve the process and limit the number of downstream errors provided to our database.

Specialty Crop Block Grant 2015

- Continued flow of pesticide use info to benefit stakeholders
- Improve quality of data, information flow, turn-around time
- Target outreach: PCAs, distributors, growers

Ellsworth/UA

Al has led another successful grant proposal and starts new funding to support education and outreach directly to pesticide use reporters. The goal is to quash any errors that happen at the point of origin.

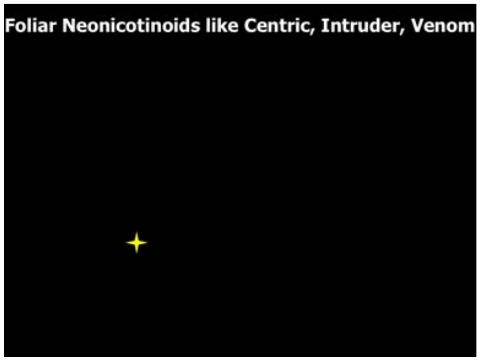
Development of Chemical Use Maps (Obj. 1)

- Why its important (Peter)
- Presenting a scale of intensity (Peter)
- Mapping & data issues (Al)
- Construction of maps & website (Wayne)

Ellsworth/UA

Wayne has led the development of the maps that populate a new, stakeholder-facing, secured website.

The group reviews the website directly here.



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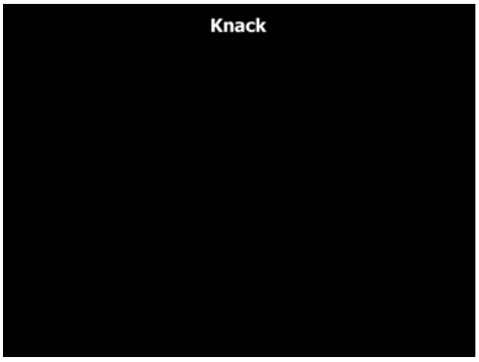

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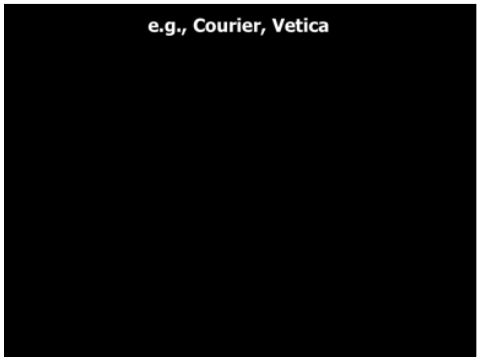

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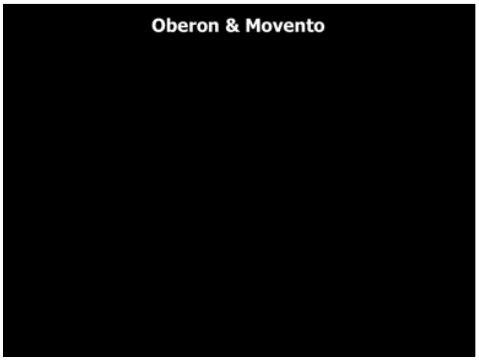

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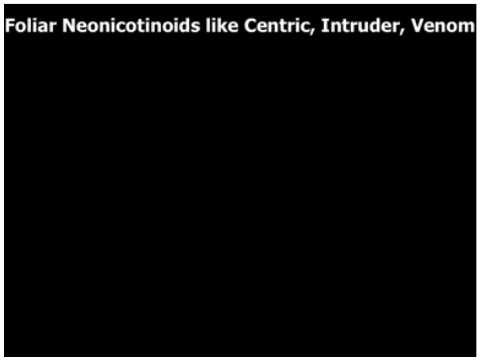

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Pyrethroids

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Test Hypotheses, chemical use : resistance

- Obj. 1: Develop spatially explicit materials for teaching landscape principles of resistance management to stakeholders
- **Obj. 2: Test hypotheses for understanding / predicting regional patterns of resistance as they relate to whitefly chemical use patterns**
- Obj. 3: Measure changes in awareness, knowledge, skills, behavior and condition with respect to resistance status, chemical use practices and landscape concepts in resistance management

Ellsworth/UA

Locations of Whitefly Collections (Obj. 2)

- Naomi took the lead this summer in securing 41 populations of whiteflies from cotton from around the state
- Goals included
  - spatial independence,
  - sufficient numbers to secure assays,
  - no prior MoA sprays to the cotton, and
  - locations representing a diversity of chemical use practices for contrasting populations within regions.
- This was a very challenging objective
  - Whiteflies at historic lows this year
  - Learning the basics of traveling & locating fields

Ellsworth/UA

This was a quick summary approach to seeing insecticide intensity near where whitefly populations were collected this summer for this project.

Fields with Known Treatments

Field	Location	Chemistry
6	Yuma	Knack
7	Yuma	Danitol/Orthene, Transform*, Knack
28	Yuma	Knack
26	Central	Transform*
27	Central	Transform*
32	Central	Transform*
33	Central	Courier
40	Central	Transform*

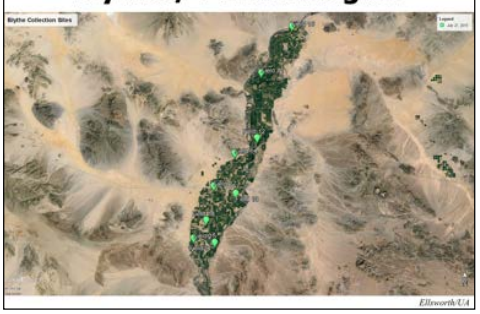
*Some limited activity on whiteflies, but not a member of one of the MoA under study

Ellsworth/UA

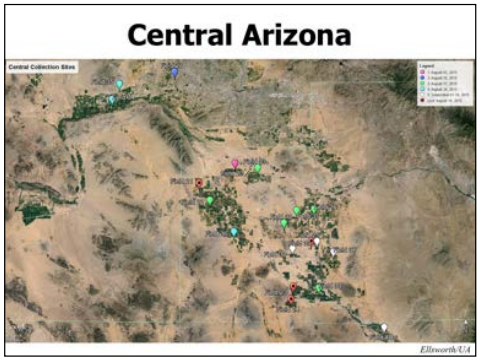
Naomi provided these field population notes. We'll have to be careful in analyses to see if inclusion of previously sprayed populations changes outcomes.

Yuma Region

Blythe / Parker Region



Central Arizona

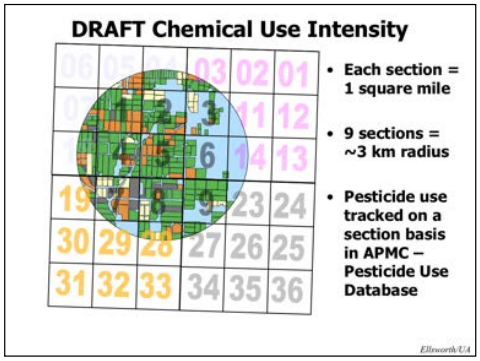


Insecticide MoA Intensities of Use (Obj. 2)

- Estimates of local intensity of use (9-section area) as a means to understanding whether we secured populations from varying MoA exposures (Naomi & Peter)

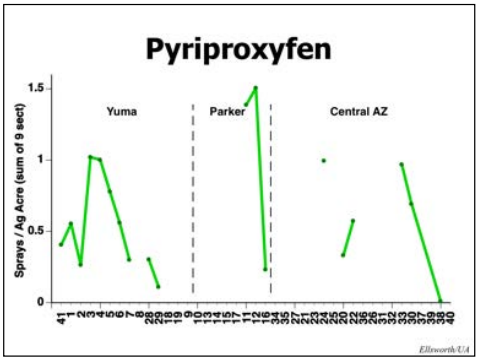
Ellsworth/UA

This was a quick summary approach to seeing insecticide intensity near where whitefly populations were collected this summer for this project.



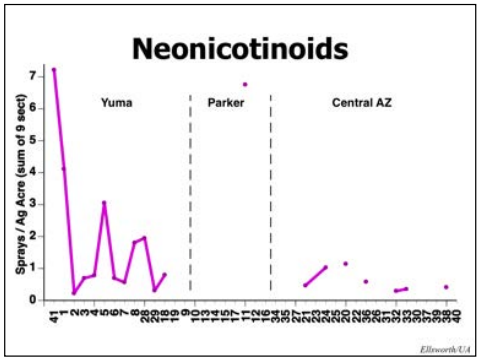
Naomi and I examined the MoAs in this study for the 9-section area that includes the central focal section where our whitefly populations were collected. The data to follow is based on a SUM(Sprays / Ag A for each section). I.e., if there was 1 spray / A on 3 sections and 2 sprays / A on 3 sections and 0 on the balance for a given chemistry, then the total shown would be 9 sprays / Ag Acre over this 9-section area.

This is not meant to be "the" analysis, but will represent one of the areas that Yves, Ben, and Naomi examine in later analyses.

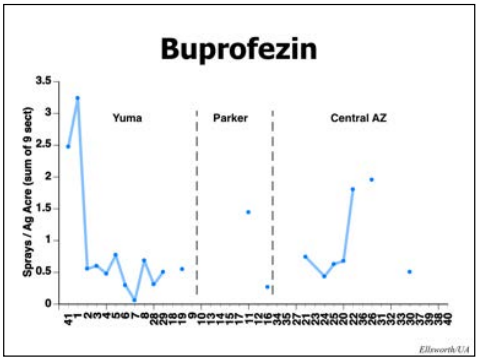


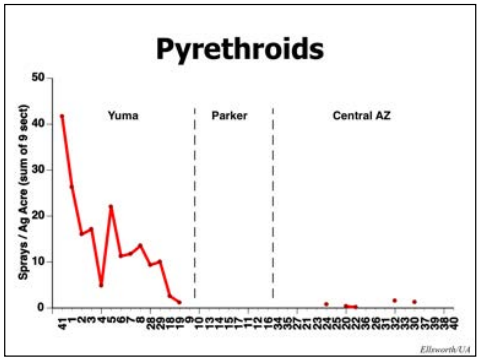
The numbers below are the number identifiers for the populations collected by Naomi, Paul, Steve, Ryan, Gilberto, Betzaira, Guadalupe and Goya this summer. They are arranged by large region, Yuma, Parker (including Blythe where we have no chemical use data yet) and central AZ (left to right). Recall that our goal was to select spatially independent locations that reflect a diversity of insecticide use intensities ranging from low to high in each large region.

Here you can see for pyriproxyfen which is limited to 1 use per season in cotton that we have highs as high as 1.5 and lows of near zero. [Note blanks in these charts denotes either zeroes where sections are completely outside of ag, areas with no reported uses for that chemistry, or locations in CA where we have not yet collected pesticide use data.]

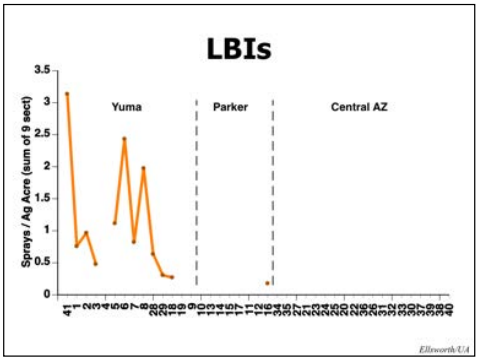


Foliar neonicotinoid uses are consistently higher in the Yuma area, which is a general trend for most chemistry.

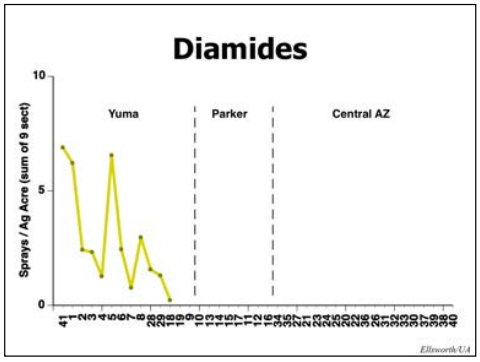




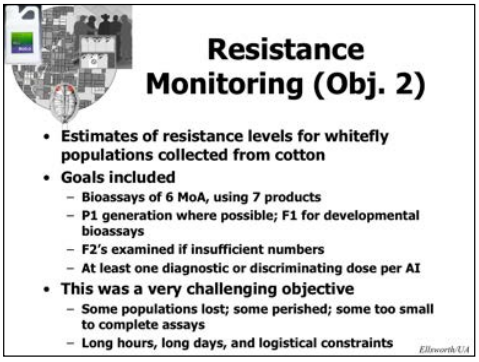
Pyrethroids in the crops that we are mapping pesticide usage for are highest in Yuma. There are many reasons why this is. But recall that we are not including alfalfa in these summaries. If we did, more would be seen in the other regions.



Oberon and Movento, the latter without a label in cotton.

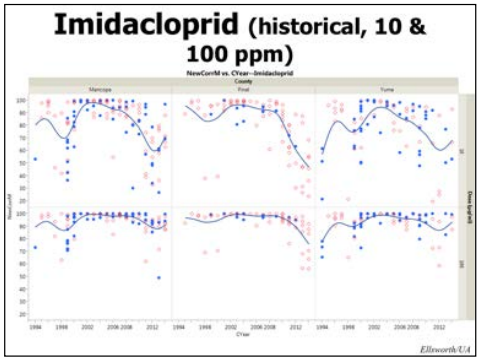


Diamides are almost exclusively used in Yuma. But again, there is diamide usage in alfalfa and corn elsewhere but not represented in these charts.



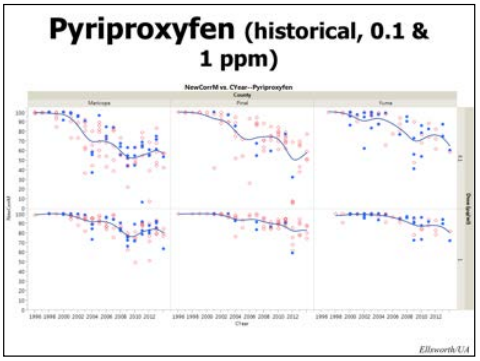
Steve and Nilima took the lead on this objective with supporting roles by Paul (Steve's tech), Naomi, and Ellsworth lab

Imidacloprid (historical, 10 & 100 ppm)



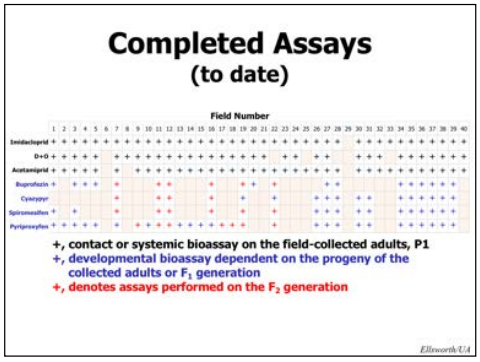
Steve presented historical data from Xianchun's and Tim's lab to illustrate why certain doses were selected for the study here. More doses is obviously better, but logistics were difficult this year and we often had to select just one dose to work with.

Pyriproxyfen (historical, 0.1 & 1 ppm)



As in the previous slide, this is historical data.

Completed Assays (to date)

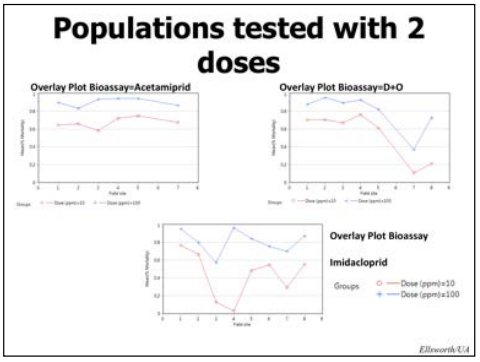


Steve and Nilima summarized the progress made to date on populations of whiteflies collected from around the state. Some colonies were lost before they could be tested. Others were not tested for all chemistries. Those in red were tested on the generation that followed the offspring of the collected adults.

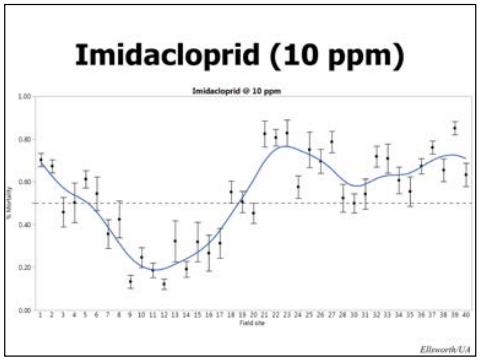
Imidacloprid, Danitol+Orthene, acetamiprid and pyriproxyfen are priority compounds because of known resistances in Arizona populations.

[Note, I believe it better to refer to all developmental bioassays as being run on F1 or progeny of the collected adults. Those held longer to build numbers should be referred to as F2's to avoid confusion.]

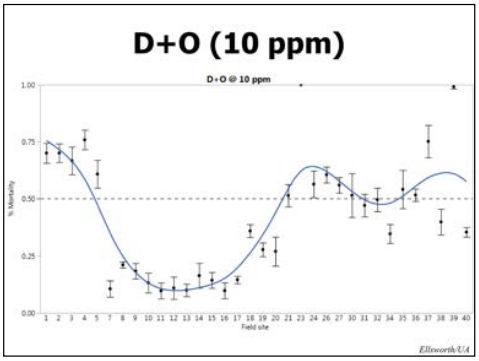
Populations tested with 2 doses

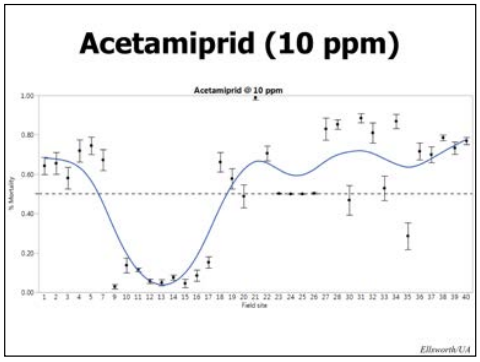


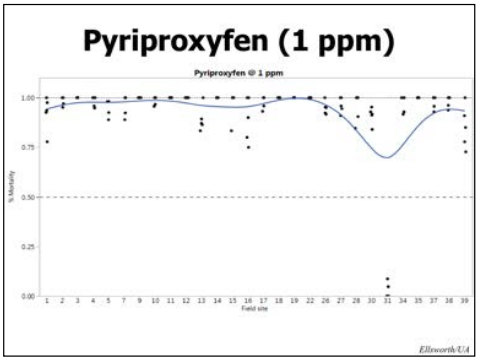
Some of the earliest collected populations were tested with two doses. Most show very similar trends. Population 4 had an unusual blip between the two doses of imidacloprid.



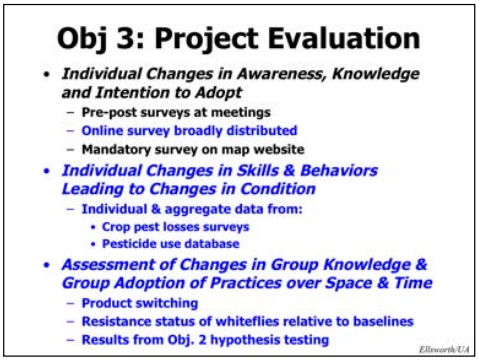
Steve noted the unusual trend of reduced mortality for populations 9–17. Was there something else going on (besides just resistance)? This pattern persists for several chemistries.





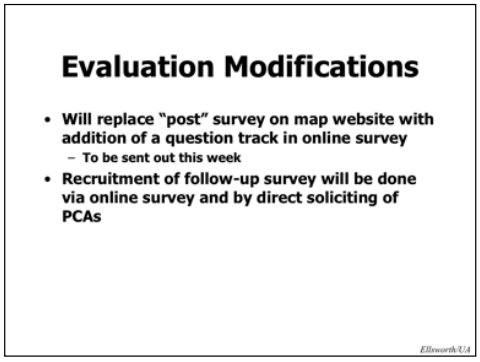


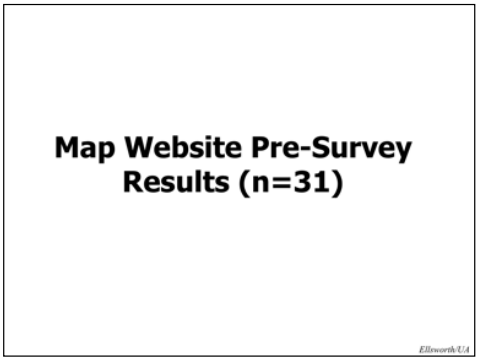
Pyriproxyfen showed less in differential responses than the other chemistries, with in general very high mortalities at 1 ppm.



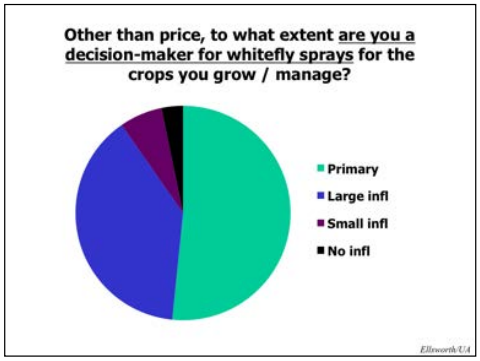
The final objective revolves measuring changes in and potential impact on stakeholders. Al reviewed this area, much of which will be occurring in Y2.

Much work was performed to lay the groundwork for comparing endpoints to preliminary measurements.

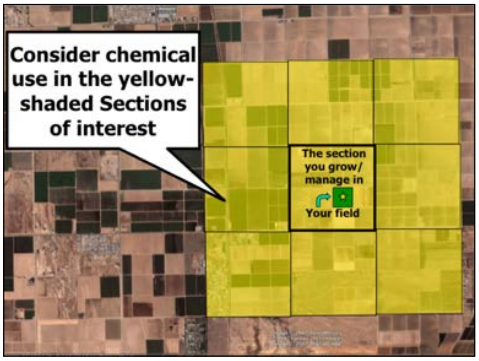




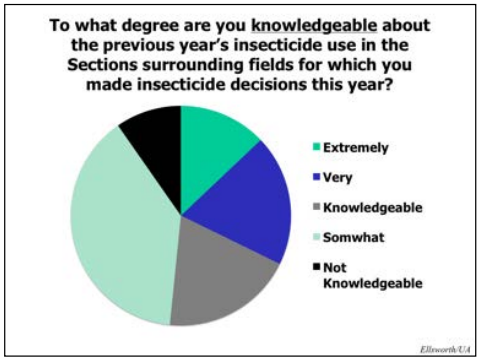
Al reviewed a few of the results from those PCAs who logged onto the website and took the mandatory survey.



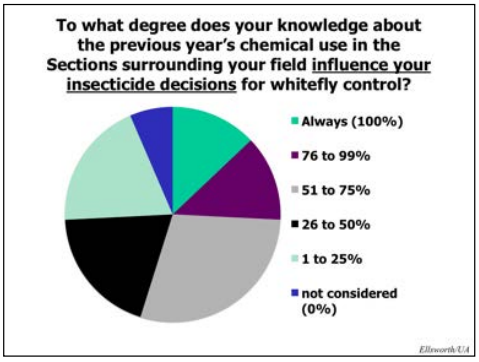
Most PCAs have the primary or a large influence on the whitefly control decisions.



This is the graphic that is shown during the survey to orient the user to the next two questions.



About 1/3rd of the PCAs cite being very or extremely knowledgeable about the surrounding area's insecticide use patterns.



About 1/4th suggest that this knowledge influences their decisions for whitefly control. This suggests that some are ready to use the information we are providing. It also suggests that many others will improve their understanding of these patterns through this project.