Department of Entomology
and
Entomology & Insect Science
Graduate Interdisciplinary Program

Academic Program Review
Self-Study Report
2023

Department of Entomology
and
Entomology & Insect Science Graduate Interdisciplinary Program
Self-Study Report
2023

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This self-study report was prepared by Rachel Doty, Alfred Fournier, Molly Hunter, Raine Ikagawa, Wendy Moore, Paula Nielsen, and Bruce Tabashnik

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SECTION A: INTRODUCTION AND OVERVIEW

Welcome to the self-study report for the first joint Academic Program Review of the Department of Entomology (ENTO) and the Entomology & Insect Science (EIS) Graduate Interdisciplinary Program (GIDP) at the University of Arizona!

1. Administrative Homes and Unit Leaders

The Department of Entomology is one of 10 academic units in the College of Agriculture, Life & Environmental Sciences (CALES, formerly CALS: College of Agriculture & Life Sciences (Appendix A1). Dr. Bruce Tabashnik has led the Department as Head since 1996.

The EIS GIDP is one of the approximately 20 Graduate Interdisciplinary Programs in the Graduate College (GC, Appendix A2). In 2009, the graduate program of the Department of Entomology merged with the GIDP in Insect Science to create the EIS GIDP. Dr. Martha ("Molly") Hunter has led the EIS GIDP as Chair since its founding. Dr. Hunter is a Professor in ENTO, which facilitates close collaboration between the Department and the EIS GIDP.

2. Productivity and Impact

Of the 52 students who earned degrees (24 PhD and 28 MS) in the EIS GIDP from 2014 to September 2023, 100% are employed and 98% are employed in areas related to their graduate education (Section I).

UA Entomology faculty ranked in the top three nationally among 36 entomology departments and programs in the percentage of faculty with articles, awards, and citations, as well as in awards and federal grant dollars per faculty member based on the most recent Academic Analytics data (through 2021, Section D).

The Arizona Insect Festival hosted by the Department of Entomology and over 100 volunteers delights thousands of children and their families annually by getting them up close and personal with insects and the scientists who study them (Section J).

Extramural funding awarded to the Department of Entomology reached an all-time high of $8.6 million in Fiscal Year 2023 (ended June 30, 2023), equivalent to over $600,000 per core Entomology faculty member who had research as part of their assigned duty (Section D).

The 26 current EIS students have won over 70 awards and honors and given 64 presentations, including 39 at national or international conferences and 15 for Extension and outreach (Sections D and I).

Since 2018, the Public Health Integrated Pest Management (IPM) Team led by Entomology faculty has partnered with 15 of Arizona's federally recognized Native American Nations to benefit over 240,000 residents with programs that reduce the risk of diseases vectored by insects and ticks.

On a scale from 0 to 100% (best), courses taught by Entomology faculty from Spring 2020 to Spring 2023 were rated 92% by undergraduate students and 95% by graduate students (Section E).

Entomology publications include 275 journal articles and 9 book chapters listed by Scopus for 2016 to July 2023, with 27% of the journal articles and 22% of the book chapters coauthored by EIS students (Section D).

The three most recent faculty hires by Entomology identify as female and the two most recent tenure-track faculty hires identify as female and Hispanic.

Increased enrollment in Entomology courses raised Entomology teaching revenue 113% in FY2022 relative to FY2016, despite the 9% college-wide decrease in teaching revenue over the same period (Section G).

Entomology faculty and staff were instrumental in a collaborative effort that eradicated the invasive pest pink bollworm from the U.S., which helped to reduce insecticide use 82% overall in cotton in Arizona and saved U.S. growers $192 million from 2014 to 2019 (Section E).

3. Overview of Faculty

We refer to faculty appointed in the Department of Entomology with at least 0.75 full-time equivalent (FTE) as core ENTO faculty. No faculty have a portion of their appointment in ENTO and a portion in another unit. We currently have 17 core faculty. Dr. Paulina Maldonado-Ruiz will join us in January 2024, bringing us to 18 core faculty with a total of 17.7 FTE including two Assistant Professors of Practice at 0.83 FTE each (Table A1, Figs. A1 and A2). Sixteen core ENTO faculty are also members of EIS. In addition, 12 additional faculty from seven departments and three colleges across UA are active members of EIS (Fig. A3).

Table A1. Department of Entomology core faculty: rank and mission areas

	First	% FTE in each mission area*						Total
Core faculty member	year	Rank	Res	Instr	Ext	Serv	Cur	Admin	FTE
Carrière, Yves	1998	Full	75	15		10			1.0
Davidowitz, Goggy	2009	Full	75	15		10			1.0
Ellsworth, Peter	1991	Full	10		80	10			1.0
Fournier, Al	2007	Assoc.	10		80	10			1.0
Gouge, Dawn	2000	Full	20		70	10			1.0
Hunter, Martha	1996	Full	75	15		10			1.0
Lanan, Michele	2022	Asst.		90		10			0.83
Li, Xianchun	2005	Full	75	15		10			1.0
Maldonado-Ruiz, Paulina	2024	Asst.	75	15		10			1.0
Matzkin, Luciano	2017	Assoc.**	75	15		10			1.0
McKnight, Tristan	2019	Asst.		90		10			0.83
Moore, Wendy	2010	Assoc.**	50	15		15	20		1.0
Palumbo, John	1990	Full	25	5	60	10			1.0
Riehle, Michael	2005	Full	75	15		10			1.0
Schlenke, Todd	2016	Assoc.	75	15		10			1.0
Tabashnik, Bruce	1996	Full	60			10		30	1.0
Tigreros, Natasha	2023	Asst.	75	15		10			1.0
Walker, Kathleen	2011	Assoc.	50	25	15	10			1.0

*Full-time equivalent (FTE) in Research, Instruction, Extension, Service, Curation of the UA Insect Collection (UAIC), and Administration; **Promotion review in progress

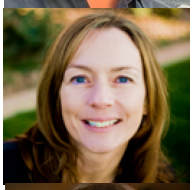
Figure A1. Entomology core faculty: titles and areas of interest

Yves Carrière
Professor
Insect ecology, resistance management for transgenic crops
Integrated Pest Management (IPM)

Goggy Davidowitz
Professor &
University Distinguished Scholar
Ecological and evolutionary physiology, edible insects

Peter Ellsworth
Specialist (Extension) & Professor
IPM Coordinator, IPM
Industrial & field crops pest management
Maricopa Agricultural Center (MAC)

Alfred Fournier
Assoc. Specialist & Assoc. Professor
Evaluation of IPM adoption, implementation, and impact
MAC

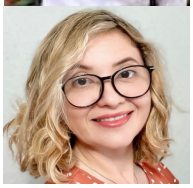


Dawn Gouge
Specialist and Professor
Public health entomology
IPM
MAC

Martha Hunter
Professor & Chair, Entomology &
Insect Science GIDP
Insect symbionts

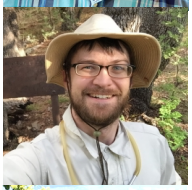
Michele Lanan
Assistant Professor of Practice
Evolution of diet and gut morphology, ant collective foraging

Xianchun Li
Professor
Insect-plant interactions, molecular biology, resistance mechanisms & management, transposable elements



Paulina Maldonado-Ruiz
Assistant Professor
Medical entomology
Understanding and managing ticks that vector diseases

Luciano Matzkin
Associate Professor
Ecological genomics
Cactophilic *Drosophila*



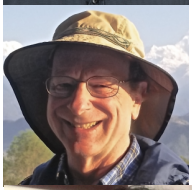
Tristan McKnight
Assistant Professor of Practice
Robber fly ecology and evolution

Wendy Moore
Associate Professor
Curator, UA Insect Collection
Insect systematics

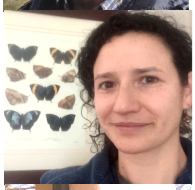
John Palumbo
Specialist and Professor
Endowed Chair
Vegetable IPM
Yuma Agricultural Center (YAC)

Michael Riehle
Professor
Physiology & medical entomology
Controlling mosquitoes and reducing the diseases they vector

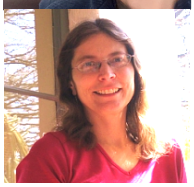
Todd Schlenke
Associate Professor
Evolutionary genetics of host-parasite interactions



Bruce Tabashnik
Regents Professor &
Department Head
Understanding and managing pest resistance to transgenic crops

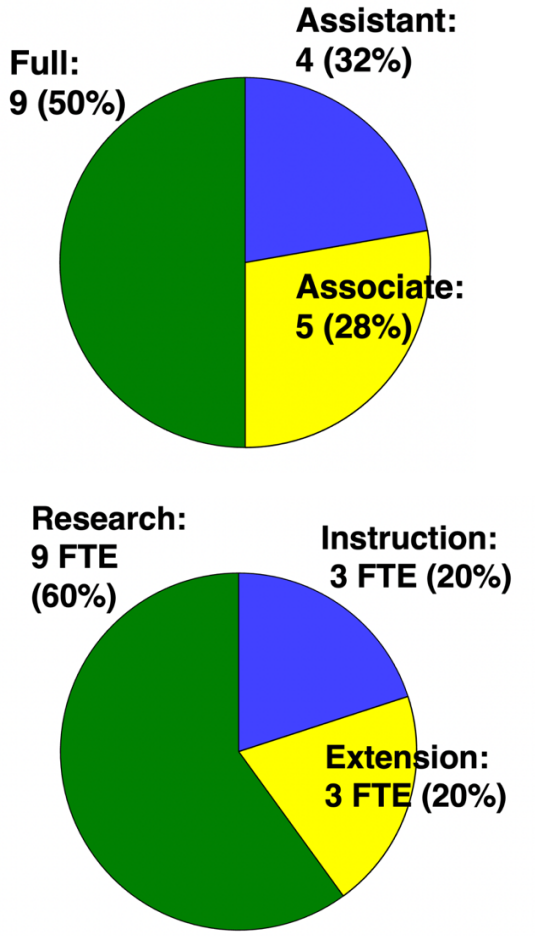


Natasha Tigreros
Assistant Professor
Insect nutritional ecology and life history



Kathleen Walker
Assoc. Specialist & Assoc. Professo
Ecology of arthropod vectors of human diseases
Insect Discovery Outreach Progam

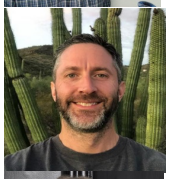
Fig A2. Distribution of ranks and mission areas for Entomology core faculty. Two of the five Associate Professors are under evaluation now for promotion in 2024.



Of the 18 core faculty, 14 are stationed at the main UA campus in Tucson, whereas four with Extension appointments are at the Maricopa Agricultural Center near Phoenix (Ellsworth, Fournier, and Gouge) or the Yuma Agricultural Center (Palumbo). ENTO has two postdoctoral fellows and no lecturers or adjunct instructors. Academic programs for undergraduates in ENTO are the Minor in Entomology established in 2022 with current enrollment of 10 and the Certificate in Entomology and Insect Science, established in 2021 with four certificates earned and one in progress.

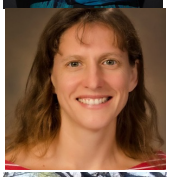
Fig. A3. Active EIS GIDP faculty members at UA (excluding ENTO core faculty) and USDA associates who are active in the EIS GIDP. Active participants have participated in events, served on EIS committees, taught EIS graduate courses, or mentored EIS students as either major advisor or committee member in the last three years.

Kirk Anderson
Lead Scientist
USDA Agricultural Research Service
Social insect ecology and honey bee microbial ecology

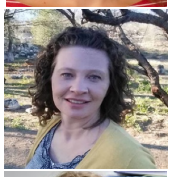


Michael Bogan
Associate Professor
Wildlife Conservation and Management
School of Natural Resources and the Environment
Freshwater and riparian ecology

Judith Bronstein
University Distinguished Professor
Ecology and Evolutionary Biology
Evolution and ecology of mutualisms

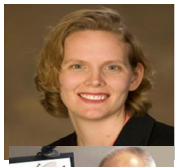


Heidi Brown
Associate Professor
Epidemiology and Biostatistics
Spatial epidemiology and climate change



Vanessa Corby-Harris
Research Physiologist
USDA Agricultural Research Service
Honey bee nutrition and physiology

Anna Dornhaus
Professor
Ecology & Evolutionary Biology
Social insects, ants/honey bees



Kacey Ernst
Professor & Department Chair
Epidemiology and Bioscience
Epidemiology of infectious diseases

Wulfila Gronenberg
Professor
Neuroscience
Movement control, muscle biomechanics, learning and memory

John Hildebrand
Regents Professor Emeritus
Neuroscience
Olfaction and learning and memory

Lisa Nagy
Professor
Molecular and Cellular Biology
Development and evolution of pattern formation in arthropods

Daniel Papaj
Professor
Ecology & Evolutionary Biology
Learning and cognition in bees, fruit flies, butterflies; plant-insect interactions

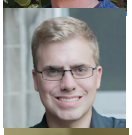
Nicholas Strausfeld
Regents Professor
Neuroscience
Functional organization of arthropod central nervous systems, learning and memory

4. Overview of EIS Students

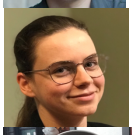
The academic program for graduate students is the Entomology & Insect Science Graduate Interdisciplinary Program (EIS GIDP) with current enrollment of 20 PhD and 6 MS students (as of August 22, 2023, Fig. A4).

Fig. A4. Students in the EIS MS and PhD programs.

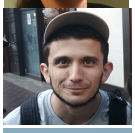
Nathan Allen
PhD student
Advisor: Kirk Anderson
Symbiosis and dysbiosis in honey bees



Joshua Arnbrister
PhD student
Advisor: Kathleen Walker
Dengue in *Aedes aegypti*

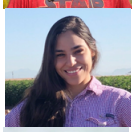


Meagan Ash
PhD student
Advisor: Todd Schlenke
Physiology of host-parasitoid interactions



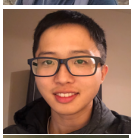
Davide Bergamaschi
PhD student
Advisor: Wendy Moore
Systematics of ants

Charles Bradley
PhD student
Advisor: Wendy Moore
Microbiome of native bees and their parasites

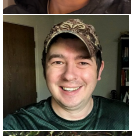


Isadora Bordini
PhD student
Advisor: Peter Ellsworth
Biological control of whiteflies in cotton

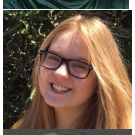
Emiliano Calvo
PhD student
Advisor: Anna Dornhaus
Behavior of social insects



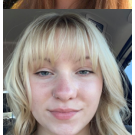
Xingsen Chen
PhD student
Advisor: Luciano Matzkin
Reproductive interactions among populations of cactophilic *Drosophila*



Hunter Clark
MS student
Advisor: Goggy Davidowitz
Insects for food and feed



Megan Deeter
PhD student
Advisor: Vanessa Corby-Harris
Nutrition, lipid metabolism and honeybee healt

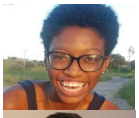


Skyler Finucane
MS student
Advisor: Kathleen Walker
Knowledge, attitudes and practices survey about ticks for dog-adjacent professions

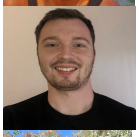
Kyle Harrington
PhD student
Advisor: Yves Carriere
Biology and pest management of a species complex of alfalfa weevil

Raine Ikagawa
PhD student
Advisor: Wendy Moore
Systematics and metagenomics of bombardier beetles

Zoe Jensen
PhD student
Advisor: Luciano Matzkin
Genetics of Bt resistance in *H. zea*



Marnesha Jones
PhD student
Advisor: Goggy Davidowitz
Herbivory under drought stress



Oliver Kortenkamp
PhD student
Advisor: Kirk Anderson
Symbiosis in honey bees

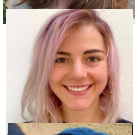
Alex Lombard
MS student
Advisor: Wendy Moore
Symbiosis in bombardier beetles

Bailey Payne
MS student
Advisor: Kathleen Walker
Field survey for mosquito pesticide resistance in Arizo

Brendan Riske
PhD student
Advisor: Mike Riehle
Physiology of insulin signaling in mosquitoes

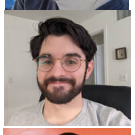
Liam Roberts
PhD student
Advisor: Luciano Matzkin
Drought stress adaptation in cactophilic *Drosophila*

Shianna Rodriguez
MS student
Advisor: Yves Carriere
Pest management of an invasive thrips

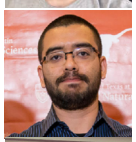


Mara Short
PhD student
Advisor: Kathleen Walker, Wendy Moore
Systematics and biology of the brown dog tick

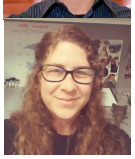
Ethan Stahura
MS student
Advisor: Yves Carriere
Mass rearing technique development



Liam Sullivan
PhD student
Advisor: Molly Hunter
Symbiosis in a leaf-footed bug



Edwin Umanzor
PhD student
Advisor: Molly Hunter
Symbiosis in a leaf-footed bug



Andrea Walton
PhD student
Advisor: Yves Carriere
Comparative fitness of mass-reared insects

SECTION B: GOALS

Entomology & Insect Science GIDP Mission Statement

EIS GIDP faculty members are an interdisciplinary and collaborative community of researchers and scholars engaged in providing an internationally recognized graduate program in research involving arthropods as models, pests, vectors, and critical components of biodiversity and ecosystem services. We are dedicated to providing a graduate program that is flexible to student goals, and blends innovative research training, coursework, dedicated mentoring, as well as trains students in science education and outreach to foster the next generation of insect scientists.

Department of Entomology and EIS GIDP

For details, please see our complete Strategic Plan (Appendix B1).

1. Purpose, Mission, Shared Values and Strategic Perspective, Vision, and Strategic Goals

a. Purpose: Improve the quality of life of the people of Arizona and the world by generating, disseminating, and applying information about insects.

b. Mission

- Conduct outstanding research to better understand insects and their impact on humanity
- Provide distinguished education in insect biology
- Provide innovative solutions to address critical issues such as food security and vector-borne diseases
- Facilitate capacity building of vector management programs in vulnerable communities
- Develop and deploy the most advanced technologies and progressive IPM programs in the world to minimize the negative impacts of insects and maximize their positive impacts
- Provide outstanding outreach programs about insects accessible to all community members

c. Shared Values and Strategic Perspectives

- Respect for all people
- Collaboration among department members
- Collaboration within and across disciplines with others in CALES, UA, and other institutions
- Put knowledge to work to improve lives
- Serve our profession and the people of Arizona and the world
- Excellence in all pursuits
- Passion for achieving positive outcomes
- Work hard and have fun doing what we love to do
- Provide value for resources invested in Entomology
- Develop programs with local and global relevance
- Take advantage of our desert environment and position in the front line of climate change

d. Vision (each Vision item is addressed in a specific strategic goal, see below)

1. The quality and impact of our research will be recognized in Arizona, nationally & globally.

2. Our Integrated Pest Management (IPM) programs will be implemented in Arizona and other regions worldwide and will promote better health, protect the environment, and boost the economy.

3. We will engage undergraduate students with active-learning courses and mentoring to help them succeed in the fourth industrial revolution (4IR).

4. The graduate program in Entomology & Insect Science (EIS) will attract the best students; students completing EIS degrees will be in high demand by employers.

5. Our outreach programs will educate, delight, and connect community members with Entomology, CALES, and the University of Arizona.

6. The UA Insect Collection will be the best source of specimens from the Sonoran Desert Region and a global center for specimen-based insect research.

7. Our programs will be well supported by private donors, as well as by governmental agencies.

e. Strategic Goals

1. Research: Increase Entomology research productivity 30% by 2025.

2. IPM: By FY25, greatly enhance the effectiveness of Integrated Pest Management (IPM) research, education, and Extension programs in Arizona for teaching students and stakeholders, and for addressing health, environmental, and economic problems caused by pests.

3. Undergraduate Engagement: Increase the yearly undergraduate student credit hours taught 30% by FY2025.

4. Graduate Program: Double the stable funding for EIS graduate students by FY25.

5. Outreach: Double the number of people served each year by FY25 through sustainable outreach programs to meet public demand for insect information, to support K-12 science education, and to connect underserved communities to UA Entomology and CALS.

6. Insect Collection: By FY25, double our holdings of expertly-identified insect pollinators and triple our holdings of expertly-identified DNA barcoded voucher specimens.

7. Development: Raise $2M from private donors to support our programs by FY25

f. Relationship of Entomology Strategic Goals to the University of Arizona Strategic Plan
https://strategicplan.arizona.edu/

For details, please see Appendix B2.
Pillars of the University of Arizona Strategic Plan most relevant to ENTO Strategic Goals:

Pillar 1. "Wildcat Journey: Preparing students with the skills and mindsets to lead in the 4th industrial revolution"

Pillar 2. "Grand Challenges: Tackling society's biggest challenges by enabling discoveries that will fundamentally shape the future"

Pillar 3. "Arizona Advantage: Advancing our land grant mission to drive social, cultural and economic impact"

Pillar 5. "Living our values and innovative culture to enable a high performing institution"

Entomology Goal	UA Strategic Plan Pillar
1	2, 5
2	2, 3, 5
3	1
4	1, 2,
5	1, 3
6	1, 2
7	1

C. CHANGES SINCE PREVIOUS REVIEWS

Department of Entomology

The most recent previous Academic Program Review (APR) of the Department of Entomology was completed in May 2009.

1. Major changes in instruction since 2009 include:

a) Development and teaching of two General Education courses (ENTO 160 & 170) in person and online via iCourses, Arizona Online, and Arizona International Direct (aka UA Global).

b) In 2021, we established a 12-unit Undergraduate Certificate in Entomology that offers a flexible course of study students can tailor to their own interests (Appendix C1) https://cals.arizona.edu/ento/content/undergraduate-certificate-entomology-and-insect-science

c) In 2022, we established an 18-unit Undergraduate Minor in Entomology to provide students with advanced education and skills in insect-related fields to be competitive for employment in agricultural and biotech industries as well as for graduate programs in disciplines such as Entomology, Public Health, Environmental Sciences, Epidemiology, Biology, and Ecology (Appendix C1). https://cals.arizona.edu/ento/content/undergraduate-certificate-entomology-and-insect-science/minor

d) In November 2009, we merged the Entomology Graduate Program with the Insect Science Graduate Interdisciplinary Program to create the Entomology & Insect Science Graduate Interdisciplinary Program (EIS GIDP).

2. Response to recommendations from the 2009 APR of the Department of Entomology

The main recommendation of the 2009 APR of the Department of Entomology was to hire seven new faculty in the following areas: 1) Insect Systematics, 2) Insect Genomics, 3) Insect Ecology, 4) Crop Integrated Pest Management (IPM), 5) Urban IPM, 6) Biological Control, and 7) Economic Entomology.

Response: Since 2009, we have hired faculty in 1) Insect Systematics (Wendy Moore), 2) Insect Genomics (Luciano Matzkin and Todd Schlenke), 3) Insect Ecology/Physiological Ecology (Goggy Davidowitz and Natasha Tigreros), and 4) Crop IPM (Al Fournier). We are currently recruiting for another position in Crop IPM (Assistant Specialist in Extension). Although we have not received approval yet for a faculty position in Urban IPM, current grants support two Associates in Extension who address this area (Drs. Shaku Nair and Shujuan Li).

Entomology & Insect Science Graduate Interdisciplinary Program

The recommendations of the 2014 APR of EIS and changes made in response to the recommendations are summarized below.

Recommendations 1 & 2: The most recent previous APR of the EIS GIDP was completed in 2014. Note that EIS was reviewed alone at this time. The 2014 review team found the program "excellent overall" and made several recommendations. **As the most pressing concerns,** the review team noted the 1) "erosion of faculty expertise in critical research areas," particularly in

sub-organismal disciplines, and the 2) "unpredictability and limited financial support available for students."

Response 1: As noted above, the Department of Entomology has hired two faculty in genomics (Schlenke and Matzkin) and two ecological physiologists have or will join the faculty in 2023-24: Natasha Tigreros (plant-insect interactions and ecological physiology) and Paulina Maldonado Ruiz (medical entomology and the ecological physiology of ticks). Two of these critical hires (Schlenke and Maldonado) were facilitated by the GIDP-Shared Hiring Process (formerly known as the GIDP-Partnered Hire) contributions to the first two years of salary of these CALES hires.

Response 2: The unpredictability of financial support for students has not gone away, but the lines of communication among students, faculty mentors and the Chair have improved such that students are directed towards TA opportunities as they occur, the Chair takes an active role in finding TA opportunities, and funding has been found for all students who are making progress in the program. Very important for this increase in student confidence of being funded in the period from 2014-2022 has been the availability of one or two GIDP administration-supported TAs (for courses in Entomology or elsewhere on campus). We face challenges in funding our students because of a substantial increase in their stipends that has not been fully matched by increased funding from the Graduate College (GC) and CALES, which are dealing with budget constraints and uncertainty associated with a new budget model at UA. Please see Sections G and I for additional details on EIS funding.

Recommendation 3: The review team praised the EIS Graduate program coordinator at the time and recommended that she be moved closer on campus.

Response: We had a lot of turnover in coordinators (three in three years in one stretch) since this time, but our current coordinator Paula Nielsen, has now been in the position for three years and has restored stability and institutional knowledge to this position. She is also based in the Marley building where the greatest concentration of EIS faculty and students are housed and has an open-door policy so students can walk in (and do!)

Recommendation 4: The review team suggested a change in administrative structure, whereby the Executive Committee run admissions and oversee student progress reports without separate committees.

Response: We retained the ability to be flexible on committee membership and draw from the faculty at large but made the expectation of committee service more explicit when recruiting executive committee membership. In our generous and collaborative faculty community, we have not had trouble finding faculty willing to serve on these important committees.

Recommendation 5: The review team recommended that EIS devote more concerted effort to recruiting students of underrepresented groups.

Response: Concerted recruiting via advertisements on listservs over a few years following the review did not clearly yield greater diversity of US resident applicants in our pool. Our current

students are nonetheless diverse, balanced in gender identity (Figs. I1 and I2) and four recent students have been recipients of Graduate Access Fellowships that provide aid to matriculating students who are first generation or have surmounted financial or other obstacles to attend graduate school since 2014. We note that gender balance figures derived by the current university analytic software does not capture students identifying as non-binary, and so does not represent all of our current students as they would self-identify.

Recommendation 6: The review team evaluated several curriculum issues, including the value of a) research rotations, b) the EIS seminar series, c) a student-invited speakership, the two tracks currently in place for PhD students (Insect Science or Entomology), and program curricula requirements.

Response: Following a day-long retreat with EIS students and faculty in 2015 and several subsequent discussions, we:
a) standardized required PhD student research rotations to two of eight weeks each.
b) moved the joint EIS/ENTO seminar to Friday morning and attendance has improved.
c) established the Hagedorn Speakership as an endowment through the GIDP Administration, which enables students to invite one outside speaker per year. It has been in place for several years, even in a pandemic year when the visit was virtual.
d) ended PhD program tracks, a vestige of the previously separate, now defunct Entomology graduate program and Insect Science GIDP.
e) selected three core courses of which students must complete at least two: Insect Systematics, Insect Ecology, and Insect Molecular Biology (which later became Insect Systems Biology). Because the third course had consistently low enrollment, it has not been offered in recent years. In effect, this means students must complete the first two core courses.

Recommendation 7: The Review team noted the accomplishments of the program faculty and students in outreach, with special recognition going to the annual Arizona Insect Festival, and Insect Discovery, an outreach program led by Dr. Kathleen Walker that reaches thousands of school children annually, while simultaneously providing training opportunities for graduate and undergraduate students. The team hoped that these activities could be continued to be supported at the College and University levels.

Response: Outreach remains central in its importance in our program. We are still looking for opportunities to secure permanent funding for these two programs and for dedicated EIS graduate assistantships in support of these programs. In recent years, a critical piece has been the availability of GIDP-supported TAs that the program can allocate to Insect Discovery. These experiences have had a large impact on our students, who often find them one of the most rewarding experiences of their program.

D. QUALITY AND PRODUCTIVITY

1. Publications and Citations. Based on the Scopus literature database, the UA Department of Entomology and EIS GIDP students published 275 journal articles and 9 book chapters from 2016 to July 7, 2023 (Appendix D1). These include many papers in prestigious journals, such as *Nature Biotechnology* (1), *Annual Review of Entomology* (2), *Science* (4), and *PNAS* (7), with a total of 21 publications in 11 journals that have an impact factor >10 (Table D1). EIS students coauthored 74 of the 275 journal articles (27%) and two of the nine book chapters (22%) (Appendix D1).

Scopus listed 4,717 citations of the total of 284 publications as of July 7, 2023, which yields a mean of 17.2 citations per publication. Because most citations occur a year or more after publication of the cited material, we also note that Scopus listed 4,650 citations of our 234 journal articles and book chapters published from 2016 to 2021, which yields a mean of 19.9 citations per publication. In addition, Associate Professor Wendy Moore co-edited the textbook *Invertebrates*, which is not tracked by Scopus and has been cited over 6,400 times according to Google Scholar.

Table D1. Twenty-one publications in 11 high-profile journals (impact factor >10) by the UA Department of Entomology and EIS GIDP students (2016-July 7, 2023)

Journal	Impact factor [a]	Number [b]
BioScience	10.1	1
Environmental Health Perspectives	10.4	1
ISME Journal	11.0	1
PNAS	11.1	7
Science Advances	13.6	1
Plant Biotechnology Journal	13.8	1
Nature Communications	16.6	1
Trends in Biotechnology	17.3	1
Annual Review of Entomology	23.8	2
Nature Biotechnology	46.9	1
Science	56.9	4

[a] Impact factor from Journal Citation Reports 2022

[b] Scopus search 7-7-23 based on affiliation with UA Department of Entomology or EIS

2. Extramural Funding. Extramural support of Entomology including grants, contracts, and gifts averaged $3.7 million per year during the past seven fiscal years (starting FY2017: July 1, 2016 to June 30, 2017 and ending FY2023: July 1, 2022 to June 30, 2023, Fig. D1). Data provided by the CALES Data Solutions Team indicates that grants and contracts awarded to Entomology reached an all-time high of $7.9 million in FY2023 (Appendix D2). Combined with gifts, a total of $8.6 million in extramural funding was obtained during FY2023 (Fig. D1). The total extramural funding received by Entomology is nearly triple for FY2023 versus the mean for FY2017-FY2022 ($2.9M). This increase was caused by a 2.4-fold increase in the percentage of requested dollars funded (46% in FY2023 vs. 19% in FY2017-FY2022) and a 1.2-fold increase in the proposed dollars. The number of proposals submitted was 13% higher in FY2023 (60) vs. FY2017-FY2022

(53). In an extremely competitive environment, this surge in extramural funding is resounding confirmation of the quality of our programs and bodes well for our future productivity.

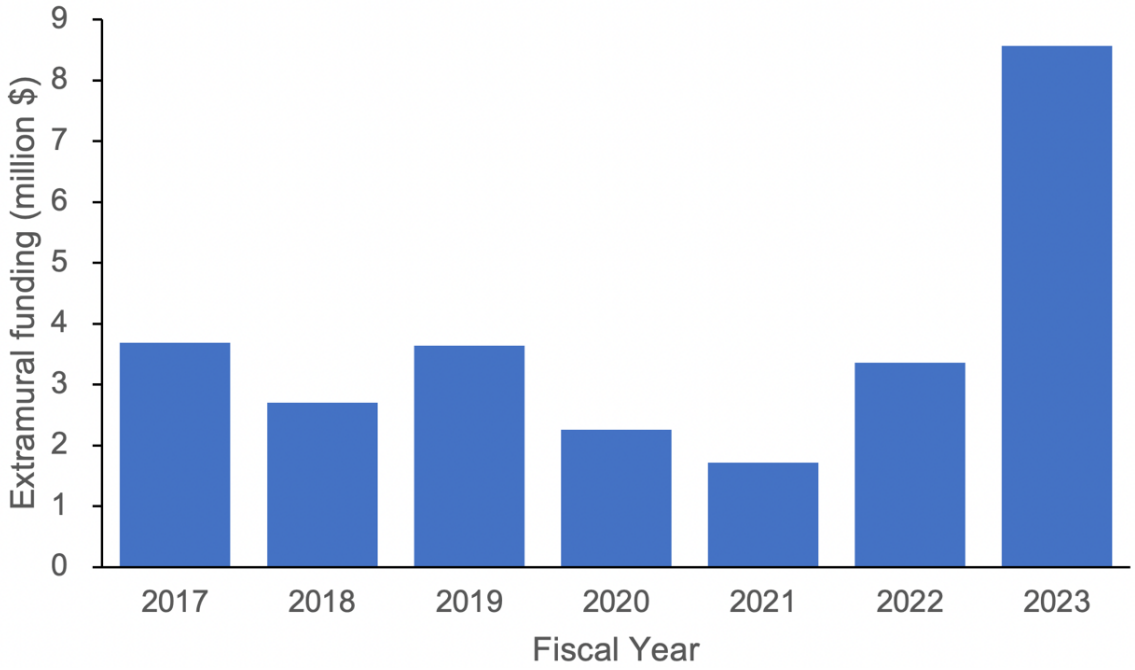


Fig. D1. Extramural funding (grants, contracts, and gifts) awarded to the Department of Entomology FY2017-FY2023.

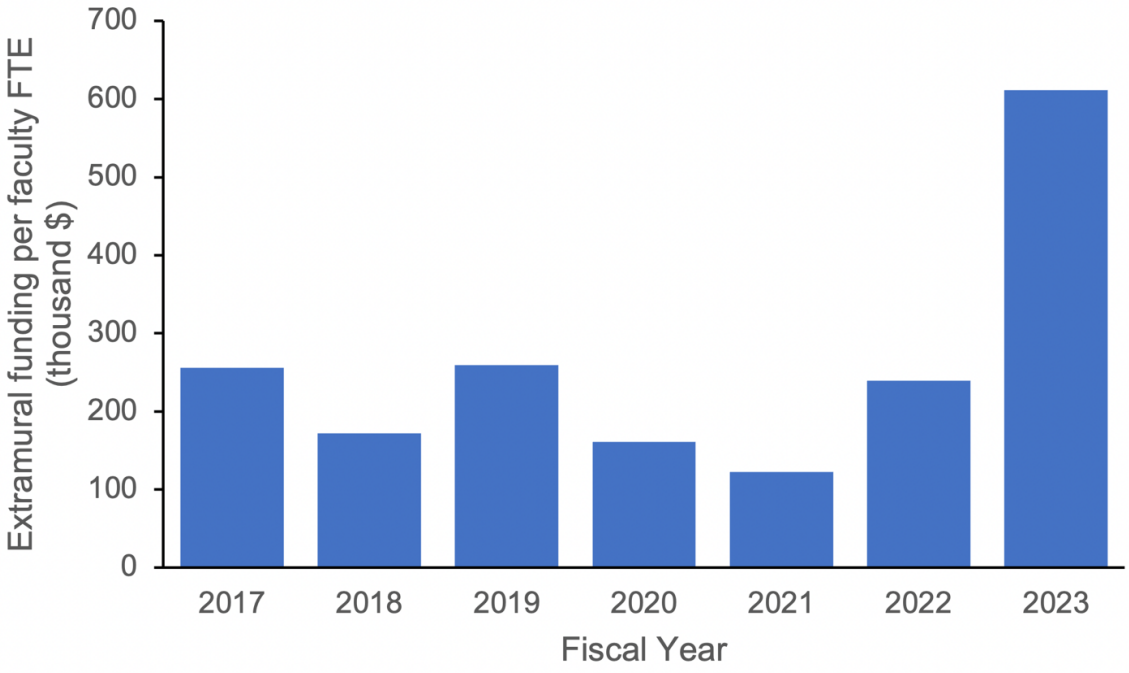


Fig. D2. Extramural funding awarded to the UA Department of Entomology per faculty full-time equivalent (FTE, excludes Professors of Practice -- they have no

Research or Extension FTE). Faculty FTE was 14.4 in FY2017, 15.7 in FY2018, and 14 in FY2019-2023.

Grants and contracts accounted for 86% of the total extramural funding for FY2017-2023. Federal agencies were the primary funding source, accounting for 96% of the grants and contracts awarded in FY23 (Appendix D2). Federal funding sources in FY2023 included the Centers for Disease Control and Prevention (CDC), NIH, NSF, U.S. Department of Housing and Urban Development (HUD), and USDA (Appendix D2). The remaining sources of grants and contracts in FY2023 were State agencies (2%) and industry (2%).

For faculty who have a portion of their FTE assigned to Research (including the Department Head and excluding Professors of Practice), we calculated the extramural funds awarded to the Department of Entomology per faculty member (Fig. D2) relative to the mean faculty salary. For FY2017-2023, the annual mean extramural funding awarded to ENTO per faculty member was $260,400. The mean annual salary was approximately $113,300 for FY2017-2023 (based on FY2023 and back-calculated for previous years, assuming a 3% increase had occurred each year). Thus, for FY2017-2023, the mean annual extramural funding awarded per faculty FTE was 2.3 times the mean annual FY2017-2023 salary. In FY2023, the mean extramural funding awarded to ENTO per faculty member was $611,700 and the mean ENTO faculty salary was $123,600 (n = 14 faculty with Research FTE). Thus, for FY2023, the mean extramural funding awarded to ENTO per faculty member with Research FTE was 4.9 times the mean salary per faculty member.

3. Awards and Honors.
Entomology faculty and EIS students have earned many awards and honors (**Tables D2 and D3).** For example, 6 of 17 (35%) of current Entomology core faculty are Fellows of the American Association for the Advancement of Science (AAAS). Excluding our department, 50 of 698 (7.2%) of entomology faculty nationally were AAAS Fellows in 2021 according to Academic Analytics. Thus, the percentage of faculty earning this honor is about five times higher for UA Entomology relative to the pooled percentage for other entomology faculty in the U.S (Table D2). Current EIS students include six who have received external fellowships for one or more semesters of funding, four who have won awards for presentations, and many who have been awarded scholarships and prizes for their excellence (Table D3).

Table D2. Entomology faculty: selected career awards and honors (72 listed of >100 total)

National and International Awards and Honors (34)
Fellow, Association for the Advancement of Science (AAAS)
Yves Carrière, Goggy Davidowitz, Molly Hunter, Mike Riehle, Todd Schlenke, Bruce Tabashnik

Fellow, Entomological Society of America (ESA)
Yves Carrière, Molly Hunter, Bruce Tabashnik

Lifetime Achievement Award, Plant-Insect Ecosystems Section, ESA
Yves Carrière, Bruce Tabashnik

Integrated Pest Management (IPM) Team Award, Plant-Insect Ecosystems Section, ESA
Yves Carrière, Peter Ellsworth, Xianchun Li, Bruce Tabashnik

NSF CAREER Award
Goggy Davidowitz

Award for Excellence in IPM, ESA
Peter Ellsworth, John Palumbo, Bruce Tabashnik

Pesticide Environmental Stewardship Program Gold Tier Shining Star Award, U.S. EPA
Peter Ellsworth, Al Fournier, Dawn Gouge et al., Arizona Pest Management Center (team award)

Recognition Award for Excellence in Cotton IPM, National Cotton Council
Peter Ellsworth

Outstanding Contributions to National IPM in Schools, U.S. EPA
Al Fournier

International IPM Award of Excellence, International IPM Symposium
IPM Recognition Award, IPM Institute of North America
Childcare and School IPM Recognition Award, IPM Institute of North America
Dawn Gouge

Fellow, Japan Society for the Promotion of Science
Molly Hunter

Henry and Sylvia Richardson Research Grant, ESA
Early Career Professional Award, ESA
Paulina Maldonado-Ruiz

Invited participant, National Academies of Science, Engineering and Medicine:
Next Steps for Functional Genomics
Luciano Matzkin

Rosemary Grant Award, Society for the Study of Evolution
Tristan McKnight

Distinguished Achievement Award in Extension, ESA
John Palumbo

Time magazine's 50 best inventions (2010): Malaria-proof mosquito (#1 Health & Medicine)
New Scholar Award in Aging, Ellison Medical Foundation
Michael Riehle

Member, National Academy of Sciences
Louis Malassis International Scientific Prize for Agriculture and Food, Agropolis Fondation
Researcher of the Year Award, International Cotton Advisory Committee
Fellow, Royal Entomological Society, United Kingdom
Nan-Yao Su Award for Innovation and Creativity in Entomology, ESA
Bruce Tabashnik

Award for Eradication of Pink Bollworm from the United States, USDA
Bruce Tabashnik on behalf of the University of Arizona

Regional and State Awards and Honors (13)
Distinguished Achievement Award in Extension, Pacific Branch, ESA
Peter Ellsworth

Industry Appreciation Award, Arizona Cotton Growers Association
Peter Ellsworth, Bruce Tabashnik

Outstanding Work & Dedication to Crop Protection Industry, Arizona Crop Protection Association
Al Fournier

Environmental Achievement Award, Pacific Southwest (Region 9), US EPA
Dawn Gouge

Award for Distinction in Student Mentoring, **Pacific Branch, ESA**
Molly Hunter

Editor's Choice Award, ***Diversity and Distributions***
Southwest Book of the Year Award, Pima County Public Library, Arizona
Wendy Moore

Outstanding Contribution to Agriculture Award, Yuma County Farm Bureau
Distinguished Service Award, Yuma Fresh Vegetables Association
Outstanding Contribution to Agriculture Award, California Assoc. of Pest Control Advisors
John Palumbo

Recognition Award in Medical, Urban and Veterinary Entomology, Pacific Branch, ESA
Michael Riehle

Environmental Protection and Technology Award, Arizona Farm Bureau
Bruce Tabashnik

Honorary Lectures & Awards from Universities other than University of Arizona (13)
Distinguished Alumnus Speaker, Simon Fraser University
Yves Carrière

Visiting Eminent Ecologist, Kellogg Biological Station, Michigan State University
Goggy Davidowitz

H. Gunderson Memorial Lecture in Entomology, Iowa State University
P. L. Adkisson Distinguished Speaker Award, Texas A&M University
Peter Ellsworth

A. M. Boyce Lecturer, University of California, Riverside
H. R. MacCarthy Lecturer, University of British Columbia and Simon Fraser University
Molly Hunter, Bruce Tabashnik

C. P. Alexander Speaker, University of Massachusetts
Molly Hunter

Chutian Scholar Award, Huazhong Agricultural University, China
HouJin Scholar Award, Northwest A. & F. University, China
Xianchun Li

C. C. Doane Lecturer, University of Wisconsin
C. V. Riley Lecturer, University of Missouri
Bruce Tabashnik

UA and College of Agriculture & Life Sciences (CALS) Awards and Honors (12)*
Research Faculty of the Year Award, CALS
Yves Carrière

Distinguished Scholar Award, UA
Goggy Davidowitz

Honored Faculty, Graduate Interdisciplinary Programs, UA
D. E. Cox Faculty Teaching Award, CALS
Eminent Researcher Award, ALVSCE**
Molly Hunter

Endowed Chair in Integrated Pest Management, CALS
John Palumbo

Cooperative Extension Faculty of the Year, CALS
Peter Ellsworth, John Palumbo

Faculty Member of the Year, 'Ag' 100 Council of CALS Alumni
Peter Ellsworth, John Palumbo, Bruce Tabashnik

Regents Professor, UA
Koffler Prize for Research/Scholarship/Creative Activity, UA
Bruce Tabashnik

*name recently changed to College of Agriculture, Life & Environmental Sciences (CALES)
**Division of Agriculture, Life, and Veterinary Sciences and Cooperative Extension, which includes CALS/CALES

Table D3. EIS current students: selected awards and honors (70 listed).

Fellowships with stipend
UA One Health Initiative Graduate Research Assistantship (1 year)
Josh Arnbrister

N**ational Science Foundation Graduate Research Fellowship** (3 years)
Charles Bradley, Mara Short

UA/Sloan Partnership Indigenous Graduate Scholarship (2 years)
Charles Bradley

UA NSF Research Traineeship (NRT) Building Resources for an InterDisciplinary training in Genomics and Ecosystem Sciences (BRIDGES) (2 years)
Zoe Jensen

Pacific Southwest Center for Excellence, Vector-Borne Disease Training Grant (1 semester)
Josh Arnbrister (twice)

UA University Fellows Award (20 incoming PhD students chosen annually across campus, 1 year)
Raine Ikagawa

EIS First year recruiting assistantship (1 year)
Nate Allen, Davide Bergamaschi, Xingsen Chen, Emiliano Calvo, Hunter Clark, Megan Deeter, Skyler Finucane, Raine Ikagawa, Bailey Payne, Liam Sullivan, Edwin Umanzor

Student excellence awards
EIS Carruth award for outstanding student
Isadora Bordini, Meg Deeter

Center for Insect Science Chapman Award for outstanding student studying insects
Isadora Bordini

UA Graduate Access Fellowship
Skyler Finucane, Edwin Umanzor

Western IPM Center Student Fellowship
Isadora Bordini (twice)

UA Department of Entomology Jack Root Graduate Fellowship for Integrated Pest Management & Urban Entomology
Isadora Bordini (twice), Skyler Finucane, Kyle Harrington, Bailey Payne, Mara Short

North America Alfalfa Improvement Conference Student Award
Kyle Harrington

Center for Insect Science Research Award
Davide Bergamaschi, Isadora Bordini, Megan Deeter

Outstanding Master's Student in Biological Control, International Organization for Biological Control (IOBC)
Isadora Bordini

Ford Foundation Fellowship Honorable Mention
Ford Foundation Fellowship Alternate
NSF Graduate Research Fellowship Program Honorable Mention
Edwin Umanzor

Coleopterists Society Graduate Student Research Enhancement Award
Raine Ikagawa

UA CALES Stanley M. Alcorn Memorial Scholarship
Davide Bergamaschi, Megan Deeter

UA CALES Lee S. Stith Scholarship
Isadora Bordini (twice), Edwin Umanzor

UA CALES General Scholarship
Raine Ikagawa

UA CALES Lynham Student Support Scholarship
Skyler Finucane

UA CALES Impact Leader Professional Development Program
Isadora Bordini, Brendan Riske

UA CALES Kingston J. Smallhouse Scholarship
EIS Leadership award
Liam Sullivan

EIS Education award (for teaching, mentorship and/or outreach)
Davide Bergamaschi, Raine Ikagawa

UA CALES Online Course Design Bootcamp Award
Davide Bergamaschi, Raine Ikagawa et al.

Scholarship to attend "Trees in the Desert" workshop, Tucson, AZ
Davide Bergamaschi

Research awards
Research grant from T&E, Inc.
Raine Ikagawa

UA BRIDGES Summer Research Experience Award
Zoe Jensen

Presentation awards
Entomological Society of America
Meagan Ash, 2nd place oral presentation, Genetics; Raine Ikagawa, 1st place oral presentation, Systematics and Evolutionary Biology; Mara Short, 1st place poster, Medical, Urban and Vector Entomology; Liam Sullivan, 2nd place oral presentation Award, Systematics and Evolutionary Biology

Travel Awards
UA Graduate Interdisciplinary Programs Herbert E. Carter Travel Award
Davide Bergamaschi (twice), Isadora Bordini, Megan Deeter, Raine Ikagawa, Liam Sullivan, Edwin Umanzor

UA Graduate and Professional Student Council Travel Award
Davide Bergamaschi, Edwin Umanzor

Gordon Research Conference in Animal Microbe Symbiosis, Carl Storm Travel Fellowship
Edwin Umanzor

4. National Rankings from Academic Analytics. Fig. D3 shows the percentile for UA Entomology relative to 36 U.S. entomology departments and programs for 22 metrics reported by Academic Analytics. We highlight eight of these metrics that indicate per capita productivity rather than department size (i.e., number of faculty). The focal eight metrics (with years covered by Academic Analytics) are the percentage of faculty that contributed and the output per faculty for each of four categories: articles published (2018-2021), awards (years not specified), citations and federal grants (both 2017-2021; Table D4).

Fig. D3. Academic Analytics percentile for 22 metrics for UA Entomology relative to 36 entomology departments and programs in the U.S. (50% is the median, 100% indicates #1 ranking).

For six of the eight Academic Analytics metrics indicating per capita productivity, UA Entomology was in the top 86th percentile or higher (% of faculty with articles, awards, citations, and grants; and awards and federal grant dollars per faculty). We were in the top 51st percentile for articles per faculty and 59th percentile for citations per faculty (Table D4). Based on these eight metrics, the median percentile for UA is the 95th percentile and the median rank is #3 nationally (Table D4).

Based on the Scholarly Research Index (SRI) derived from the private algorithm of Academic Analytics, UA Entomology was in the 76th percentile and ranked #10 nationally. Relative to peer departments at six other public universities, the UA SRI ranking was below University of Illinois (#1), University of California, Davis (#4), and Colorado State University (#6); and above University of California, Riverside (#15), Purdue University (#16), and Washington State University (#26) (Table D5).

Table D4. UA Entomology articles, awards, citations, and grants from Academic Analytics*

Productivity metric	Value	Percentile**	Rank**
Faculty with articles (%)	100%	100	1
Articles per faculty	12.4	51	19
Faculty with awards (%)	75%	95	3
Awards per faculty	1.8	95	3
Faculty with citations (%)	100%	100	1
Citations per faculty	217	59	16
Faculty with federal grants (%)	69%	86	6
Federal grant $ per faculty	$373,491	95	3
Median***	NA	95	3
Scholarly research index****	0.2 (Z-score)	76	10

*Data years: articles: 2018-2021, awards: varies, citations and grants: 2017-2021
**Among 36 entomology departments and programs in the U.S.
***Calculated from the eight metrics listed
****From Academic Analytics based on their private algorithm

Table D5. National ranks from Academic Analytics for UA & six peer entomology departments (U. Illinois, UC Davis, Colorado State U., UC Riverside, Purdue U., and Washington State U.)*

Productivity metric	U. Illinois	UCD	CSU	UA	UCR	Purdue	WSU
Faculty with articles (%)	1	1	1	1	1	22	24
Articles per faculty	2	1	11	19	16	17	28
Faculty with awards (%)	2	10	13	3	4	32	20
Awards per faculty	1	4	12	3	7	30	22
Faculty with citations (%)	1	1	1	1	1	24	25
Citations per faculty	5	1	4	16	12	20	30
Faculty with federal grants (%)	1	4	13	6	17	7	29
Federal grant $ per faculty	7	9	18	3	19	11	12
Median rank**	1.5	2.5	11.5	3.0	9.5	21.0	24.5
Scholarly research index***	1	4	6	10	15	16	26

*Rank among 36 entomology departments and programs in the U.S. based on coverage of these years from Academic Analytics: articles: 2018-2021, awards: varies, citations and grants: 2017-2021
**Calculated from the eight metrics listed
***From Academic Analytics based on their private algorithm

SECTION E: FACULTY

1. Nature and Breadth of Research and Extension

Entomology faculty generate knowledge about insects that advances fundamental science and has applications that improve the quality of life of the people of Arizona and the world. Significant contributions that advance the discipline have been reported in hundreds of publications in leading journals, including 21 publications from 2016 to July 7, 2023 in journals that have an impact factor >10 (Table D1). Recognition of this excellence includes more than 100 awards received by faculty, including 34 national and international awards (Table D2). Areas of entomology where major advances have been made include integrated pest management, management of pest resistance to insecticides and transgenic pest-killing crops, biology and management of insect vectors of disease; insect behavior, ecology, evolution, genetics, genomics, microbiomes, physiology, symbioses, and systematics; as well as host-parasitoid interactions, insect-plant interactions, and insects as food.

As one example of our impact (see Section J for many others), a team of Entomology faculty and staff was instrumental in a collaborative program with farmers, industry, and government that eradicated the invasive cotton pest pink bollworm from the U.S. and Mexico. This innovative program used environmentally friendly tactics including a synergistic combination of mass releases of sterile moths and genetically engineered cotton that produces bacterial proteins lethal to some pests but safe for non-target organisms including people. Contributions of the Entomology team included computer simulation modeling to evaluate potential outcomes of different management strategies as well as discovery and tracking of pink bollworm mutations that confer resistance to the transgenic cotton. This landmark success helped to reduce insecticide use 82% overall in cotton in Arizona and saved U.S. growers $192 million from 2014 to 2019, as reported in our multi-authored paper featured on the cover of *PNAS* in 2021 (Appendix D1).

2. Current Grants

Appendix D2 lists the principal investigator, title, source, and duration of 24 Entomology grants and contracts for $7.9 million awarded in FY2023 (July 1, 2022 to June 30, 2023). Federal agencies are the primary funding source, accounting for 96% of the grants and contracts awarded in FY23 (Appendix D2). Federal funding sources in FY2023 include the Centers for Disease Control and Prevention (CDC), NIH, NSF, U.S. Department of Housing and Urban Development (HUD), and USDA (Appendix D2). The remaining sources of grants and contracts in FY2023 are State agencies (2%) and industry (2%).

3. Leadership in Professional Service

Many Entomology faculty serve in leadership roles in the profession of Entomology. Thirty-six examples of service on grant review panels and in journal editorial roles (2016-2023) are listed below (Table E1).

Table E1. Entomology faculty service on grant panels & journal editorial roles (2016-2023).

Grant Panels

Yves Carrière: USDA Crop Protection and Quarantine (2020), USDA Biotechnology Risk Assessment Grants Program (2021)

Goggy Davidowitz: NSF Biology Integration Institute (2020)

Molly Hunter: NSF Population and Community Ecology (2016), USDA Pests and Beneficial Species (2017)

Luciano Matzkin: NSF Animal Behavior (2017), USDA Pests and Beneficial Species (2022), NSF Enabling Discovery through Genomics (2023)

Wendy Moore: NSF Phylogenetic Systematics (2017), NSF Advancing Digitization of Biological Research Collections (2019)

Michael Riehle: NIH panels (2016, 2018, 2020), NIH Tropical Medicine Research Centers (2021), NIH Co-Chair Special Emphasis Review Panel (2022)

Todd Schlenke: NSF Organismal Response to Climate Change (2023), NIH: Centers of Biomedical Research Excellence (2020), NIH Biological Materials Resource Centers (2018) NSF Symbiosis, Defense, and Self-recognition (2016).

Editorial Roles at Journals

Yves Carrière: Co-editor, special collection in *Journal of Economic Entomology*, Global perspectives on field-evolved resistance to transgenic Bt crops (2018-2023)

Goggy Davidowitz: Associate Editor, *Functional Ecology* (2009-2018), Guest editor, special issue in *Current Opinion in Insect Science* on Edible Insects for Food and Feed (2021)

Dawn Gouge: Editorial Board member, *Journal of Integrated Pest Management* (2011-present)

Xianchun Li: Editorial Board Member, *Insects* (2021-present), *Scientific Reports* (2012-present), *Journal of Insect Science* (2012-2021)

Luciano Matzkin: Associate Editor, *Ecology and Evolution* (2018-present), Editorial Board Member, *Communications Biology* (2018-present)

John Palumbo: *Arthropod Management Tests*, Editorial Board Member (2018-present)

Michael Riehle: Review editor, *Frontiers in Physiology* (2021-present), Editorial Board Member, *Insects* (2019-present), *Insect Biochemistry and Molecular Biology* (2017-present)

Todd Schlenke: Handling editor, *eLife* (2018)

Bruce Tabashnik: Lead editor, special collection in *Journal of Economic Entomology*, Global perspectives on field-evolved resistance to transgenic Bt crops (2018-2023), Guest Editor, *PNAS* (2021), Editorial Board Member, *Insect Science* (2023).

Kathleen Walker, Subject editor, *Annals of the Entomological Society of America* (2023-)

4. Teaching

a. Courses taught and teaching loads.

Thirteen Entomology faculty are currently responsible for teaching courses in person and online (Table E2). In accord with CALES guidelines, the standard teaching load is a mean of 1 hour of course credit delivery per year for every 5% instructional responsibility. For tenure-track faculty with the standard 15% Instructional FTE (Table A1), this translates to one 3-credit course taught per year. Both of our Professors of Practice (Lanan and McKnight) have the equivalent of 75% Instructional FTE (90% Instruction times 0.833 total FTE, Table A1), which translates to five 3-credit courses taught per year. New tenure-track faculty are not responsible for teaching courses during their first year to enable them to establish their research programs. As described in Section G.3.b, we increased instructional efficiency by frequently delivering two popular General Education courses (ENTO 160 and 170).

Table E2. Courses taught by Entomology core faculty

Number*	Title	Faculty instructor(s)**
160***	Busy Bees & Fancy Fleas: How Insects Shaped Human History	Lanan, McKnight, Schlenke
165***	Edible Insects: The Food of the Future is Already Here	Davidowitz
170***	Secrets of Success: How Insects Conquered Earth!	Hunter, Lanan, Matzkin, McKnight
297	Discovering Biodiversity (prefix is CALS)	Moore
300	Insect Pest Management for Desert Cropping Systems	Palumbo
401/501	Ecological Physiology	Davidowitz
407	Insect Discovery	Walker
415/515	Insect Biology	Walker & Moore
417/517	Insect Systematics	Moore
432/532	Comparative Immunology	Schlenke
436/536	Agro-ecology	Carrière & Walker
457/557	Medical-Veterinary Entomology	Riehle
468/568	Integrated Pest Management	Xianchun Li
553****	Evolutionary & Functional Genomics	Matzkin
544	Insect Ecology	Carrière
596	Entomology Graduate Seminar	Various faculty

* < 500 is for undergraduate courses (ENTO or CALS) and > 500 for graduate courses (EIS)
** Commas indicate different offerings taught by different faculty; & indicates co-taught courses;
in addition to core faculty teaching listed above, Associate in Extension Dr. Shujuan Li has taught online summer courses.
***General Education courses, 165 will be offered for the first time in Fall 2024
****Co-taught 2017, 2018 & 2020 with EEB faculty member (50%) who retired, will not be offered in the future

b. Quality of teaching. The high quality of teaching by Entomology faculty is reflected in the overall mean student evaluation scores of 92% (range: 90 to 96% among the four categories evaluated) for undergraduate courses and 95% (range: 89 to 100%) for graduate courses based on Student Course Survey evaluations of courses taught from Spring 2020 to Spring 2023 (Fig. E1). For each of the two to four survey items for each of the four categories, the score can range from 0 to 100% (best).

For each of the four categories evaluated, the mean score was higher for courses taught by Entomology faculty than for courses taught by these four related units: the Department of Ecology & Evolutionary Biology (EEB) in the College of Science and three units from CALES (the Department of Environmental Science (ENVS) and the Schools of Animal & Comparative Biomedical Sciences (ACBS) and Renewable Natural Resources & the Environment (SNRE)) (Fig. E2). The UA Instructional Data team indicated they could not provide us with the college-wide or university-wide comparative data we requested.

Peer reviews of teaching conducted by senior faculty also indicate consistently strong teaching. We first assess teaching quality when recruiting for faculty positions that have instructional responsibilities, including a teaching presentation and discussion during interviews of finalists. Teaching is evaluated every year by the Peer Review Committee and Department Head as part of the annual performance review and by the Promotion and Tenure Committee and Department Head for promotion and tenure reviews (Appendix E1). We promote improvement in teaching via this feedback and by encouraging faculty to participate in Faculty Learning Communities (FLCs).

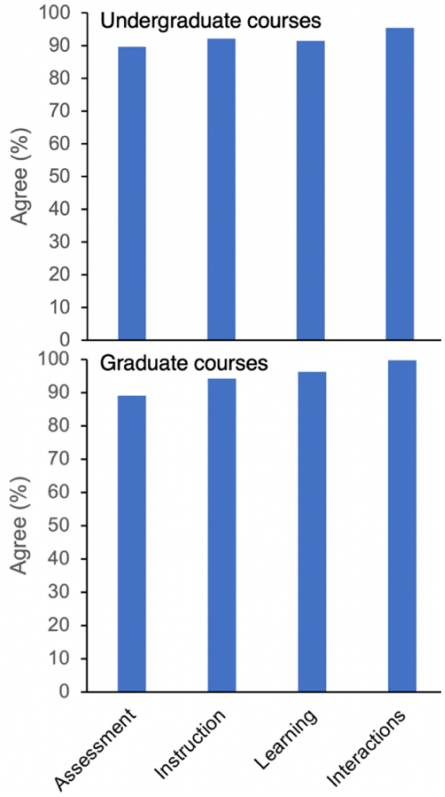


Fig. E1. Student evaluations of courses taught by Entomology faculty from Spring 2020 to Spring 2023. Bars indicate the mean percentage of respondents to Student Course Surveys who agree or strongly agree with two to four positive statements for each of the four categories shown on the x-axis. Each score can range from 0 to 100% (best). The overall mean for the four categories is 92% (range: 90 to 96%) for undergraduate courses and 95% (range: 89 to 100%) for graduate courses. 40 undergraduate courses were evaluated with 2,011 enrolled and 835 survey respondents. 22 graduate courses were evaluated with 213 enrolled and 124 survey respondents. See Appendices E2-E4 for details.

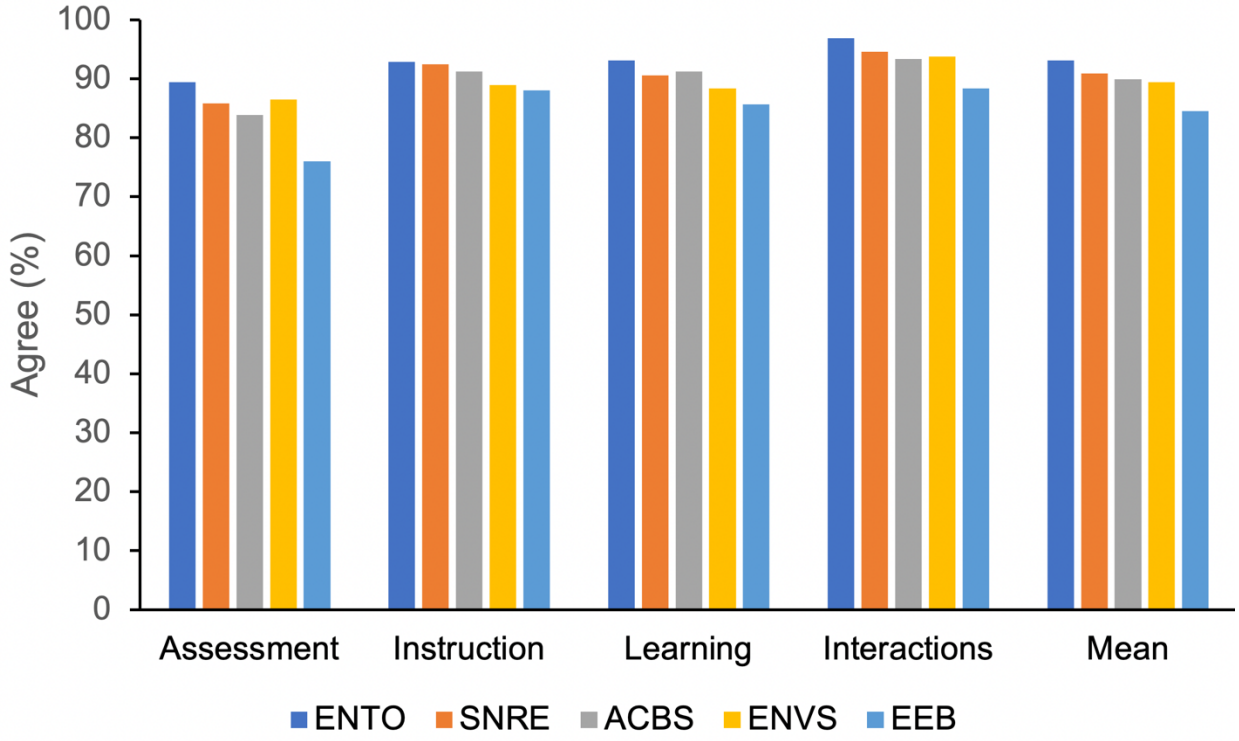


Fig. E2. Student evaluations of courses taught by Entomology faculty and by four related units. Bars indicate the mean percentage of respondents to Student Course Surveys who agree or strongly agree with two to four positive statements for each of the four categories shown on the x-axis. Each score can range from 0 to 100% (best). The scores for each unit are means based on data pooled from undergraduate and graduate courses from Spring 2020 to Spring 2023. The bars at the far right above "Mean" show the mean of the score of the four categories for each unit. Based on pairwise comparisons between ENTO and each of the four other units, the mean scores across the four categories were significantly higher for ENTO than for each of the other units (four paired t-tests, df = 3 for each test, $P = 0.045$ vs. SNRE, $P = 0.037$ vs. ACBS, $P = 0.003$ vs. ENVS, and $P = 0.017$ vs. EEB).

5. Faculty Recruiting

From July 2016 to August 2023, seven Entomology core faculty were hired, one retired, one resigned, and five were promoted (Table E3). Also, two Associate Professors are being evaluated now for potential promotion in 2024. The core faculty hired since June 2016 are two Associate Professors, Todd Schlenke (2016) and Luciano Matzkin (2017); one Associate Specialist, Al Fournier (2018), two Assistant Professors of Practice, Tristan McKnight (2019) and Michele Lanan (2022); and two Assistant Professors, Natasha Tigreros (2023) and Paulina Maldonado-Ruiz (2023) (Table E4). Since 2016, two core faculty departed for the following reasons: one resigned to accept a position as Dean at California State University, Chico (Patricia Stock, 2021) and one retired (Diana Wheeler, 2019).

We now have 17 core faculty versus 14 in June 2016. We anticipate a total of 19 in the near future with Dr. Maldonado-Ruiz starting in January 2024 and a May 2024 start date projected for a new hire we are currently recruiting as Assistant Specialist in Extension to be stationed at the Yuma Agricultural Center. If we succeed as expected in hiring this Extension Specialist, we will have hired four new faculty in about two years (2 per year), which is triple the rate of faculty hiring in the previous six years (0.67 per year; Table E3). The hiring of seven faculty from 2016 to 2023 (0.9 per year) is triple the rate for the previous decade (3 hired from 2006 to 2015 = 0.3 per year).

Hiring an additional Assistant Professor of Practice could be warranted if our new course in Edible Insects (ENTO 165) attracts sufficient enrollment. It is under evaluation as a General Education course and slated to be taught first in Fall 2024. We might also consider hiring an additional faculty member in Extension in the next few years to meet the urgent needs of stakeholders in Arizona. However, CALES has paused tenure-track faculty recruiting because of budget constraints. Moreover, we do not expect to have the resources to hire additional tenure-track faculty in the next year or two. Currently, Entomology must pay 65% of the startup cost for new faculty members, which recently has been an investment of ca. $400,000 to $500,000 of department funds per tenure-track faculty member. Future directions in hiring will be influenced by the contributions and ideas of new faculty members as well as retirements. Restoration of the contribution to startup from UA central administration would facilitate the hiring needed to fill gaps created with 5 to 7 retirements of senior faculty (mostly tenured faculty) expected in the next 5 years.

We have obtained resources for faculty hiring using all available means, including one hire supported by the UA Strategic Priorities Faculty Initiative (SPFI) and two hires supported by the GIDP-Shared Hiring Process (formerly known as the GIDP-Partnered Hire), as noted in Section C. We will continue to seek all resources available for faculty recruiting and hiring. We are currently pursuing a UA President's Postdoctoral Fellowship for a promising candidate. According to the program's website, "The University of Arizona views these presidential postdoctoral fellowships as an exceptional opportunity to recruit potential new faculty to the University whose research, teaching, and service will contribute to the diversity and equal opportunity at UArizona."

Table E3. Entomology core faculty at all ranks hired, retired, resigned, and promoted (2016-2023). All faculty evaluated for promotion were promoted.

Year	Hired	Retired	Resigned	Promoted
2016	1	0	0	2
2017	1	0	0	1
2018	1	0	0	1
2019	1	1	0	1
2020	0	0	0	0
2021	0	0	1	0
2022	1	0	0	0
2023	2**	0	0	0*

*Two Associate Professors are being evaluated now for potential promotion in 2024.
**Dr. Paulina Maldonado-Ruiz was hired in 2023, will start in 2024.

6. Faculty Compensation

Table E4. Entomology annual faculty salaries by rank.

Universities	Assistant		Associate		Full	
	n	Mean	n	Mean	n	Mean
UA	4	89,887	5	109,839	8	125,730*
ESA 2021**	35	91,300	17	95,561	42	122,236*
ESA 2023***	35	95,922	17	100,399	42	128,424*
Peer mean	19	95,310	16	116,945	42	182,234
Peer 1		86,802		99,175		162,270
Peer 2		93,176		108,440		134,047
Peer 3		94,206		130,471		183,628
Peer 4		101,074		114,390		230,354
Peer 5		101,293		132,250		200,872

***** Excludes Department Head/Chair
** Data from Entomological Society of America (ESA) survey based on 2021 salaries.
*** ESA 2021 salaries multiplied by 1.05 (equivalent to 2.5% increase per year)

Methods and notes: The annual salaries above are base salaries that do not include amounts faculty pay themselves using grants or other sources. The mean salaries above are from pooled data for academic year salaries (9 months) and calendar year salaries. UA salaries are as of August 21, 2023. Peer salaries were provided by peer departments at public universities during July 2023. The set of five peers for this analysis are similar but not identical to the five peers in Section D because some peers identified in Section D did not provide salary data. Peers are labeled 1-5 and sample sizes are not given for each peer because a subset of the peers that provided salary data asked to not be identified. The sample sizes for Peer mean are based on only four of the peers because one of the peers did not provide sample sizes. The cost of living for Tucson is 1.04 versus a mean of 1.15 for the cities of the five peer universities according to Sperling Best Places (https://www.bestplaces.net/).

7. Faculty Gender and Race/Ethnicity

Although women and Latinos tend to be underrepresented in STEM disciplines such as entomology, four of our last five faculty hires identify as female, Latinx, or both. We have succeeded in recruiting diverse faculty by creating a welcoming, collegial, and inclusive work environment, and by advertising widely. We have also benefited from the UA Strategic Priorities Faculty Initiative (SPFI), which enhances the University's distinctive strengths in advancing inclusive excellence. Of the 18 core Entomology faculty, 39% identify as female, 6% as Asian, and 17% as Latinx (Table E5).

Table E5. Gender and race/ethnicity of core Entomology faculty.

	Number	Percentage
Gender		
Female	7	39%
Male	11	61%
Race/ethnicity		
Asian	1	6%
Latinx	3	17%
White, not Latinx	14	78%

8. Curriculum Vitae

Appendix E5 provides one-page CVs for each of the 18 core Entomology faculty that include recent publications, other notable scholarly work, honors, awards, and synergistic contributions.

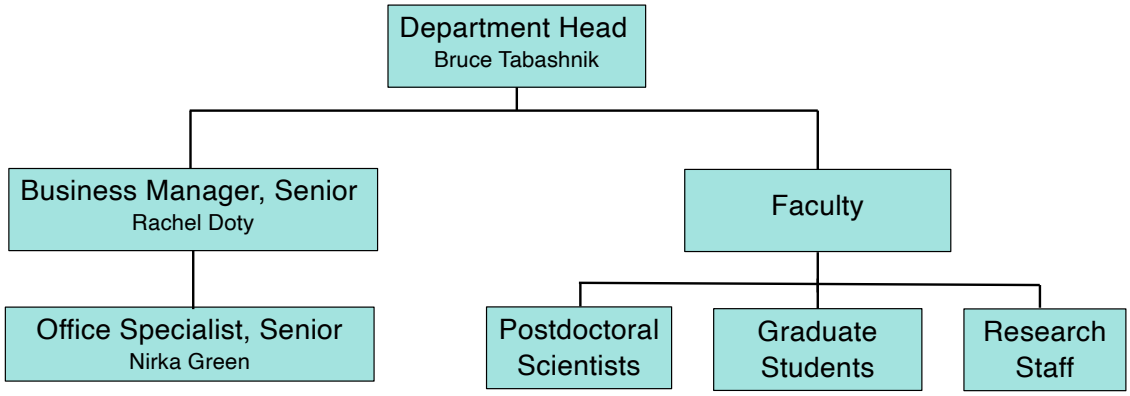
SECTION F: UNIT ADMINISTRATION

Department of Entomology

1. Governance and organization

The Department Head provides administrative leadership for the unit. Administrative decisions are made by the Head following appropriate consultation with faculty, staff, and students. Faculty votes on major issues. Although votes are not binding, the Head's decisions virtually always align with the majority. Routine faculty meetings of about one hour are held monthly during the academic year. Special faculty meetings are scheduled as needed to deal with critical issues, such as choosing among finalists for faculty hiring. Faculty and non-voting representatives of the graduate students and staff attend faculty meetings. The Head supervises the faculty who supervise postdoctoral scientists, graduate students, and research staff (Fig. F1). The Head supervises the Business Manager, Sr. (Rachel Doty) who supervises the Office Specialist, Senior (Nirka Green) (Fig. F1).

Figure F1. Department of Entomology organization chart



Committees that evaluate faculty for promotion and tenure or continuing appointment (the equivalent of tenure for Extension faculty) are composed of all faculty above the rank of the faculty member being evaluated, excluding any who have a conflict of interest with the candidate. Annual evaluations of all faculty (including the Department Head) are performed by the Peer Review Committee, consisting of four tenure-track faculty and two continuing-track faculty (excluding the Department Head) chosen by the Department Head to serve 2-year terms in accord with the policy approved by a unanimous vote of the faculty.

2. Staff

The 42 Entomology staff members consist of two administrative staff (Fig. F1), one IT staff member (0.2 FTE), and 39 research and Extension staff (Appendix F1). The 39 research and Extension staff include 6 Assistants in Extension (5 of which have a PhD), 12 Research Technicians, and 5 Research/Laboratory Aides (Appendix F1).

3. Gender and race/ethnicity of Entomology staff

Table F1. Gender and race/ethnicity of Entomology staff.

	Number	Percentage
Gender		
Female	13	33%
Male	26	67%
Race/ethnicity		
Asian	2	5%
Latinx	11	28%
White, not Latinx	26	67%

4. Adequacy of staff support

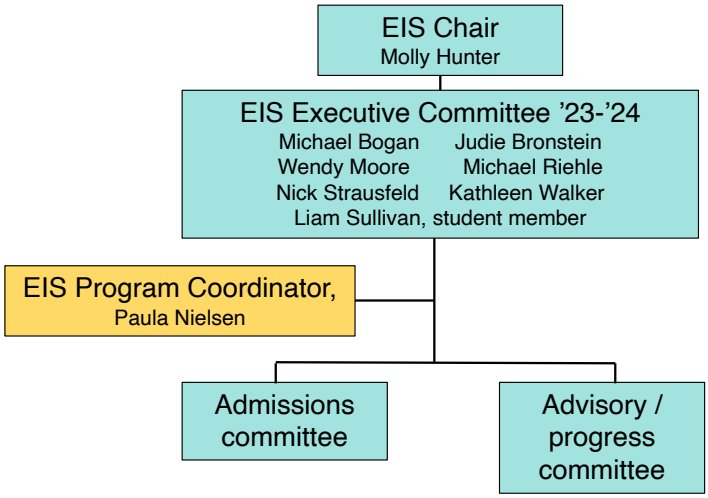
With the FY2023 surge in grants and the concomitant increase in administrative work for the next few years, we need to increase Entomology's administrative staff support. We need at least 2.25 FTE and currently have 1.75 FTE (Rachel Doty, Business Manager, Sr. 1.0 and Nirka Green, Office Specialist, Sr., 0.75). For additional details, please see Section G.2.

EIS GIDP Administration

5. Governance and organization

The EIS GIDP reports to the GIDP Administration and the Dean of the Graduate College through its Chair. EIS obtains financial support from the Graduate College (GC) for operations, for a program coordinator, and for student tuition and stipend support. EIS also receives financial support from the College of Agriculture, Life Sciences, and the Environment (CALES) for student tuition, stipends, and teaching assistantship support. While CALES has no formal authority over or obligation to EIS, the College recognizes that EIS students are largely advised by Dept. of Entomology faculty and has supported us accordingly, albeit at a lower rate than CALES programs to adjust for EIS GC support.

Fig. F2. Organizational structure of the EIS program. For an overview of how EIS fits into UA generally, see Appendix A2.



The Executive Committee (EC) of the GIDP is charged with administration of the academic program (See Appendix F2 for EIS Bylaws). A half-time Graduate Program Coordinator assists the Chair and EC, currently Paula Nielsen. The EC consists of six faculty members plus the Chair, all of whom are elected to staggered, renewable three-year terms by the GIDP faculty. In addition, there is one student representative to the EC, with a one-year non-renewable term. In EIS, the balance between Entomology core faculty and faculty with primary appointments in other units is maintained by the stipulation in the by-laws that three EC members are from Entomology core faculty, and three are drawn from faculty with primary appointments in other units. Each year two EC members and the student member rotate off. The election process includes a nomination period in which nominations for Chair, EC members and the student member are first solicited and forwarded to the EIS Program Coordinator. Faculty members nominate and vote for the faculty Chair and EC members, while students nominate and elect the student member. Elections are conducted using an anonymous online tool such as Survey Monkey conducted by the Program Coordinator, where email addresses of all eligible voters are submitted. The results of the election are then forwarded from the Coordinator to the Chair, who notifies the Dean of the Graduate College. EIS EC and EIS Chair appointments must be approved by the Dean of the Graduate College.

EIS has two standing committees. The Advisory or Progress Committee is charged with overseeing graduate student progress. This committee meets annually to read and evaluate all graduate students' annual progress reports. Each student gets a letter from the committee, commending them on progress and suggesting things to take care of or consider. The committee evaluation allows faculty overview of common student obstacles and may suggest solutions, or policy changes. For example, in 2023 an observation of frequent delays on comprehensive exams prompted discussion of either a shorter format dissertation proposal, or a more formal assignment of comprehensive exams to all students in a certain semester. These thoughts will be discussed at our next EC meeting. The Advisory Committee may also identify students who are not making progress and communicate with the student and advisor to better understand how to help the student advance. For more detail on mentoring and annual progress reports, please see I.3.d.iii.

The Admissions Committee is responsible for coordinating the recruitment and admission of graduate students. After the admissions deadline on Dec. 1, potential major advisors for applicants are contacted for feedback on candidates. The Admissions Committee evaluates the applicants and meets to draw up an interview list. All domestic candidates are brought to campus, usually in late January or early February for a 1.5-day interview process. Candidates meet with members of the admissions committee, students, and postdocs in the laboratories of their potential advisor(s), and with potential advisors. A pizza lunch is provided on the second day for applicants and the community, and a casual reception and light dinner is provided at the house of the Chair on the second day for applicants, EIS students and faculty. The Admissions Committee then meets to evaluate the candidates and discuss priority acceptances given limited funding. One or two students may be placed on a wait list if they are strong applicants but not as competitive as the highest priority candidates. An effort is made to distribute accepted students into several laboratories, and if all else is equal, we prioritize PhD candidates over MS students. This is not

because of candidate quality or any limits to career opportunities but simply because the CALES formula for GRA support is based on PhD admissions.

Appointment to these two committees by the Chair has been a casual process, typically drawn from the Executive Committee and from the faculty and USDA associates. In recent years, the Chair has served on both committees and the student EC representative participates on the Admissions Committee. In general, EIS faculty are generously willing to serve on one or the other of these committees.

The responsibilities of the EIS Executive Committee and Chair are explained in the by-laws (Appendix F2).

6. Current Administration of EIS

Chair: Molly Hunter
2022-2023 Executive Committee (EC), with term expiration dates: Molly Hunter, Professor, Entomology (2024); Mike Riehle, Professor, Entomology (2025); Nick Strausfeld, Professor, Neuroscience (2024); Judie Bronstein, Professor, Ecology & Evolutionary Biology (2026), Michael Bogan, Associate Professor, School of Natural Resources and the Environment (2025); Wendy Moore, Associate Professor, Entomology (2024); Kathleen Walker, Associate Professor, Entomology (2026), Liam Sullivan, EIS student representative (2024).

2023 Advisory Committee: Molly Hunter (Chair); Wendy Moore (EC member); Mike Riehle (EC member), Luciano Matzkin (GIDP faculty), Vanessa Corby-Harris (USDA scientist and EIS associate).

2023 Admissions Committee: Molly Hunter (Chair), Michael Bogan, Michael Riehle, Kathleen Walker, and Meagan Ash EIS student representative.

7. EIS staff

We have one staff person associated with the program, Paula Nielsen, who is a Program Coordinator. Her position as EIS Program Coordinator is half-time (0.5 FTE). This level of staff-support is adequate, primarily because Paula is efficient and proactive. The program coordinator position is hugely varied, and includes events organization and publicity, website maintenance, working with the chair on student funding, providing logistical support for both major EIS committees, including travel and funding for student recruitment, among many other tasks. Paula has been very active recently as a member of the Self Study Committee, preparing figures and analysis. Perhaps most importantly, Paula provides individual attention and support for students throughout their program, registering students for research, thesis and dissertation and providing support and advice whenever asked. She is housed in the Marley building where many faculty and students are housed, works entirely in the office, and maintains an open-door policy every morning from 9 am to 1 pm.

SECTION G. RESOURCES: SUPPORT PERSONNEL AND INFRASTRUCTURE

Department of Entomology

1. Current support personnel

As noted in Section F.2, 42 Entomology staff consisting of 39 research and Extension staff, two administrative staff, and one IT staff member (0.20 FTE in Entomology) provide support services (Fig. F1 and Appendix F1). Nearly all of the research and Extension staff are paid partially or entirely by extramural funding. Accordingly, their work focuses on the objectives specified in the relevant grants, contracts, and gifts. One notable exception is Mr. Wesley ("Gene") Hall. He is paid with State funding via CALES and provides substantial general support services for the department in addition to his contributions to Insect Diagnostic services and as Manager of the UA Insect Collection (see Section J). Gene is the building manager for the Forbes building, which houses personnel from CALES administration, Entomology, and other CALES units. He was absolutely essential in providing logistical support for all personnel in Forbes during the pandemic and continues in that role now.

2. Support personnel needs

As noted in Section F.2: With the FY2023 surge in grants and the concomitant increase in administrative work for the next few years, we need to increase Entomology's administrative staff support. We need 2.25 FTE and currently have 1.75 FTE (Rachel Doty, Business Manager, Sr. 1.0 and Nirka Green, Office Specialist, Sr., 0.75). In early July 2023, Ms. Doty discussed this need with Janis Rutherford, CALES Assistant Dean, Finance and Administration. Ms. Rutherford encouraged us to formally request funding for the additional 0.50 position from CALES, implicitly recognizing that the cost of this position is not covered by the additional indirect cost return to Entomology generated by the surge in grants or by transfer of accounts to Entomology of faculty stationed at the Maricopa and Yuma Agricultural Centers (MAC and YAC, see below). However, on July 11, 2023, Jeffrey Ratje, ALVSCE Senior Associate Vice President, Finance and Administration, paused the posting of all staff positions (and all non-Extension faculty positions) funded by CALES. He indicated this "extraordinary step" was taken because the UA central administration did not approve the requested Strategic Budget Allocation and "CALES must reduce its expenditures by a significant sum this year."

3. Changes that increased efficiency

The Department of Entomology made remarkable progress in increasing efficiency since the 2009 Academic Program Review, particularly in administration and delivery of undergraduate courses.

a. Administration. For Entomology administrative staff, the current 1.75 FTE is less than half of the 4 FTE in 2009. The administrative staff functions more effectively now than before, despite this 56% reduction in FTE and substantial increases in the administrative workload. Relative to 2008 (the last year included in the 2009 Entomology APR), extramural funding awarded to Entomology in funding tripled in FY2023; adjusted for inflation (42%), it still more than doubled. Relative to 2009, we now have 21% more core faculty. Moreover, accounts for four core

Entomology faculty at the MAC and YAC previously handled by administrative staff at those sites (not Entomology employees) are now handled by the Entomology administrative staff on the UA campus in Tucson. Overall, the number of faculty supported by the Entomology office staff has increased by 80% (from 10 to 18) since 2009. We have also implemented a new Undergraduate Minor in Entomology and an Undergraduate Certificate in Entomology & Insect Science, as well as dramatically increasing undergraduate enrollment in our courses. Furthermore, the administrative burden has grown for all programs because of heightened compliance requirements mandated by the government and the University.

The key factor enabling the department's tremendously increased efficiency is the stellar performance of Rachel Doty, Business Manager, Senior. She was hired as Business Manager at 0.75 FTE in 2021 and was soon promoted to Business Manager, Senior at 1.0 FTE. Paula Nielsen, the EIS GIDP Program Coordinator (a position funded by the Graduate College), now administers the graduate program. This has relieved the Department of Entomology of some of the administrative work that had been associated with the Entomology graduate program before the merger with the Insect Science GIDP in 2010 to create the EIS GIDP. However, ENTO still does the hiring for Graduate Research Assistant and Graduate Teaching Assistant positions for the EIS program and manages the funding for the subset of these positions that are funded by CALES. This requires close coordination between the two units, facilitated by the cooperation and capability of Rachel Doty (ENTO) and Paula Nielsen (EIS).

We also note that in 2014, CALES began providing pre-award grant support to Entomology from Contracts & Grants Manager Fatemah Dili. Her excellent work streamlined our grant submissions, freeing us up to focus on the intellectual work as deadlines approached. However, she left her CALES position in August 2023 to work for another university. Her departure and the concomitant retirement of her supervisor Parker Antin, CALES Associate Dean for Research, have created considerable uncertainty and concern.

b. Undergraduate courses. Entomology markedly increased teaching efficiency, enrollment in our undergraduate courses, and the associated revenue by developing and frequently delivering two popular General Education courses (ENTO 160 Busy Bees and Fancy Fleas: How Insects Shaped Human History and ENTO 170 Secrets of Success: How Insects Conquered Earth!). We now offer both of these courses in several modes online and in person during every Fall and Spring semester as well as during several of UA's many Summer sessions. Hiring Entomology's two Assistant Professors of Practice (McKnight in 2019 and Lanan in 2023) made it possible to increase the frequency of offering sections of these General Education courses about 10-fold, from one per year to about 10 per year. Data provided by CALES show a 113% increase in ENTO teaching revenue in FY2022 relative to FY2016, despite the 9% college-wide decrease in teaching revenue over the same period.

Because CALES shares teaching revenue with academic units, the increased enrollment dramatically improved Entomology's financial resources. This was instrumental for Entomology's commitment to contribute over $800,000 to startup funds for two tenure-track Assistant Professor we successfully recruited in 2023 (Tigreros and Maldonado-Ruiz). Primarily because of the success of our two General Education courses, Entomology has recently ranked in the top two or

three of the ten academic units in CALES in student credit hours (SCH) delivered per instructional faculty FTE.

Because of Entomology's strategy to focus on General Education courses and our lack of an undergraduate major, the percentage of SCH accounted for by General Education courses has been highest for Entomology among the 10 academic units in CALES. This was intentional, in part because SCH in General Education courses largely determined the allocation of graduate teaching assistantships (GTAs) among graduate programs by CALES for many years. However, CALES abruptly changed this policy in 2022 to allocate GTAs based on all SCH equally rather than preferentially for SCH in General Education courses. This change cut the CALES funding for GTAs generated by Entomology from this source by ca. 60%. The impact of this cut has been exacerbated by increases in the mandated minimum stipends for EIS students (see I.3.c).

4. Projected changes with additional resources

Wendy Moore, Associate Professor of Entomology, received a grant of $200,000 for 2023-2024 from the UA Provost's Investment Fund (PIF) for her project "Engaging Students in Specimen-based Research on Arizona's Insects of Importance to Agriculture, Human Health, and Natural Areas." This will provide funding to support some undergraduate and graduate students and to renovate our classroom (Forbes 412) as well as some of the space (Forbes 409) recently acquired from CALES to expand the University of Arizona Insect Collection (UAIC).

This project aims to permanently increase the capacity for ENTO faculty to teach undergraduates to make insect collections and conduct research on them, through Vertically Integrated Projects (VIPs) and courses, including Course-based Undergraduate Research Experiences (CUREs). Acquiring high-resolution images and raw DNA sequences will enhance our ability to offer undergraduates authentic research experiences without charging a course fee or compromising data integrity. Renovations of Forbes 409 will transform the old lab space into a safe, modern wet lab for interactive hands-on learning and research through VIPs and CUREs. Renovations of Forbes 412 will allow us to optimally tailor the configuration of desks and chairs for each course, seminar, or other use, including social distancing or arrangements to facilitate collaborative learning. Renovations will also allow us to stream our courses to remote learners, enabling us to dramatically increase enrollment.

A staff outreach coordinator at 0.5 FTE is an additional resource that would provide potent synergy between major community impact and education of graduate and undergraduate students. The coordinator would organize the Insect Festival and Insect Discovery (see J.1 and J.2), as well as collaborate with the ALVSCE development office to increase donor support for these programs, the Department of Entomology, and the EIS GIDP. The outreach coordinator would organize the logistics for the Insect Festival, a single-day event that attracts thousands of children and their families annually. The coordinator would also administer and participate in the Insect Discovery Cooperative Extension program that serves thousands of elementary schoolchildren and their teachers every year. The coordinator would provide continuity that cannot be achieved by graduate students, thereby enabling faculty members to focus on the design and educational impact of these wildly successful outreach programs.

Entomology & Insect Science GIDP

5a. Support personnel

The Graduate College (GC) supports the administration of EIS through a 0.5 FTE Program Coordinator, Ms. Paula Nielsen, housed in the Department of Entomology (Marley 641G), and centrally from GIDP Administrator, Alicia Lopez, who oversees and supports the administration of all the 22 GIDPs. The program coordinator has a long list of duties that span organization of events, web site, administration of admissions, daily email and in-person support for current and prospective students, assessment of learning outcomes, allocation of GC funds to incoming and current students, and updating the handbook. These activities all take place against the backdrop of constantly changing university computer systems that aim to increase efficiency but often have a steep learning curve. Ms. Nielsen does all these things capably and cheerfully and has retrieved several students from bureaucratic quagmires with patience and persistence. We have no need for further support personnel currently.

5b. EIS budget

EIS receives funding from two sources, the GC and CALES. Funding from the GC includes operations support, salary support (for the program coordinator), stipend support for the GIDP Chair and student support in three different flavors: cash (can be used for current students or incoming students), GC fellowship funds (for student support but student cannot be asked to work), and tuition-only funds (GC Tuition funds or GTS; Table G1). In addition, the GC houses the Hagedorn speaker endowment, produced by a fundraising effort in memory of a beloved faculty member, Henry Hagedorn. This yields approximately $1000 annually and allows the EIS students to invite an annual speaker of their choice for the fall seminar series. The GC will also pay half of the salary for two years for Entomology's new tenure-track assistant professor Dr. Paulina Maldonado-Ruiz via the GIDP Shared Hire Program. She is scheduled to start her position in January 2024 and will be a member of the EIS GIDP faculty.

Table G1. 2023-2024 EIS budget from the Graduate College

Type of funding	Amount
Salary support program coordinator, 0.5 FTE (salary+ ERE)	$44,205
EIS Chair stipend (stipend + ERE)	$15,840
Operations (recruiting and other)	$10,000
Graduate Assistantship funding	$70,000*
Graduate Fellowship	$15,000
Graduate Tuition Scholarship (for tuition awards only)	$35,000
Total	**$148,386**

*This includes a historical allocation of $35,000 annually (funding allocated since the start of the EIS GIDP, increased from $30,000 and set to expire in 2024), and $35,000 additional funds.

Most EIS students are mentored by faculty in the Department of Entomology (which is in CALES) and accordingly, CALES funds EIS students. Relative to graduate programs that are entirely within CALES, first year support from CALES for GAs is half for EIS, in recognition of the funding EIS receives from the GC.

Table G2. 2023-2024 CALES funding for EIS graduate students in the Department of Entomology.

Type of funding	Amount
Assistantship support (principally meant for incoming student first year support)	$38,171*
TA support (generated by ENTO teaching and used for current student TAs)	$29,505*
Graduate Fellowship	$13,000
Responsibility Center Waiver (for tuition awards only, equivalent for us to Graduate Tuition Scholarship, above)	$18,162
Total	**$98,838**

***** These CALES fund amounts include tuition and ERE. This means these CALES funds go farther than the GC Assistantship support above. For example, one year of student support at current rates is $31,467 of these CALES funds (because tuition and ERE are included) and ~$47,000 of GC funds (from which tuition and ERE must also be deducted).

The number of students that we can support for first year funding and TAs within our control has declined by a minimum of 1.9 to a maximum of 2.9 student years of stipend support since 2014 Table G3. This is two to three students per year we can no longer offer either first year funding or a TA in the Department of Entomology annually. Less critically, our capacity for tuition support has also eroded, dropping from 7.5 student years of tuition to 3.9 student years Table G3. Because most of our students are on RAs or TAs, the tuition funding is generally more than enough. In 2023-2024, however, with one student self-funding and several others fully employed, we have used all our tuition budget and have none left for the spring semester.

Table G3. EIS student costs (stipend and in-state tuition) and funding from all sources in 2014 (last EIS APR) versus 2023.

	2014-2015	2023-2024
Student costs		
Stipend rate	$22,000	$31,467
In-state tuition rate	$10,581	$13,600
Stipend funding		
Cash funds for student support (tuition and ERE must also be paid from this)	$30,000 (0.9 of a student year)	$70,000 (0.74 – 1.5 student years)
State funds (includes tuition and ERE)	$28,250 (1.3 student years)	$67,676 (TA and assistantship funds) (2.1 student years)
CALS allocated TAships	1 per semester (1 student year)	NA (TA funds in cell above)
Fellowship funds	$31,100 (1.4 student years)	$28,000 (0.89 student years)
GIDP supported TA positions 2-4 semesters annually (includes tuition & ERE)	$22,000-$44,000 (1-2 student years)	Funds for GAs in first cell above
Approximate student years of stipend funding	5.6 – 6.6 student years depending on no. of TAships allocated by GC	3.7 – 4.5 student years depending on whether the one-year allocation of carry forward funds are included
Decline in stipend in student years from 2014-2017	1.9 – 2.9 student years	
Tuition funding		
Tuition only funds	$80,000	$53,162
Approximate student years of tuition support	7.5	3.9
Decline in tuition support in student years	3.6 years	

We are grateful for the financial support from the GC and CALES, especially because we understand the current constraints on their budgets. We are increasingly concerned, however, that substantially increased costs to support EIS students have not been fully matched by increased support. This will make it more difficult to provide stellar candidates with first year funding, and to provide our students with high impact TAs that teach science communication strategies and foster

scientific literacy in the target audience. Also, many EIS students have been supported as TAs for courses in the College of Science. We expect challenges in addressing gaps in funding from that source in 2024 and beyond.

6. EIS Resource needs

Our greatest resource need is for support for student assistantships (recruiting research assistantships and TAships and fellowship funds) that are controlled by the EIS program (please see budget details above in Tables G1 – G3). While we are proud of our record of keeping our students funded throughout their studies (Tables I3 and I5), the lack of program control over most of the TAships that support our students (especially in Introductory Biology labs in courses offered by the College of Science), creates uncertainty each semester. Until this year, the 1-2 TAs allocated from the GC per semester to our program were a great help for this problem, and the one-year extra allocation of $35,000 extra funds from the GC this year, while very welcome, is less than one student year of support. The GC and CALES are supporting us as much as they can. With additional TA support from the UA central administration, we could have an outsized impact on graduate student education, community engagement, and K-12 scientific literacy.

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With a long-term commitment of two TAs per semester, we could a) hard-wire support for Insect Discovery, one of UAs most impactful outreach programs for scientific literacy of elementary school students in Tucson schools (see J.2), b) provide many EIS students with immersive, hands-on training in scientific communication with lay audiences, and c) reduce the threat of funding gaps for our students.

7. Program efficiency

EIS Program Coordinator roles and communication with the EIS Program Chair. Our Program Coordinator, Paula Nielsen, plays an active role in monitoring student progress and supporting students throughout their program. She follows each student's progress, resolves registration and GradPath and bursar statement problems, schedules monthly lunch seminars for the students and plans program events. She answers emails promptly and handles administrative issues as they arise. She also helps organize the EIS Admissions and Advisory Committees, oversees all steps of the recruiting season, arranges travel for recruits, and helps with offer letters.

We believe communication between the Program Chair and Coordinator is essential. The Chair and Coordinator currently have offices across the hall from each other, are in almost daily contact, and meet informally several times per week, and over coffee when a planning meeting is needed.

We are working more efficiently because Ms. Nielsen has now been in her position for 2.5 years and has accumulated institutional knowledge (in contrast to three one-year tenures of previous coordinators, two ending with a family move, and one ending with retirement). We also benefit by Ms. Nielsen's commitment to having a physical presence on campus and open-door policy; this is very helpful for students who regularly drop in to iron out problems.

8. Projected changes in EIS activities and quality outcomes if additional resources were available

Two TAships available each semester would be used to create predictable long-term TA support for Insect Discovery, and in concert with the addition of a half-time outreach coordinator (G.4), would provide some assurance that this wildly popular and impactful community outreach program would endure beyond the career of the one faculty member keeping it afloat, Dr. Kathleen Walker. EIS student TAs for Insect Discovery are immersed in teaching scientific concepts to 3000 elementary school children annually and in supporting that experience for undergraduates (see J.2), an experience that many report as one of the most meaningful in their college career. Dr. Walker has applied to numerous sources in Tucson and beyond for Insect Discovery funding over the last fifteen years and has not been successful.

We would also use one semester of TA support in alternate years (one of eight in a 2-year cycle) for a TA for the foundational, required EIS course in Insect Systematics (ENTO 417/EIS 517). This course has intense laboratory and field components as students grapple with the evolution and immense diversity of the most speciose animals on earth. With enrollment of ~20, this course does not generate enough student credit hours to garner a TA through regular channels yet is perhaps the course EIS and upper-level undergraduate students value most.

SECTION H: ENTOMOLOGY UNDERGRADUATE MINOR AND CERTIFICATE

The Department of Entomology does not offer an undergraduate major, but recently established an undergraduate minor and a certificate program. The CIP code is 26.0702 for both programs. As noted in Section A, 10 students are currently enrolled in the Entomology minor. We expect larger enrollment as awareness of this new program grows, especially considering the enthusiasm of our current students. Four students have completed the Undergraduate Certificate in Entomology and one is in progress.

As noted in Section C: In 2021, we established a 12-unit Undergraduate Certificate in Entomology that offers a flexible course of study students can tailor to their own interests (Appendix C1) https://cals.arizona.edu/ento/content/undergraduate-certificate-entomology-and-insect-science

In 2022, we established an 18-unit Undergraduate Minor in Entomology to provide students with advanced education and skills in insect-related fields to be competitive for employment in agricultural and biotech industries as well as for graduate programs in disciplines such as Entomology, Public Health, Environmental Sciences, Epidemiology, Biology, and Ecology (Appendix C1). https://cals.arizona.edu/ento/content/undergraduate-certificate-entomology-and-insect-science/minor

In addition to the Undergraduate Minor and Certificate programs noted above, more than 60 undergraduates are engaged in research projects conducted by Entomology faculty.

SECTION I. GRADUATE STUDENTS, DEGREE PROGRAMS, AND OUTCOMES

I.1. Degree programs

The EIS GIDP is an interdisciplinary graduate program with a focus on insects. The CIP (Classification of Instructional Programs) code is 26.0702 for Entomology. Entomology is described as "a program that focuses on the scientific study of insect species and populations in respect of their life cycles, morphology, genetics, physiology, ecology, taxonomy, population dynamics, and environmental and economic impacts." Our students span the basic/applied spectrum and also levels of biological organization – from genetic and genomic (and metagenomic) studies to physiological studies to population, community ecology and spatial ecology. Students often incorporate approaches combining techniques and questions from across the biological hierarchy.

EIS offers Master's and Doctoral Degrees. The program is flexible in its requirements, allowing students to design, in collaboration with faculty across campus, programs of study tailored to individual interests and needs. We particularly seek out creative, enthusiastic applicants who have multidisciplinary interests. For example, combinations of interests include insect ecology–plant chemistry, behavioral ecology–neurobiology, pest management–spatial ecology, epidemiology of vector-borne disease–climate science, and systematics–metagenomics. We encourage students to develop cross-disciplinary connections and bring together aspects of insect biology in unconventional ways.

All students must take two of three required courses (see major requirements below), and some units of graduate seminar (two semesters for MS students, four for PhD students). In addition, PhD students must complete two research rotations (potentially in one semester), at least one of which must be outside of the advisor's laboratory.

I.2. Curriculum and courses

PhD program

The majority of current our students are pursuing doctoral degrees (in August of 2023, 17 of 26 students, 65%). **Requirements for PhD:** 36 units of coursework are required by the Graduate College. EIS program requirements include two of three core courses: EIS 517 Insect Systematics, EIS 544 Insect Ecology, and EIS 520 Insect Systems Biology and four semesters of the graduate seminar EIS 596A (offered for two and three units in fall and spring, respectively). In addition, PhD students must complete two research rotations, potentially in one semester, at least one of which must be outside of the advisor's laboratory. Students completing research rotations enroll in EIS 792. At least 22 of the units in the major and minor must be letter-graded courses (not research or independent study units).

EIS PhD students are required to complete a minor in an area other than EIS. Recent students have minored in Ecology & Evolutionary Biology, Neuroscience GIDP, Biosystems Engineering

(including Metagenomics), Geography (including GIS), Ecosystem Genomics GIDP, among others. Students choose one graduate committee member with the appropriate affiliation to represent the minor and to approve the student's coursework in the minor.

Minor requirements for PhD: Most programs require nine units of coursework in the minor discipline to earn a minor in the field, but a few programs may require up to 15 units for completion of a minor in their department/program. **Dissertation Units:** At least 18 units of dissertation research are required.

MS program

For the MS program, 32 units of coursework are required. Like PhD students, MS students must take two of the three core courses, but take just 2 semesters of EIS 596A Current topics in Entomology and Insect Science (Seminar), typically in their first year. At least 15 of the 32 units must be letter-graded courses (not research or independent study units). **Thesis Units:** At least 8 of the 32 units must be thesis research units.

Table I1. Current EIS courses, including courses cross-listed in EIS.

No.	Course title	Instructor	Dept. of Instructor
501	Ecological Physiology	Davidowitz	Entomology
503C	Intro to Computational Neuroscience	Fellous	Psychology
503L	Parasitology Laboratory	Cooper	Anim & Comp Biomed Sci
503R	Biology of Animal Parasites	Cooper	Anim & Comp Biomed Sci
505	Aquatic Entomology	Bogan	School of Natural Resources & Envt
512A	Biological Electron Microscopy	Staff	Physiology
513	Applied Biostatistics	Staff	School of Natural Resources & Envt
515R	Insect Biology	Walker / Moore	Entomology
517	Insect Systematics	Moore	Entomology
520	Insect Systems Biology	Riehle / Li / Gronenberg	Entomology, Neuroscience
532	Comparative Immunology	Schlenke	Entomology
536	Agroecology	Walker / Carrière	Entomology

544	Insect Ecology	Carrière	Entomology
553	Functional and Evolutionary Genomics	Staff	Ecol & Evol Biol
557	Medical & Veterinary Entomology	Riehle	Entomology
567	Pollination Ecology	Dornhaus	Ecol & Evol Biol
568	Integrated Pest Management	Li	Entomology
588	Principles of Cellular and Molecular Neurobiology	Zinsmaier	Neuroscience
597C	Controlled Environment Agriculture & IPM	Hooks	Biosystems Engineering
660	Infectious Disease Epidemiology	Ernst	Epidem & Biostat
596A	EIS seminar. Topics change with semester. The current skills and research support series: Fall: reading primary literature and presenting, Spring: proposal writing	Davidowitz (fall) Hunter (spring)	Entomology
792	Methods in Entomology (Research rotations)	EIS faculty	various
593/693	Internship	EIS faculty	various
599/699	Independent Study	EIS faculty	various
900	Research	EIS faculty	various
909	Master's report	EIS faculty	various
910	Master's thesis	EIS faculty	various
920	Dissertation	EIS faculty	various

I.2.a. *Do EIS graduate students in undergraduate/graduate co-convened courses do extra work?* **Yes.** Some of the graduate EIS courses are co-convened with undergraduate courses in the Department of Entomology (e.g., ENTO 401/EIS 501). The graduate students in such courses have additional assignments relative to the undergraduates. For example, in EIS 536 Agroecology, the graduate students have an extra assignment worth 20% of the grade. In EIS 517 Insect Systematics, graduate students curate a more diverse insect collection, have extra exam questions, and do an in-class presentation. In EIS 532 Comparative Immunology, graduate students make a presentation

and write a grant proposal. Lastly, in EIS 557 Medical and Veterinary Entomology, grads do a literature review and present a topic for the class.

I.2.b. *Are learning outcomes consistent across sections?* **Yes.** One EIS course is online (Integrated Pest Management), and the others are in person. All courses are taught as a single section so there is one set of learning outcomes for each course.

I.2.c. *Are courses in the program sufficient and balanced across specialties to meet student needs and interests?* **Yes.** As a GIDP, we require a minimum set of foundational courses, enhanced with courses that ignite or broaden interests across disciplines (EIS prefix or not) and additional specialist courses after students choose an area of concentration (EIS prefix or not). EIS 517 Insect Systematics and EIS 544 Insect Ecology rotate as the fall classroom course. Incoming students take one of these (and the other the following year) as well as the EIS seminar. Foundational content is balanced with elective additional courses (Table I2). Cohort-building experiences in shared courses are balanced with interdisciplinary exploration.

Table I2. Courses from other programs that current EIS students have taken recently. This list shows the breadth of disciplines and interests of our students as well as the rise of data science and computational analyses.

No.	Course title	Dept. of Instructor
BE 534	Biosystems analytics (Python for data analysis)	Biosystems Engineering
BE 587	Metagenomics	Biosystems Engineering
BIOS 576A	Biostatistics in public health	Epidemiology & Biostatistics
BIOS 576B	Biostatistics for research	Epidemiology & Biostatistics
ECOL 596W	Special topics in Ecology and Evolution: Practical and reproducible data science	Ecology & Evolutionary Biology
ECOL 530	Conservation genetics	School of Natural Resources & the Environment
ECOL 528R	Microbial genetics	School of Plant Sciences
ECOL 506R	Conservation biology	Ecology & Evolutionary Biology
ECOL 519	Introduction to modeling in biology	Ecology & Evolutionary Biology
ECOL 526	Population genetics	Ecology & Evolutionary Biology

ECOL 587R	Animal behavior	Ecology & Evolutionary Biology
ECOL 600B	Fundamentals of ecology	Ecology & Evolutionary Biology
ENVS 567	Introductory statistics and multivariate statistics with R	Environmental Science
EPID 573A	Basic principles of epidemiology	Epidemiology & Biostatistics
PLP 550	Principles of plant microbiology	School of Plant Sciences
NRSC 572	Neurodevelopment in action	Neuroscience

Currently EIS 520 Insect Systems Biology, the third EIS core course, focusing on molecular biology, neurobiology, and physiology, has not been offered in several years, largely because enough students have not signed up for it to be taught. Now, retirement of one of the instructors, Dr. Wulfila Gronenberg, in spring 2024 necessitates a new approach. In the meantime, students with interests in molecular biology, neurobiology and physiology have been taking other courses (e.g., BE 587 Metagenomics, EIS 501 Physiological Ecology, EIS 532 Comparative Immunology, and others, Tables I1 and I2). Please also see Section L *EIS Policy changes and retreat*.

PhD students also do research rotations in their first year. Two are required and one can be in the laboratory of one's advisor. Since the last APR, a discussion at a retreat resulted in rotations being formalized to make them no more than 8 weeks, to prevent open-ended expectations from enthusiastic faculty from keeping students at a project beyond their utility for the students. Before the pandemic, students customarily performed three rotations, but since the onset of the pandemic two have been more common.

I.2.d. *Does the program employ active-learning strategies?* **Yes.** Our graduate classes inculcate active discussion, hands-on activities such as collection and curation of an insect collection for EIS 517, Insect Systematics, and independent reading, presentation and writing. Even more consequentially, both MS and PhD programs in EIS center around an original piece of research (a thesis or dissertation) that is entirely active learning, with classroom and non-classroom components. Guided by their advisor outside the classroom and in the fall semester seminar course, the students learn to read the literature critically and independently. They formulate an original research question that will move a field forward or address a critical applied problem in agriculture or public health. In the spring 'proposal writing' seminar and outside the classroom, students develop their research proposal. They learn what is feasible based on reading, discussion, experiments, observations, and feedback from peers, instructors, and advisors. Beyond the classroom, students work closely with their advisor and other faculty members on their graduate committee to execute their research, analyze it, and write it up for publication.

I.2.e. *Is instructional technology used in program courses?* **Yes.** Our graduate courses employ D2L for content delivery. Some use it to receive student assignments and post assignments for peer review. Additionally, Zoom was used heavily in 2020-2021, and is still used for our one online course (EIS 568 Insect Pest Management). Podcasts and/or YouTube assignments have been made. Most learning in our program occurs in person, in conversation among students, between students and faculty, and in hands-on experimentation in the field or laboratory. We believe frequent, positive personal interactions builds trust and facilitates graduate learning and growth.

I.2.f. *Are online courses available for program requirements?* **Yes.** *Do you offer or plan to offer any online graduate programs?* **No.** Most of our courses are designed for our graduate students on campus. However, one course, EIS 568 Insect Pest Management, includes EIS students but is aimed towards a much broader audience across Arizona and beyond. It is a self-paced online course, thus making it available to working people in a variety of industries. Non-campus students for EIS 568 include Extension personnel and those who want to be a licensed pest control agent, greenhouse or nursery manager, as well as farm workers, children of growers, and community college students.

In general, while many EIS faculty engage in online teaching for undergraduate instruction, we believe the program mission for EIS is best accomplished by faculty-student and student-peer interactions in classrooms, laboratories and in the field. Further, the development of a thesis or dissertation relies on close faculty mentorship of in-person laboratory or field research.

I.2.g. *Are adequate resources available for graduate students to carry out their studies?* **Generally, yes**. Office and laboratory space as well as supplies for our students are generally adequate. Students may have desks in laboratories or in separate offices as well as assigned laboratory benches. Office and research supplies are generally provided by the advisor and supported by grants. Students may also apply for small research grants through the Graduate and Professional Student Council or from extramural sources. Our students benefit greatly from the UA library's excellent loan program for infrequent office needs such as laptops and cameras (https://lib.arizona.edu/visit/tech) as well as from site licenses for software (e.g., Microsoft Office, Adobe Creative Cloud, Endnote, and Geneious for DNA sequence analysis).

We encourage our students to attend national and international conferences to present their research. Twenty-two of our current 26 students have given 64 presentations (see I.3.e). Student travel is supported by a variety of sources. Faculty grants support travel and the GIDP Administration in the Graduate College offers travel grants (Herbert Carter) that have often been awarded to our students (Table D3), generally $600 awards. EIS has also supplemented travel funding for students who are unsuccessful in a Carter application. Lastly, the UA Graduate and Professional Student Council also provides travel grants. It is less clear, however, whether our students are unconstrained by travel funding; some faculty do not have extramural funding and small on-campus travel grant amounts have not increased over several years. An informal poll of students by the student member of the self-study committee found that students find it difficult to

piece enough funding together for conference attendance and are choosing closer conferences over more distant ones.

I.2.h. *What proportion of EIS PhD students take courses or complete minors in other disciplines?* EIS PhD students are required to complete a minor outside EIS. See I.1 above for examples of minor disciplines our students have chosen. *What about PhD students from other disciplines taking courses or completing a minor in your program?* Our graduate offerings often have students from other disciplines taking them, sometimes as many as EIS students. Eight students from other disciplines have minored in EIS since 2014.

I.2.i. *Provide the link to an electronic copy of your graduate student handbook*. The EIS GIDP graduate student handbook has been recently revised and updated (Appendix I1)**.** It was reviewed by the Dianne Horgan, Senior Consultant for Graduate Education and she approved it, commended it and suggested it as a model to Senior Associate GC Dean of Academic Affairs, Dr. Pitts.

I.3. Graduate Students

I.3.a. *Describe mechanisms used to recruit students*. *Compare the quality of students in this (these) graduate program(s) with students in other similar programs and the quality since the last APR review (based on GREs, GPAs, or other admissions criteria).* In general, Entomology & Insect Science applicants find our program or particular members of our faculty. We have observed they are not applying widely to other biology programs, although they may be applying to Entomology programs nationally and may have a public health, ecology or molecular biology background. When faculty receive an inquiry from candidates, they generally correspond and perhaps arrange a Zoom meeting prior to the application due date. Once candidates apply, we evaluate them based on a) GPA and course preparedness, b) a personal statement showing maturity and a reasoned motive for graduate study, c) overlap of research interests with one or more faculty in the program, and d) letters of reference providing detailed assessment of the applicant's readiness and motivation for graduate study. We have dropped GRE scores as an application requirement (see I.1.b below). We have and will always lose students to programs that guarantee more years of stipend support via research assistantships. However, our students are excellent, hardworking, and self-motivated and this has not changed since our last APR. They are also caring, team players, and conscientious and effective teachers. Many are teaching assistants for multiple semesters, and we repeatedly receive unprompted testimonials from both the Introductory Biology Laboratory directors (MCB 181 and ECOL 182) about the high quality of our program's students.

We have no quantitative way to assess the quality of our students versus other programs or our own past students. We find GPA, although useful, not helpful as a sole predictor of graduate student success, in part because some of our students are older and their youthful self in college does not represent them well as applicants. Conversely, a graduate program requires creativity and adaptability that may not be captured by stellar course performance alone. However, we have a consistently high retention rate **(**Table I5**)** and our alumni find employment that matches their interests and training in our program at an extraordinary rate (Table I6).

I.3.b *Provide data on gender and race/ethnicity composition of the current graduate students with majors in the unit.* EIS is relatively gender-balanced with approximately 50% of our 26 students

female or non-binary, continuing a trend of approximate gender parity since Fall 2015 (Fig. I1). We note that these data may not capture our current cohort of students perfectly. Some of our students prefer they/them pronouns and may decline to identify as male or female.

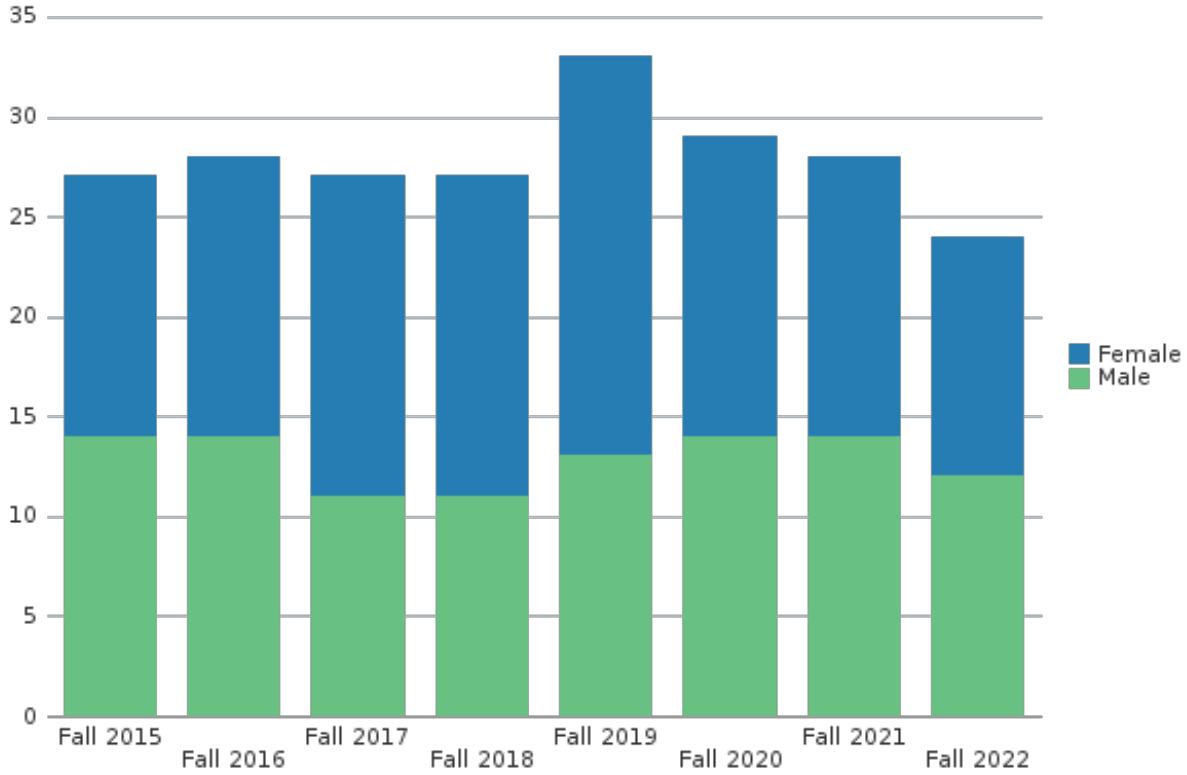


Fig. I1. Gender representation in EIS GIDP 2015 to 2022 (from UA Analytics).

EIS has also become slightly more diverse in ethnic and racial composition in recent years (Fig. I2), with students in 2022 identifying as "white" only slightly greater than 50%. As discussed in Section C, response to recommendation 5, EIS made a concerted effort to increase outreach to underrepresented groups with extensive advertising on recommended listservs following the last APR for EIS in 2014. Ultimately it is unclear what effect that had. Things have changed considerably since 2014, however, and it may be a good time to re-engage with the Office for Diversity and Inclusion to extend our outreach. Perhaps a more influential decision of ours than listserv advertising was to drop the requirement of GREs for applications. Besides published evidence that suggested GREs were weak predictors of graduate student success, some of our reading suggested these exams provide obstacles that discourage applications from first generation college students and students from underrepresented groups.

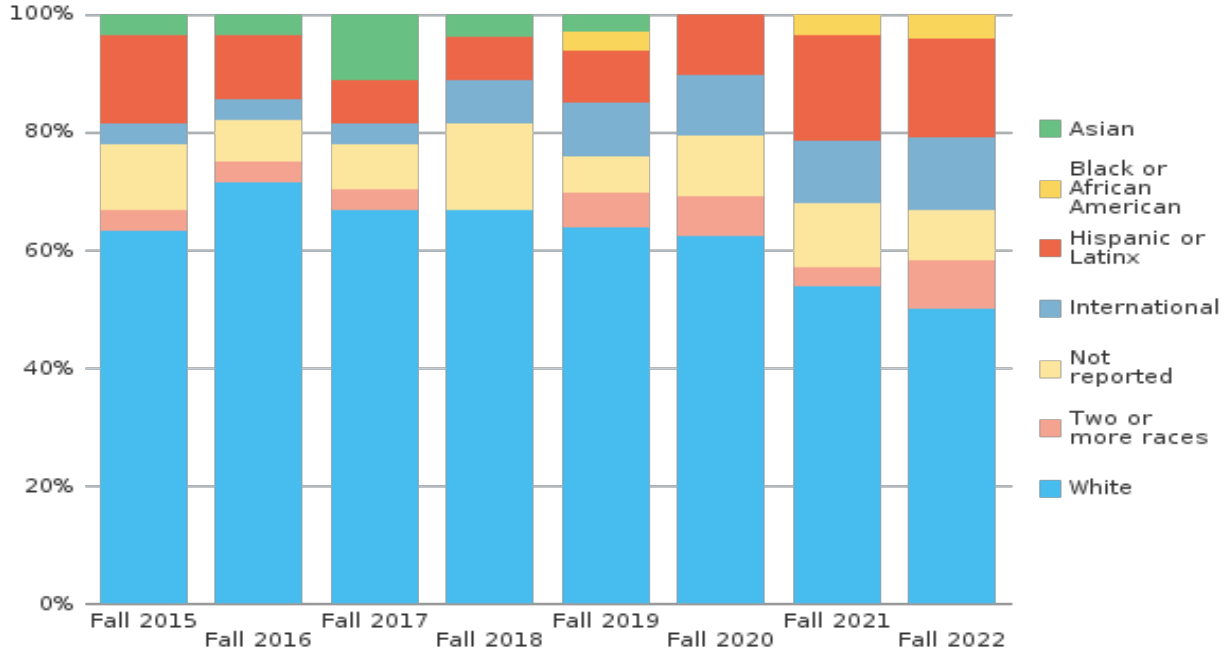


Fig. 1.2 Ethnic and racial representation in EIS GIDP 2015 to 2022 (from UA Analytics).

I.3.c. *Comment on the number and adequacy of the stipends and assistantships. In addressing this, indicate the percentage of graduate students in the program(s) that have a teaching or research assistantship; the salary range of stipends for half-time research assistantships and teaching assistantships.*

Both MS and PhD student in EIS are generally supported with stipends throughout their program, via first year EIS program funds (usually 2-3 offered per year), TAs, RAs funded from faculty grants or fellowships to the student, full-time employment (e.g., for UA Extension, USDA ARS Carl Hayden Bee Laboratory, USDA APHIS; Table I3). Rarely a student matriculates without a stipend offered, or is without a stipend in their finishing semesters, especially if they have moved from Tucson. In these last cases, and for full-time employees outside the UA system, we use allocated tuition funds to pay in-state tuition and health insurance for students without a stipend. Our success in attracting excellent students is dependent on our ability to match students with TAs when they need them, and although most of these TAs are not within our control (e.g., Intro Biology laboratory courses in the College of Science), and are variable in number from semester to semester, we have had a near perfect rate of success of keeping our students funded. A qualitative overview of the variety of funding typical in a full student career can be seen in Table I5.

Table I3. Fall 2023 funding of EIS MS and PhD students

First year RA funding (EIS or CALES)	TAship*	Student fellowship	Faculty supported RA	Full time employment	Self-funding#	Total
2	8	3	4	7	2	26
7%	30%	15%	15%	26%	7%	100%

*This semester 7/8 students are TAing for Molecular & Cell Biology (MCB) 181, Introductory Biology Laboratory. The last is a TA for ENTO 160.
#One MS student matriculated without a stipend. The other is completing her MS writing after relocating outside of Tucson. Both are receiving tuition support.

All of our current students are receiving full tuition remission as a result of being an RA or TA or on a fellowship (17 of 26) or are being paid tuition from EIS or CALES tuition funds (GTS or RC Waivers) for the self-funding students and those employed outside of the UA system (7 of 26), or have tuition paid by UA Qualified Tuition Reduction plan for full-time UA employees (2 of 26).

In the past year, the EIS annual 12-month stipend (0.5 FTE) increased from $24,500, slightly above the Graduate College minimum, to $31,467 for 2023-2024. This was mandated by CALES. A spring 2022 memo states: “effective July 1, 2022, all [CALES] graduate students on assistantships will be paid at an annual rate that exceeds the highest average rate being offered by any peer university within their discipline.” A task force that did not include EIS faculty analyzed peer stipends in different disciplines in 11 institutions and determined that EIS students should receive $31,467 over a 12-month period to exceed peer rates, the third highest rate of 11 programs affiliated with CALES.

The response of the EIS and ENTO leadership was to celebrate the fact that all our students would be paid at a rate that would relieve their financial hardship due to rising housing and food costs in Tucson. However, this new mandate has put EIS and ENTO in a financial bind that is unresolved. Our faculty are writing the new stipend rates into grant proposals, and when grants are funded, students with such an RA will be paid appropriately. However, at any one time approximately 1/3 of our students are supported on TAs from the College of Science (Introductory Biology laboratory sections, Table G3), and the semester rate in 2023-2024 is approximately $11,000. Therefore, students who TA in both the spring and fall semesters will need to be paid $9500 in the summer to meet the annual 12-month stipend of $31,467. We will ask the advisor to pay such shortfalls for each student when grant funds are available. The surge in grants in FY2023 (Section D) will be somewhat helpful in dealing with this, particularly for grants that include graduate student support. EIS and ENTO will contribute as much as possible, but this is a new financial liability for both entities. It is not clear how this will work given the modest budget of EIS (Tables G1, G2) and the many commitments for Department of Entomology funds, including faculty start-up ($812,500 for two recent hires and recruiting underway for a third hire) and a projected payback to CALES of

$735,000 in FY2024 in addition to the payback to CALES of $188,000 in FY2023. Although a reader might question why a CALES mandate would apply to a GIDP, we greatly appreciate the student funding from CALES and do our best to comply with CALES policies. Lastly, despite what we perceive as stiff logistical challenges to meet this new standard, we think the mandated stipend is fair, we just need to determine a way to implement it sustainably. Each spring we plan to tally the amount paid to each student from TAs and RAs and calculate the shortfall from our standard rate. This will be paid to the student as supplemental compensation, from all possible sources.

I.3.d.i. *Comment on the average ratio of student/faculty thesis and dissertation supervision in each graduate program since the last APR and compare to other programs in this discipline.* The number of EIS MS and PhD students has varied between ~25-30 since the last APR. Currently, our 26 students are in 13 different laboratories. Twenty-two of the 26 are mentored among 10 core ENTO faculty laboratories, three are mentored by USDA scientists and co-advised by UA faculty, and one is in an Ecology & Evolutionary Biology laboratory. Our enrollment is limited by the number of applicants we can offer recruitment first year funds to, our promise to find stipend funding to students after their first year (often in TAs), and the number of spots and potential funding for new students in popular laboratories. In general, however, we believe we are about the right size for the number of qualified applicants we receive, and the number of employment opportunities available.

Table I4. Students, faculty and student/faculty ratios at UA and other entomology departments.

	UA	UC Davis	Wisconsin	UC Riverside	Washington State	Texas A&M
MS	9	5	--	5	10	10
PhD	17	24	--	37	20	44
Total	26	29	27	42	30	54
Faculty*	25	24	11	24	20	24
Student/ faculty ratio	1.0	1.2	2.5	1.8	1.5	2.2

*For UA this is all active EIS faculty members (in ENTO and other units); for other universities this is faculty members in entomology.

When we compare our numbers of students per faculty member (Table I4), the ratio depends on what faculty are included. While any EIS faculty member can serve as major advisor of an EIS student, faculty in units other than ENTO are more likely to participate in EIS via graduate committee membership and teaching, because they are more likely to be major advisor of students in their own departments. At UA, if all 25 active EIS faculty are included, the ratio of students/faculty is 1.0, whereas including only the 13 ENTO faculty who are active EIS members the ratio is 2.0. Interestingly, peer institutions fall within this range or just outside.

I.3.d.ii. *Summarize information from exit interviews in your programs.* Exit interviews are an opportunity for the EIS Chair to speak informally to recent graduates and to invite comment on the strengths and challenges of navigating the EIS program, to learn about their future directions, and what they wished they'd known when entering the program. In general, graduates identify as strengths: the social cohesion of the students, the accessibility of faculty and the program coordinator, and the supportive climate of the program. One graduate spoke highly of the outreach opportunities she took advantage of, including Insect Discovery, the Insect Festival, UA Science Sky School (http://skyschool.arizona.edu/), opportunities at Biosphere 2 (https://biosphere2.org/), and various BioBlitzes.

Challenges included sudden immersions in academic culture new to them, for example the protocols for hosting and introducing a seminar speaker. Another student mentioned that as the first in his family to attend college, he did not know initially that he could step down from a PhD to a MS (although eventually he did) and would have appreciated more exposure to different careers available to graduates. This is clearly something we can implement and will look for a few possible opportunities to do this (e.g., invitations to alumni to talk to the group at program lunches in person or via Zoom).

A substantive change to the program emerged from an exit interview with one 2017 PhD graduate. He said he would have welcomed a formal structure to support his dissertation planning. He said he was told not to worry and so found himself 18 months in without much of an idea about what his dissertation would be about. After some thought, we revamped the fall and spring seminar classes that all students take. Now students read, present, and discuss the scientific literature relating to their thesis or dissertation project in the fall seminar and work on writing a proposal in the following spring semester. PhD students do this series twice but value a second pass at more reading and a proposal that was rough in the first year and more cohesive in the second. This structure has been in place for four years. In a 2023 summer exit interview, one MS graduate said that the spring seminar was especially helpful because by writing and peer editing others' proposals, he gained insight into the writing process and into the strengths and weaknesses of his own writing.

I.3.d.iii. *Describe your unit's mentoring practices, including graduate students' annual Individual Development Plan conversations with mentors and support for employment goals in multiple career pathways.* Faculty mentorship in our unit generally includes weekly or alternate week individual meetings with students in their laboratory, as well as group laboratory meetings, practice talks, research retreats and other activities. Students are encouraged to visit the program coordinator to learn about upcoming milestones in GradPath, the online Graduate College for plans of study, committee appointments, comprehensive exam planning etc. The program coordinator and the chair both have an open-door policy. We have not implemented Individual Development Plans formally, although some of the self-reflection in these is represented by progress reports and advisor mentoring.

The GC has recently enhanced resources for professional development, including mentoring workshops for students and faculty, fellowship writing workshops, one-on-one writing mentoring, and career planning resources. EIS students have benefited tremendously from fellowship

mentoring and writing workshops. Also, Shelley Hawthorne-Smith, Associate Director of the Graduate Center and Assistant Professor of Graduate Writing, has visited our seminar class to explain the resources available. We aim to take full advantage of these resources and are considering options to do so, including requiring two or three workshops for first-year students and directing faculty to participate in mentoring workshops.

In addition to frequent meetings with mentors, all students fill out an annual progress report (due in the third week of May; the form is Appendix 2 in the EIS GIDP Handbook: https://insects.arizona.edu/sites/default/files/2023-08/GIDP_EIS_Handbook_%2723_8.25.pdf). Students are asked to report their progress on program milestones, to describe their research project, to reflect on progress on their goals for the previous years and to set new goals. They also attach a 2-page CV with the previous year's activities and achievements highlighted. Importantly, the report is then discussed with the mentor. This is an opportunity for the student and advisor to discuss the past year's goals, the next year's goals and how the student's work will provide them with the skills they need for positions of interest after graduation.

All the students' progress reports are read by the EIS Advisory Committee, which meets to discuss the progress of each student. The committee members write a letter to each student, commending them on recent progress and making suggestions for the coming year. The Advisory Committee meeting also serves as an opportunity for one group of faculty to achieve an overview of our students' strengths and challenges. For example, the 2023 meeting showed that several of our students were delinquent on scheduling committee meetings, filing plans of study and scheduling their comprehensive exams. Since the letters were sent, a clear uptick in activity has been observed.

I.3.d.iv. *Analyze your annual survey data of current graduate students' professional development needs.* This is not something we've done, but seems like a good idea, and we would appreciate examples from other programs that have done this. As we describe in I.3.d.iii above, we are considering ways to make professional development a more integral part of student training and faculty mentorship by accessing GC resources.

I.3.e. *Discuss the scholarly activities of your graduate students (being mindful of FERPA policy), such as conference presentations and publications.* As we mentioned, our current 26 students, including five first year students who have not yet had time to complete research, have given 64 presentations, an average of 2.9 per student for the 22 current students who have completed at least one year. We encourage our students to present their research frequently in poster and oral presentations on and off campus. On campus opportunities include EIS program lunches (4-6 per year), the GIDP Showcase, where two posters per program are selected for sharing in a gathering of all the GIDPs, and others. Our students also travel to conferences to present their work. Despite the pandemic interruption to travel and in person conferences, our current students (with variable numbers of years in the program) have given 33 presentations at national conferences (largely Entomological Society of America conferences), 6 international conference presentations, 15 outreach and/or extension presentations and 10 on-campus presentations. EIS students are also active in publishing their research before they graduate. As mentioned in section D, EIS students coauthored 74 of 275 journal articles that are products of ENTO & EIS faculty scholarship (27%

of these papers) and two of the nine book chapters (22%; Appendix D1). Our students have also been recipients of numerous awards (Table D2), including intramural and national awards.

I.3.f. *Provide a table of the trends, time to degree, and number completing the degree for the last seven years, for each graduate degree program, providing student data pulled from the APR Dashboard in UAccess Analytics. Also indicate the six- and eight-year completion rates.*
We downloaded data on all students completing and not completing the EIS PhD and MS programs from UAccess Analytics from 2014 and corrected it for errors (e.g., students that appeared to arrive and graduate the same year) and redacted names (Table I5). We did not include any students in progress in the program. We included those individuals that graduated from a different EIS program they entered (two from MS to PhD, two from PhD to MS) as students who had completed. We also indicate sources for student stipends, both to show the wide variety of funders and the potential impact of outside employment on time to EIS program completion.

Table I5a. EIS PhD students 2014-2022: Time to degree, retention, and funding. Summary statistics for retention of MS and PhD students combined are below Table S1b.

Student code	Matriculation	Graduation date	Years to graduate	Sources of funding while a student				
PhD				**Teaching assistant**	**Research assistant**	**Fellowship**	**Full time position**	**Self-funding**
1	Fa 2017	Sp 2022	5	X	X		X	
2	Fa 2015	Sum 2023	8	X	X		X	
3	Fa 2009	Sum 2015	6	X	X			
4	Fa 2011	Sum 2016	5	X	X			
5	Fa 2017	Sum 2022	5	X	X	X		
6	Fa 2016	Sp 2019	3	X		X		
7	Fa 2016	Sum 2021	5	X	X			
8	Fa 2012	Fa 2020	8	X	X		X	
9	Fa 2010	Sum 2017	7	X	X			
10	Fa 2011	Sum 2018	7	X	X			
11	Fa 2011	Win 2019	8	X	X		X	
12	Fa 2016	Fa 2020	4	X	X			
13	Fa 2013	Win 2021	8	X	X			
14	Fa 2013	Sp 2020	7	X	X			
15	Fa 2012	Sp 2020	8				X	
16	Fa 2011	Fa 2016	5	X	X			
17	Fa 2011	Win 2017	6	X	X			X
18	Fa 2011	Fa 2016	5		X			
19	Fa 2016	Sum 2023	7	X	X			
20	Fa 2014	Sp 2020	6	X	X			
PhD students that did not complete*								
38	Fa 2018			X	X			
39	Fa 2017			X				
40	Sp 2019			X	X			
41	Fa 2015					X		
42	Fa 2015			X	X			
43	Fa 2020				X			

*Reasons for non-completion included illness, moving with advisor to a different institution, visa issues and a change to a different UA graduate program.

Summary statistics for PhD completion: Median time to degree = 6 years, mean time to degree = 6.15 years (n=20). Among the students with full time employment for part or all of their programs, the median time to degree = 8 years, and the mean = 7.4 years. Among the students who did not have full time employment during their programs, median time to degree = 5.5, and mean = 5.6 years.

Summary statistics for PhD retention: 20/26 students completed their PhDs in this period, a retention rate of 77%. This is also the 8-year completion rate. The 6-year completion rate is 11/26 = 43%.

Table I5b. EIS MS students 2014-2022: Time to degree, retention, and funding. Summary statistics for retention of MS and PhD students combined are below this table.

Student code	Matriculation	Graduation date	Years to graduate	Sources of funding while a student				
MS				**Teaching assistant**	**Research assistant**	**Fellowship**	**Full time position**	**Self-funding**
44	Fa 2019	Sp 2022	3	X	X			
45	Fa 2017	Sp 2020	3	X	X			
46	Fa 2014	Win 2016	2	X	X			
47	Fa 2015	Sp 2018	3	X	X			
48	Fa 2017	Fa 2019	2				X	
49	Fa 2014	Sp 2017	3				X	
50	Fa 2015	Sp 2017	2	X	X			
51	Fa 2019	Sp 2022	3	X	X			X
52	Fa 2015	Fa 2021	6				X	
53	Fa 2019	Sum 2023	4			X		
54	Fa 2017	Sp 2019	2	X	X			
55	Fa 2019	Sum 2021	2	X	X			
56	Fa 2014	Fa 2016	2	X	X			
57	Fa 2019	Sum 2021	2	X	X			
58	Fa 2015	Sum 2017	2		X			
59	Fa 2021	Sum 2023	2	X				
60	Fa 2018	Fa 2020	2	X	X			
61	Fa 2020	Sp 2020	2	X	X			
62	Fa 2017	Sum 2019	2	X				
63	Sp 2019	Sp 2020	1.5	X	X			
64	Fa 2016	Sum 2020	4	X				
65	Fa 2018	Sum 2021	3	X	X			X
MS students that did not complete*								
66	Fa 2018				X			

*This student did not return after the first semester of their program.

Summary statistics for MS completion: Median time to degree = 2 years, mean time to degree = 2.6 years (n=22).

Summary statistics for MS retention: 21/22 students completed their MS in this period, a retention rate of 95%.

Summary statistics for EIS program retention (combining MS and PhD) = 41/48 students who entered an EIS program completed an EIS program (including two who switched from PhD to MS), a retention rate of 85%.

Our analysis of these 2014-2022 data shows several trends. The EIS program continues to demonstrate strong retention. In the PhD program, 20/26 students completed their PhDs, a

retention rate of 77% (Table I5a). In the MS program, 21/22 students completed their MS, a retention rate of 95% (Table I5b). The overall EIS program retention (combining MS and PhD) shows 41/48 students who entered an EIS program completed an EIS program, a retention rate of 85%. Comparing these trends with data from UA Analytics across programs for students admitted in 2014, across programs, 74% of PhD students completed, and 83% of MS students. Our PhD retention rate is higher than the UA average rate (77 vs. 74%), and our MS retention is strikingly so (95 vs. 83%).

The median time to degree for EIS PhD students is 6.0 years (mean 6.5; Table I5a). The 6-year completion rate is 43%, lower than the UA rate of 65%. Clearly, our students are taking longer to finish their PhDs than students across campus. The 8-year completion rate is the same as the retention rate, 77%, and higher than the UA average rate of 74%. One reason for the longer times to graduation may be that some of our students are employed full time outside the program while completing their PhD, either for UA or outside industries or federal agencies (Table I5a). Looking just at those students who worked full time for one or more years of their program (some working throughout their program), the median time to degree is 8.0 years (mean 7.4). When these students are excluded from the data set, the median time to degree is 5.5 years (mean 5.6), and more comparable to the UA average rate.

In the PhD program six of the students who started in 2014-2022 discontinued their degrees. Three left due to illness, one followed an advisor (with a primary appointment in Ecology & Evolutionary Biology) to a new institution, one moved to a different graduate program at UA, and one attended remotely from China the first year and was unable to get a visa to come in person (in 2020). After several attempts, he got a visa to study in Canada and transferred to a Canadian university.

In the MS program, the median time to degree was 2.0 years (mean 2.6; Table I5.b). The 95% retention rate compared favorably with the UA average rate of 50% for the 2-year rate and 66% for the 3-year rate. Just one of 22 entering MS students did not complete and the reason is unclear. After one semester, the student did not return after the winter break.

Table I6 shows current employment from PhD and MS graduates since the last EIS APR in 2014.

Table I6a. Current employment (Sept. 2023) for EIS PhD graduates 2014-2023. Names redacted to protect privacy.

Student code	Grad date	Position
a	2014	Project Manager and Implementation Coach, Helps Education Fund
b	2014	Assistant Professor, Arkansas State University, Queratarо, MX
c	2014	Lecturer, School of Life Science, Zhengzhou University, CN (Faculty ranks in China start at Assistant Professor, then Lecturer, then Associate Professor and Professor)
d	2015	Assistant Professor, Dept. of Entomology, University of California, Riverside

e	2016	Foreign Service Officer, USAID Agricultural Development
f	2016	Data Scientist, Tokyo Electron, Chandler, AZ
g	2016	Laboratory Manager, University of Georgia, Dept. of Entomology
h	2016	Assistant Professor, Missouri State University
i	2016	Assistant Professor of Practice, iSchool, The University of Arizona
j	2017	Identifier (Entomologist) USDA APHIS
k	2017	Laboratory Manager, University of Georgia, Dept. of Entomology
l	2018	Program Director, Santa Clara County Vector Control District, California
m	2018	Field Operations Manager, Entomologist, Oxitec, Panama
o	2020	Senior Technical Manager, Ventana Medical Systems, Tucson
p	2020	USDA NIFA Postdoctoral Fellow, University of Arizona
q	2020	State Botanist, Bureau of Land Management, Phoenix
r	2020	Teaching Professor, Xavier University
s	2020	Conservation Biologist, US Fish and Wildlife, Portland, OR
t	2021	Molecular Diagnostics Scientist, Arizona Veterinary Diagnostics Laboratory, Tucson
u	2021	Postdoctoral researcher, University of Kentucky
v	2022	Computational and Data Science Educator, University of Arizona Data Science Institute
w	2022	Epidemiologist, CDC Inter Tribal Council of Arizona
x	2023	Wildlife Biologist, US Geological Survey, Tucson
y	2023	Founder, Arbo Scientific, a vector surveillance company and US Army Medical Entomologist

*Graduate “n” is deceased and was omitted from the table and summary statistics.

Table I6b. Current employment (Sept. 2023) for EIS MS graduates 2014-2023. Names were redacted for privacy reasons.

Student code	Grad date	Position
a	2014	Biologist, US Environmental Protection Agency, Washington, DC
b	2014	Postdoctoral scientist, Syracuse University
c	2014	U.S. Naval Entomologist, Okinawa, Japan
d	2014	Curator of Entomology, Bio Park in Albuquerque, New Mexico
e	2014	Postdoctoral Scientist, Dept. of Entomology, Washington State University
f	2014	Laboratory Director, Salt Lake City Mosquito Abatement District
g	2016	Conservation Program Manager, Appleton Whittell Research Ranch of the National Audubon Society, Elgin, AZ
h	2016	Entomologist Technician, USDA APHIS OTIS, Buzzards Bay, MA
i	2017	State Entomologist, Arizona Department of Agriculture
k	2017	Microbiologist, Northstar Medical Radioisotopes
j	2017	Soil conservationist, USDA NRCS, Poughkeepsie, NY
l	2018	Weights and Measures Agricultural Inspector, Los Angeles County
m	2019	Field Technician and Beekeeper Relations, Dalen Animal Health, Inc.
n	2019	PhD graduate student, University of Arizona
o	2019	Laboratory Assistant, University of California, Berkeley
p	2020	Biological Science Technician, USDA ARS Carl Hayden Bee Laboratory
q	2020	PhD graduate student, University of Arizona
r	2020	Research Scientist, Neilson Lab, Program Coordinator, Center for Environmentally Sustainable Mining (CESM), University of Arizona
s	2020	Biologics Engineer, Ginkgo Bioworks, Sacramento, CA
t	2020	PhD graduate student, Wayne State University
u	2021	Biological Science Technician, USDA ARS Carl Hayden Bee Laboratory

v	2021	Assistant in Extension, University of Arizona, Maricopa Agricultural Center
w	2021	Pesticide Certification and Licensing Specialist, Oregon Department of Agriculture
x	2021	PhD graduate student, University of Arizona
y	2022	Field biologist, SWCA Environmental Consultants, Pensacola FL
z	2022	Legal Processing Support Clerk, Pima County Office of Children's Counsel (within Public Defense Services)
aa	2023	PhD student, New Mexico State University
bb	2023	Border Restoration Intern, AmeriCorps and Bureau of Land Management

All 24 (100%) of the PhD EIS graduates since 2014 are employed by universities, government, or in private or non-profit companies, all in areas related to their training. Of the 28 MS students, all are employed, and all but one recent grad are employed in an area related to their training. We are extraordinarily proud of all our MS and PhD graduates.

I.4. Graduate Student Learning Outcomes Assessment

Starting in 2014, EIS used an outcomes assessment based on six learning outcomes (LOs). At each graduate committee meeting, comprehensive exam and defense, faculty and students were asked to assess student performance on each LO on a five-point scale, using paper forms filled out in the room to ensure the assessment was performed. The forms were collected, hand-tallied on Excel spread sheets, and indeed we collected a lot of data. What the analysis of the data appeared to show was that, like the children of Lake Woebegone, all of our students were above average (~4), for every LO. While heartening, these data were not helpful in providing areas to target for improvement. The assessment plan was in place during the pandemic, when all meetings went to Zoom (so no paper forms) and further, the impetus for doing something that we no longer believed to be useful was lost.

In summer 2023, we instituted a new system, devised with input from Dr. Elaine Marchello, Asst. Director of Assessment, and approved by the EIS Executive Committee in an August 23 meeting, and the EIS faculty by email. The new learning assessment has three major LOs (Table I7). We will ask faculty and students to provide qualitative feedback on relevant LOs at comprehensive exams and final defenses (for PhDs) and at final defenses (for MSs).

Table I7. Learning outcomes for EIS MS and PhD students.

Learning outcome	Learning area /When assessed	
1	**Content knowledge** MS – final defense PhD – comprehensive exam	The student demonstrates understanding of key concepts in insect biology as well as those underlying his/her general subject area (e.g., physiology, molecular biology, genomics, ecology, systematics, evolution or behavior)."
2	**Research skills** MS and PhD – final defense	The student exhibits a) critical thinking skills to evaluate the scientific literature and articulates how their research fits into and advances the discipline. The student b) develops creative and innovative research ideas and approaches. The student c) uses multiple research approaches to collect scientific data related to their research area, and can interpret, analyze, and critique their data.
3	**Communication skills** MS and PhD – final defense	The student communicates their research project effectively through oral presentation and can express the potential impact of their work on society in lay terms.

We are now developing a web-based (Qualtrics) survey, with a link to be emailed to faculty and the student after the student's comprehensive examination (PhD students only) and final defense (for both MS and PhD students). For each LO, faculty will be asked: "What are the strengths of the student's understanding with respect to LO 1, 2 and 3?" and "Are there areas for improvement, and if so, what are they?" Similarly, students will be asked to reflect on their own performance (a form of indirect assessment) and will be asked "What do you think your strengths are with respect to (LO 1, 2 or 3)?" and "Are there aspects of this set of ideas and skills that you still developing and if so, what are they?" We plan to aggregate these data by student and look at faculty and student responses for several students to look for patterns in strengths and weaknesses.

We have posted our new learning outcomes assessment plan on the Planning and Self Study website **https://planning.watermarkinsights.com/?connection_name=universityofarizona** and will assess the results on an annual basis in Fall of each year. We are asked to identify how we might modify our analysis of student learning to identify any achievement gaps with respect to student demographics, but our program is too small to identify patterns relating to underrepresented groups or first-generation college students. We will look for gender-specific patterns, even if we expect the small sample size will make subtle differences difficult to detect and non-binary identifying students will be excluded. Assessment findings will be considered among EIS faculty and the EIS Executive Committee and program changes implemented as necessary.

J. OUTREACH AND EXTENSION

The Department of Entomology and the faculty and students of the EIS GIDP are actively engaged in outreach and Extension programs that educate the public in Arizona and have tremendous social, environmental, and economic impact. These programs are described below.

1. The Arizona Insect Festival: An Annual Community Celebration

The Arizona Insect Festival is a free, single-day outreach event on the UA campus hosted by the Department of Entomology in collaboration with our local community of insect enthusiasts. The Festival began in 2011 and quickly became a beloved educational experience for the public in Tucson and beyond. It is thought to be the largest annual academic outreach event on the UA campus hosted entirely by a University unit. Visitors are treated to approximately 25 insect-themed booths run by more than 150 knowledgeable faculty, staff, graduate students, undergraduate students, and other volunteers (https://www.arizonainsectfestival.com). The Festival attracts about 5,000 visitors each year and is covered by the local media. Families with young children make up a large proportion of attendees. This is often their first time on a university campus. The Festival is exceptional because of the diversity of the insects displayed, the opportunity for visitors to hold many of these insects, and the remarkable expertise of the scientists interacting with the public. In many cases the researchers have studied their insects for decades and are world experts in the subject matter of their booths.

The Festival helps us to accomplish the following goals:
(a) enhance the connection between UA and the public, including potential students and donors;
(b) provide the public the opportunity to meet and talk with ENTO/EIS scientists and students;
(c) inform the community about exciting insect research conducted by ENTO/EIS;
(d) educate the public about the roles of insects in ecosystems and in their own daily lives; and
(e) reduce fear and increase appreciation of insects.

In recent years, we have attracted more Hispanic visitors to the Festival to support UA's mission as a Hispanic-Serving Institution. We have documented success in this effort, which includes print and radio ads in Spanish and collaboration with elementary schools in South Tucson, a city known for its Hispanic heritage. After a 2020-21 pause because of the pandemic, the 2022 Festival was perhaps the best attended ever! The annual cost of the Festival is about $13,000 with about $3,000 recovered from profits from sales of Festival t-shirts. Before 2020, local businesses provided some financial support for the Festival. We are actively pursuing community sponsors to sustain the Festival.

Future scientists inspired by the Arizona Insect Festival

More Images from the Arizona Insect Festival

Arthropod Zoo volunteers

Edible insects

Making friends with roaches

Congresswoman Gabby Giffords ready to hold a gentle whip scorpion

Build your own bug

Posters for 2023 Arizona Insect Festival designed by EIS student Alex Lombard

This year's theme insect is the big and bold tarantula hawk, *Pepsis formosa*.
Known for its sting, it paralyzes and lays its eggs on tarantulas, providing a large meal for its developing offspring.
It's easily recognized by its jet black body, bright orange wings, and often curled antennae.
They can be surprisingly large and are often seen sipping nectar from flowers all over Tucson.

2. Insect Discovery: Sparking Scientific Curiosity in Elementary School Children and Providing Science Communication Training for EIS Students and Undergraduate Students

Insect Discovery is a UA Cooperative Extension program that sparks scientific curiosity and builds scientific literacy in elementary school students in the Tucson area (Pima County) through hands-on activities with live and preserved insects. This age group is particularly excited about school-based science, but the teachers of this age group tend to have less science background and are focused on the enormous tasks of developing basic literacy and numeracy skills. Insect Discovery provides support for these teachers not just in offering classroom visits and field trips, but also by providing lesson plans and other on-line resources to make the most of their students' fascination with insects. This early engagement in science stimulates interest in pursuing scientific careers.

Started in 2005, the program has sent EIS graduate students to elementary school classrooms in the fall and provides on-campus workshops at the UA Flandrau Science Center in the spring. Insect Discovery engages over 3000 children a year, primarily from Title 1, lower-income and majority Hispanic schools. As of 2023, over 40,000 schoolchildren and their teachers have participated. Insect Discovery is a tremendous educational opportunity for EIS graduate teaching assistantships (TAs) in outreach each year, giving graduate students a unique opportunity to hone teaching and communication skills while bringing science (and a scientist!) into Tucson schools. EIS students have participated in 50 TAships for Insect Discovery. The experience has strengthened their science communication skills, one of our three core learning outcomes.

Funding for these TAs has primarily been from GIDP Administration-funded TAs but in 2023-2024 this funding has ended and additional financial resources for TA support are needed (see G.6 and G.8). NSF grants of EIS faculty members who support Insect Discovery as part of the broader impacts of their research have also provided funds but grant funding limitations usually restrict these to 1 or 2 semesters of support. As TAs funded by the GIDP Administration and grants become more uncertain, we seek sustainable funding for these TAs as a matter of some urgency (see G.6 and G.8).

Insect Discovery also provides unique opportunities for UA undergraduates. Over 300 undergraduates have participated as field trip instructors through the Insect Discovery Course (ENTO 407). Many describe the course as one of the best in their college experience and have gone on to careers in science, medicine and/or education.

We are proud that Insect Discovery continued during the pandemic by providing virtual classroom visits. The program returned to in-person visits in 2022. The spring workshops now take place in a dedicated classroom renovated specifically for Insect Discovery at the Flandrau Science Center. In addition to workshops and classroom visits, the program participates in larger science outreach programs such school science nights, the Tucson Festival of Books, Tucson Village Farm, Boyce Thompson Arboretum, and Insect Insanity at the Arizona-Sonora Desert Museum. Insect Discovery has also developed insect science curricula for 4-H and K-12 educators outside of Pima County https://extension.arizona.edu/4-h-insect-discovery-activities.

The logistical challenges of the Arizona Insect Festival and Insect Discovery are daunting for Dr. Kathleen Walker and other faculty who have carried the load for years. It would be a great benefit to obtain long-term support for a 0.5 FTE staff outreach coordinator to make these two high-impact programs for community science engagement sustainable for many years to come (see G.4).

Insect Discovery Sparks Scientific Curiosity

3. The University of Arizona Insect Collection: A Treasure Trove of Millions of Specimens

The University of Arizona Insect Collection (UAIC) in the Department of Entomology houses over 2 million insect specimens, particularly endemic arthropods of the desert Southwest (Appendix J1). It is considered one of the gems of the University and is used extensively for research, teaching, Extension, and outreach. Dr. Wendy Moore, Associate Professor of Entomology, is the Curator of the UAIC. She has obtained more than $1.5 million in external funding (three NSF grants and donations from the Schlinger Foundation) to conduct three major renovations of the UAIC since 2012, including the current renovation. These renovations have enabled expansion of its holdings and its service to researchers and the public. Dr. Moore has also raised over $1 million from private foundations to endow the UAIC's non-salary operations and host visits from arthropod systematists in perpetuity.

The UAIC serves as an important resource for interactions between EIS students, faculty, and members of the community, including students at Pima Community College and scientists and volunteers at the Arizona-Sonora Desert Museum. It is also the cornerstone of the Tucson Bee Collaborative, recognized by the UA as a Vertically Integrated Project (VIP) that engages undergraduate and graduate students in ambitious, long-term, specimen-based, multidisciplinary research led by Dr. Moore. Students and staff also work together to create artful, educational displays of insect specimens. Some displays are donated to local non-profits (such as Las Mipitas Community Farm of the Food Bank of Southern Arizona). Others are shown at the annual Arizona Insect Festival, in the Insect Discovery Program, and in other classroom visits to Tucson area schools and UA classrooms. EIS students are involved in the frequent tours of the UAIC, for example during the Festival of Books, for the Undergraduate Biology Research Program students, and for community groups. EIS students and the UAIC staff also use the collection to help provide the public and agencies with identifications of arthropods associated with homes, gardens, crops, livestock, forensics, and venomous attacks.

J. OUTREACH AND EXTENSION (continued)

4. Integrated Pest Management (IPM) Programs

Entomology faculty members with Extension appointments (Ellsworth, Fournier, Gouge, Palumbo, and Walker) develop and implement IPM programs that combine problem-solving, issue-driven research with engaged outreach to address pest problems in agriculture, communities, and public health. This includes capacity-building efforts in underserved communities. We also engage the public to increase awareness of entomology and its role in addressing societal issues such as hunger, health, disease, and food production.

Our outstanding IPM programs generate, synthesize, and transfer knowledge to yield more sustainable, profitable, and environmentally friendly pest management in agriculture and communities. For example, our Cotton IPM program has saved Arizona growers more than $600 million since 1996. Major changes since the 2009 Academic Program Review include a 185% increase in competitive base federal funding for Extension IPM programs, supporting additional staff to implement outreach; establishment of an outstanding Public Health IPM program that addresses needs of both city and rural communities; departure of Extension faculty member Baker (urban IPM/termites) in 2015 and appointment of Fournier (IPM assessment) in 2018. In 2020, stakeholder donations enabled creation of the Endowed Chair in IPM for Extension faculty member Dr. John Palumbo, reflecting the value stakeholders place on his IPM and Extension activities. The structure and impacts of our IPM programs are described below. Please also see Appendices J2-J6 for related information and Appendix J7 for Extension publications.

The Arizona Pest Management Center (APMC)

We founded the APMC in 2003 to strengthen multi-disciplinary connections, to focus limited resources on priority pest management needs, and to promote excellence, innovation, and investment in IPM programs. The APMC encompasses and synergizes the full set of University of Arizona research and Extension resources involved in IPM in Arizona, activating highly leveraged, talented personnel, and providing foundational capacity for stakeholder engagement, program delivery and measurement of outcomes. The mission of the APMC is to "*create a working environment in which the science and implementation of IPM can thrive in Arizona.*"

The APMC is led by Entomology faculty who have extensive collaborations with other academic units, county programs, and stakeholders (Appendix J2). Dr. Peter Ellsworth, state IPM Coordinator (a federal designation), and Dr. Al Fournier, IPM Program Manager, serve as Co-PIs on the competitive federal grant (USDA-NIFA Crop Protection and Pest Management Program, Extension Implementation Program (EIP), that provides base funding for the APMC. Ellsworth convenes a 20-member IPM Coordinating Committee of UA and external stakeholders (Appendix J3) that guides the APMC, while Fournier supports day to day operations, grant development, needs assessment and evaluation of programs. Drs. Gouge, Palumbo and Walker lead and/or serve on IPM program teams.

In 2009, the federal IPM funding shifted from 3-d formula funds to competitive grants. That year the APMC garnered an 81% increase in funding. In the following 3-year cycle, funding increased

another 43% and our proposal was ranked 2nd in the nation. Additional increases followed in subsequent cycles. In the 2021-2024 grant cycle, our proposal ranked #1 and we secured the highest funding of any state ($854,873). This represents a 185% increase over formula funding levels (Fig. J1). The APMC has expanded from two staff members in 2009 to nine full time staff positions in 2023. The APMC manages focused IPM Teams, each partially funded through this program. In the current grant cycle, an average of only 3.83 FTE/year is funded through the grant, providing base funding for 7 of 9 staff members and the IPM Program Manager (Fournier). These personnel resources are highly leveraged, providing a 5-fold return on EIP investments (Fig. J2, Appendix J4).

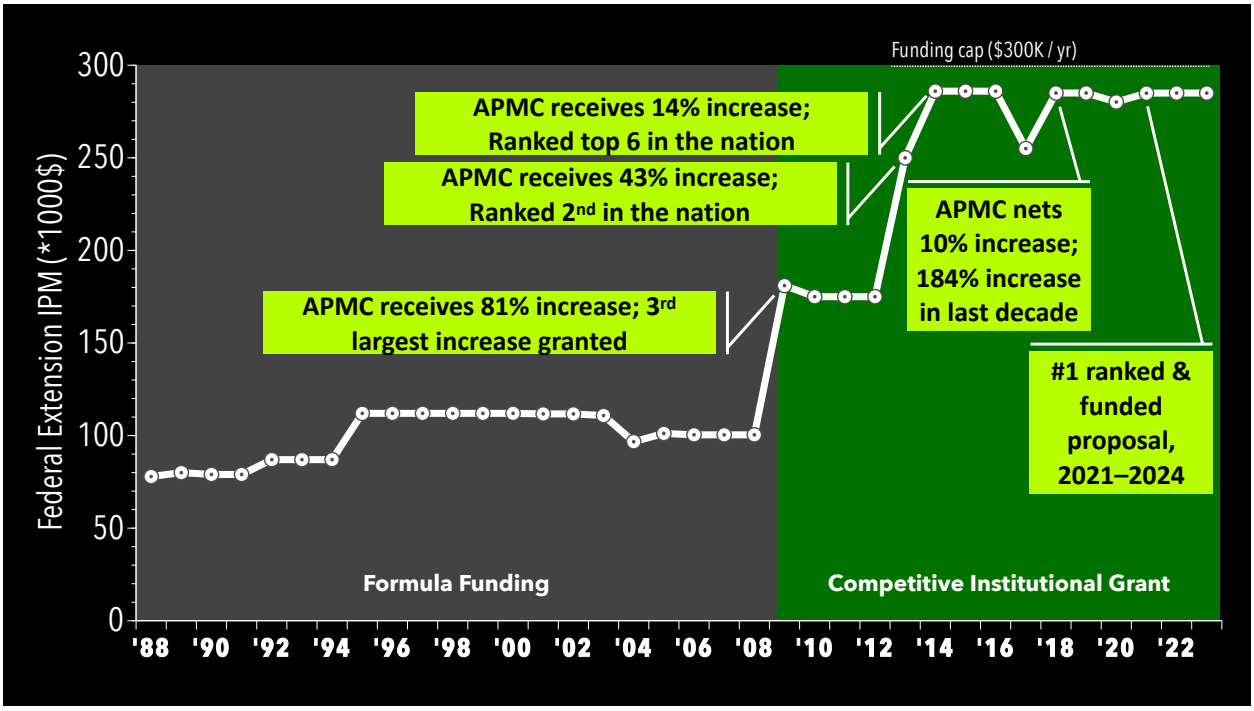


Figure J1. Arizona Pest Management Center (APMC) funding. The APMC secured significant increases in federal IPM funding following a shift from 3d formula funds to a competitive grants program. In the 2021-2024 grant cycle, APMC had the top-ranked, highest-funded proposal in nation, representing a 185% increase over formula funding levels.

Team	Leverage	Investment	N-fold
Veg IPM	$ 1,633,536	$ 390,173	4.19
Ag IPM	$ 2,022,930	$ 339,335	5.96
School IPM, Public Health IPM, PSEP	$ 1,768,302	$ 354,452	4.99
	$ 5,424,768	$ 1,083,961	5.00

Figure J2. APMC IPM team funding. IPM teams secured an average 5-fold increase in IPM program investments through leveraged funds in grants, contracts and gifts from 2017 to 2021. These dollars support key personnel that work with stakeholders to deliver IPM outcomes and impacts throughout Arizona.

We attribute the APMC's continued success to our unique model for the coordination and adoption of high-impact IPM programs by Arizona stakeholders. Our proven approach is centered around full-time Assistants or Associates in Extension (AiE, Extension Educators) who interact with County Agents, Extension Specialists and other disciplinary faculty and collaborators who provide the full range of IPM expertise (e.g., arthropod, weed, vertebrate, pathogen, economics, agronomy, food safety) to support program development and delivery. Most AiEs have master's or Ph.D. level training in Entomology or a related discipline. Each AiE is supported by a unique Leadership Team of appropriate subject experts that oversee IPM program development and guide and manage AiEs to ensure efficient functioning and delivery of IPM programs (Fig. J3). AiEs then form operational teams to implement and deploy Extension programming. Our outreach approach emphasizes use of field demonstrations; stakeholder-engaged translational research projects; and delivery of short, effective and graphically rich publications, presentations and advisories. We maintain constant contact with stakeholders via IPM Newsletters and social networking. The AiE serves a coordinating function, catalyzing outputs and impacts of each IPM effort. Each Leadership Team Chair sits on the IPM Coordinating Committee, which provides stakeholder input and serves as the advisory body for the APMC. This ensures accountability.

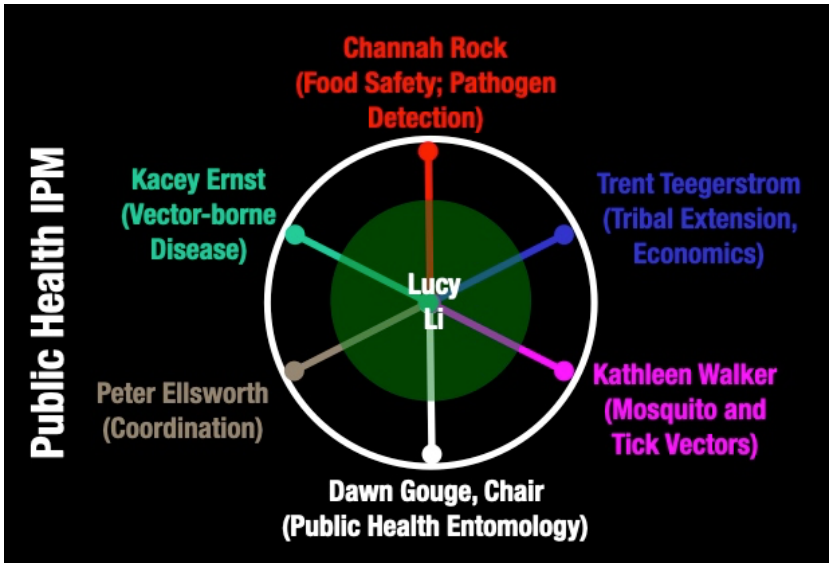


Figure J3. Public Health IPM: Example of multidisciplinary APMC Leadership Team. Each team provides diverse expertise to support Extension Educators that lead program areas (e.g., Lucy Li). This team includes 3 Entomology faculty (Chair Gouge, Walker and Ellsworth); Kacey Ernst, Professor & Department Chair, Epidemiology and Biostatistics; Channah Rock, Professor and Extension Specialist, Department of Environmental Science; and Trent Teegerstrom, Associate Director for Tribal Extension Programs and Agricultural Economics Extension Specialist.

Each AiE position is supported up to 50% from the foundational Extension Implementation Program (EIP) grant. AiEs and their Leadership Teams are obligated to secure the balance of their fulltime funding from competitive grants or other resources. By planning for sustainability, teams must secure stakeholder support, and ensure that funded projects enhance IPM outcomes. Leadership Teams include Agronomic Crops, Vegetable Crops, Climate Smart Guayule, Insect

Diagnostics, Community IPM, and Public Health IPM. The APMC provides common resources to support needs assessment, websites and communication networks, and evaluation of impacts. A unique IPM Assessment Leadership Team, led by Fournier, supports these activities for all APMC efforts.

The APMC's IPM Programs are stakeholder-driven, based on the needs of communities these programs serve. Faculty and APMC staff are highly networked with stakeholders. A 2019 network analysis of Maricopa Agricultural Center faculty, including three entomology faculty and four APMC staff, demonstrated diverse and overlapping connections to stakeholders and to each other's programs (Fig. J4).

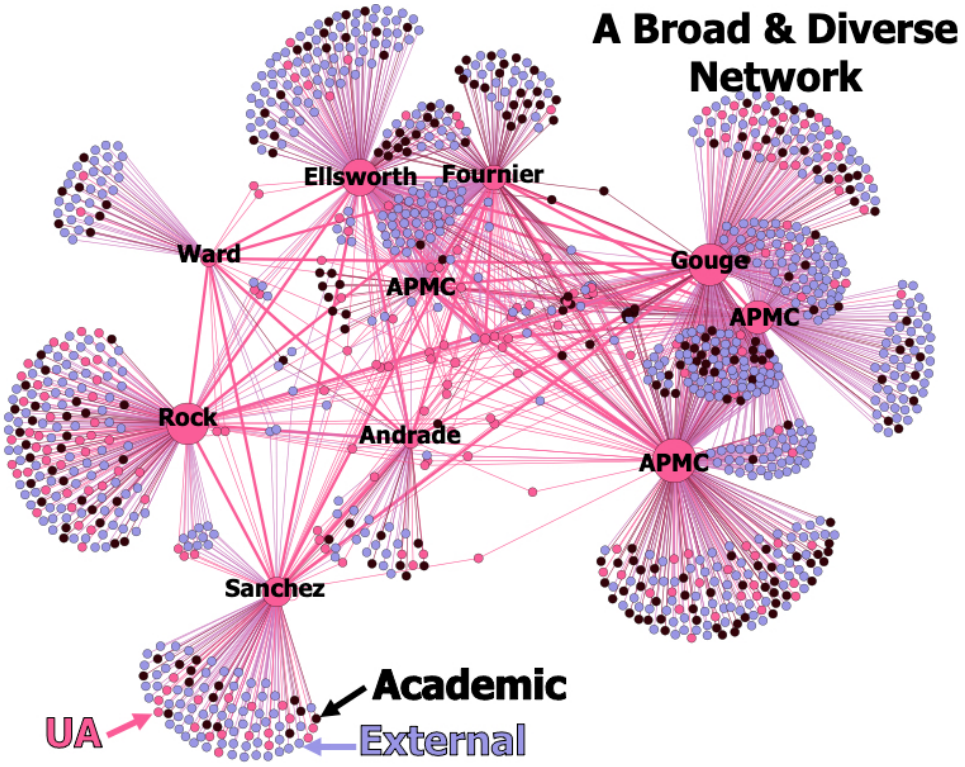


Figure J4. Network analysis of Maricopa Agricultural Center Faculty. Conducted in November 2019 and incorporating 4 APMC staff members. This shows rich and diverse connections to stakeholders that drive program successes. Each dot represents a stakeholder connection. Pink dots are UA faculty, staff or students (18%), black dots are from other academic institutions (21%), lavender dots represent other stakeholders (61%), including growers, pest managers, state and federal agencies and industry connections. Ellsworth, Fournier and Gouge are Entomology faculty. Dr. Channah Rock, Environmental Sciences Department, has a leadership role in the multidisciplinary APMC. "APMC" denotes APMC staff members included in the analysis.

Arizona Pest Management Center programs are organized in five focal areas: Detection & Diagnostics, Agricultural IPM, Community IPM, IPM Assessment, and Pesticide Research & Education. Faculty often work across focal areas and participate in many programs. A description of each focal area and highlights of recent outcomes follows.

Detection & Diagnostics

Insect Diagnostics

Gene Hall is an Entomology staff member and an expert taxonomist who works with Dr. Wendy Moore as Collections Manager for the University of Arizona Insect Collection (UAIC). The collection is the cornerstone for entomological research and insect diagnostics in Arizona. The UAIC includes approximately 2 million specimens representing 35,000 species, making it the most comprehensive collection for the Sonoran Desert Region. Mr. Hall, partially funded through Cooperative Extension, provides expert insect diagnostics to support our diverse IPM Programs and stakeholders. During 2015-2022, Insect Diagnostics processed 4,300 samples and inquiries.

Accurate insect diagnostics enable quick responses to new pest threats. For example, the UA Insect Diagnostic Lab, along with University of California and USDA collaborators worked with the Vegetable IPM Team to determine the identity and damage potential of several new pests on desert crops, including the cabbage budworm, alfalfa leaf tier, dot-lined angle moth, and white-lined sphinx moth. Mr. Hall and Dr. Moore also led an innovative project that used DNA barcoding to detect the invasive pecan bud moth for the first time in Arizona, enabling a rapid response. Barcoding was also used to identify a mirid insect (*Neurocolpus montanus*) of unknown pest status in pecans. More recently, a USDA Specialty Crop Block Grant funded a project to DNA barcode pest and non-pest insects occurring on Arizona specialty crops.

Arizona Plant Diagnostic Network

The Arizona Plant Diagnostic Network (AZPDN) is a multi-disciplinary, multi-institutional team of diagnostic and regulatory experts that help identify new and emerging plant pests and pathogens in Arizona and respond to regulatory issues. The team includes UA Extension specialists and diagnosticians in plant pathology, entomology, weed science and taxonomy and regulatory officials from the Arizona Department of Agriculture and USDA Animal and Plant Health Inspection Services. The team has developed communication and response procedures for new invasive pests, field-tested these procedures through training exercises, and improved ongoing communication among partner organizations. The AZPDN is led by Dr. Alex Hu (School of Plant Science) and is connected to a western region PDN and the National Plant Diagnostic Network.

Early efforts of the group contributed to detection of invasive weed kudzu and glassy-winged sharpshooter, an insect vector of Pierce's Disease. In both cases, early detection facilitated rapid treatment, significant suppression, and containment of these pests. The AZPDN maintains active survey and validation programs for key diseases and insect vectors, including Citrus greening/HLB (*'Candidatus' Liberibacter asiaticus*), Pierce's Disease (*Xylella fastidiosa*), Phytoplasmas in grape and other crops, pecan bud moth, and a number of plant viruses and phytopathogenic fungi.

Agricultural IPM

Our multidisciplinary agricultural teams address client needs in an integrated crop management framework and include cotton, vegetables (e.g., lettuce, cole crops, melons) and guayule. Entomology faculty either lead or co-lead these efforts, which include regular internal meetings for planning of organized applied research and outreach efforts. As nearly 100% of Arizona's acreage of these crops is professionally scouted and managed by pest control advisors, many of our programs target these professionals, as well as growers, regulatory personnel and private industry.

Cotton IPM

Dr. Peter Ellsworth leads Cotton IPM. Through a combination of fundamental and translational research, as well as organized outreach programs, we have witnessed and facilitated transition from an insecticide-dependent industry to one that has become a worldwide model for low-impact, reduced risk Integrated Pest Management (Fig. J5). Through the adoption and use of transgenic cotton, the eradication of pink bollworm, adoption of selective insecticides and conservation of natural enemies, growers have all but eliminated broad-spectrum insecticide use and generated profits while protecting the environment (Fig. J6). We can conservatively estimate that collectively Arizona cotton growers have saved over $600M since adopting IPM programs first developed in 1996, averaging about $25M per year in reduced yield losses to insects and reduced costs of their control. Over this same period (1996–2021), we estimate that growers have prevented over 40M pounds of insecticide active ingredient from reaching the environment. Furthermore, we estimate that 42% of these economic gains are due to the biological controls enabled through proper deployment of the IPM plan. Natural enemies, including predator species we've identified as key biological controls, have become increasingly abundant in area fields. In 2022, pest managers reported the lowest insect pest pressures ever, with 33.6% of Arizona's cotton acres remaining unsprayed for insects.

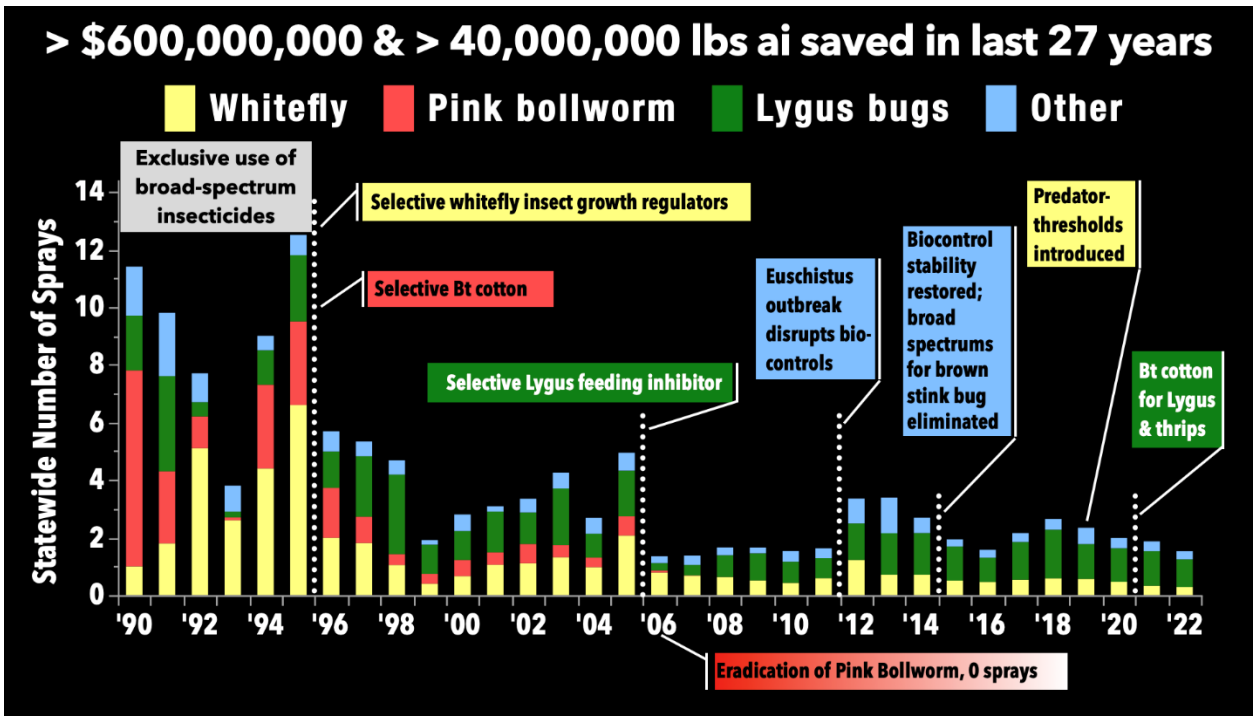


Figure J5. Average number of sprays made statewide to Arizona cotton, 1990–2021, by major insect pest group, noting major pest management periods. 2022 continues a trend towards fewer sprays (1.53). The 17-year statewide average is 2.04 ± 0.16 sprays for all arthropod pests. Cumulatively since 1996, Arizona cotton growers have saved over $600M and prevented more than 40M lbs ai of insecticide from going into the environment. Source: Cotton Pest Losses Database, Ellsworth, unpubl.

The Cotton IPM Program is dedicated to the development of measurement systems and tools for both understanding sustainability and improving IPM in cotton. This includes systems-level risk analyses of pest and pesticide use patterns in Arizona cotton. It also includes information to support biodiversity and the implementation of thresholds based on the presence and numbers of key beneficial arthropod predators in grower's fields. Current initiatives include demonstration and teaching of Predator Thresholds for whitefly management and modified thresholds for Lygus in genetically modified ThryvOn cotton.

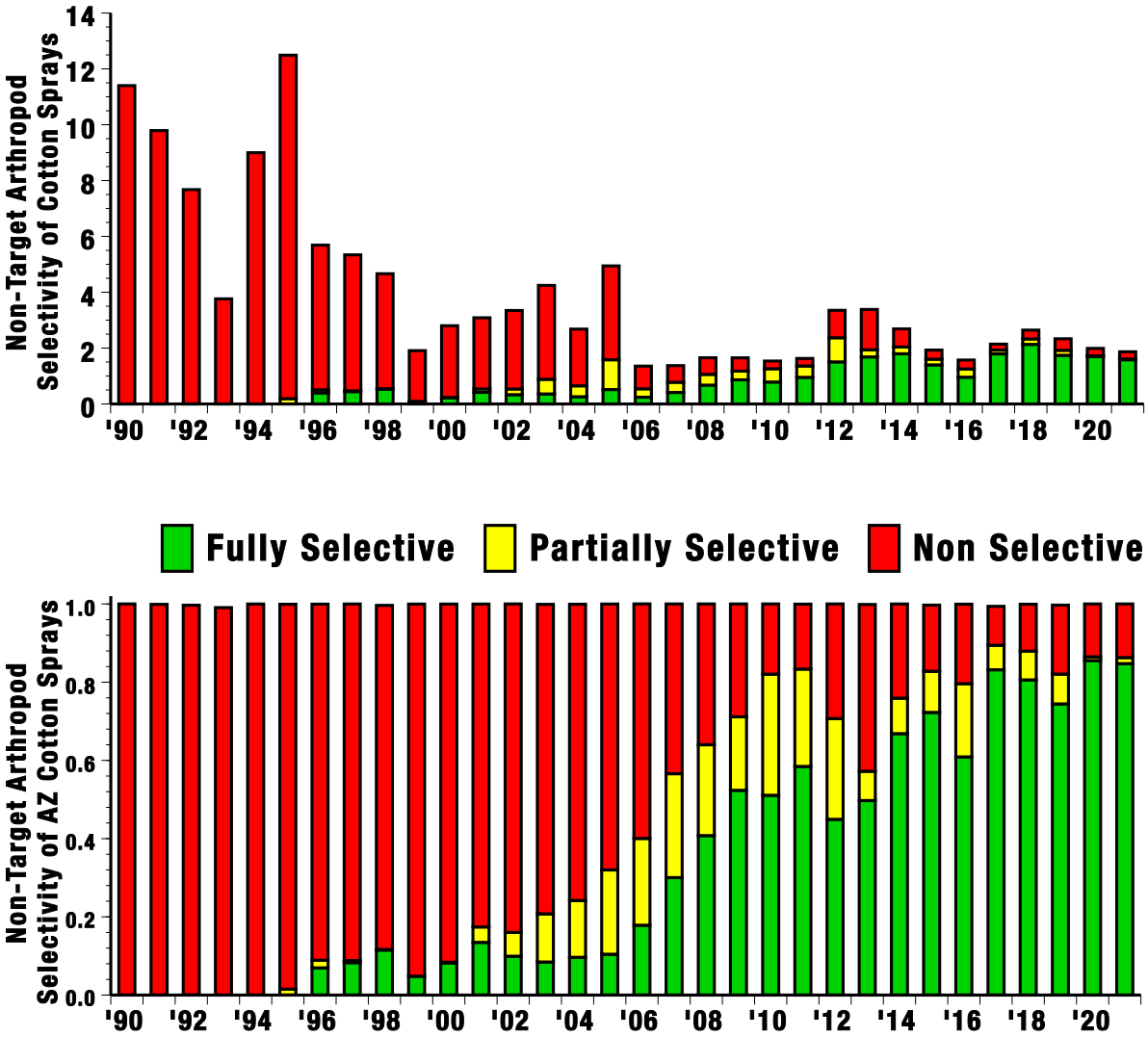


Figure J6. Longitudinal analysis of use of selective cotton insecticides (spray frequency at top and proportional use at bottom). Each bar depicts proportion of sprays made that are fully selective (green), partially selective (yellow) or non-selective (red). This shows a dramatic shift toward higher selectivity to non-target arthropods in Arizona in recent years. There are concomitant reductions in spray frequencies, increases in safety towards predators that support conservation biological control, and large savings to growers. However, when growers use non-selective insecticides, increased spraying results in significant losses. For example, in 2012–2014, as rates of non-selective insecticide use increased in Arizona to cope with a brown stink bug outbreak, the frequency of spraying doubled because of lost biological control of whiteflies, mites, and aphids. Source: *APMC Cotton Pest Losses and Pesticide Use Databases*, Ellsworth & Fournier, unpubl.

Genetically modified ThryvOn cotton, resistant to *Frankliniella* thrips and *Lygus* bugs, was successfully introduced on a limited scale in 2021. Our research and Extension supported the use of this new technology. In 2022, ThryvOn cotton increased from 6% to 8% of upland cotton in Arizona and was grown without restriction in commercial production in 2023. Our data show that

growers of ThryvOn cotton saved about 1 to 1.3 foliar sprays on their crop, valued at about $20 to $26 per acre, or about $150,000–178,000 saved by the cotton industry per year since 2021.

In a contracted project with Better Cotton Initiative (BCI) in 2022, Ellsworth & Fournier analyzed use of seven highly hazardous insecticides in cotton in Arizona, California, and the rest of the cottonbelt. Today less than 1% of Arizona's cotton acres make use of any of seven highly hazardous pesticides targeted for elimination by Better Cotton's sustainability standards (Fig. J7). The Arizona Cotton IPM program has helped prepare Arizona cotton growers to better withstand environmental and regulatory disruptions, while providing opportunities to market their cotton as a premier sustainable product in the global marketplace. We have received additional funding from Better Cotton Growth and Innovation Fund in 2023 to expand our analysis to additional pesticides, to conduct demonstration-outreach to growers and pest managers, and to review Better Cotton's procedures for tracking grower pesticide use to improve assessment of program outcomes.

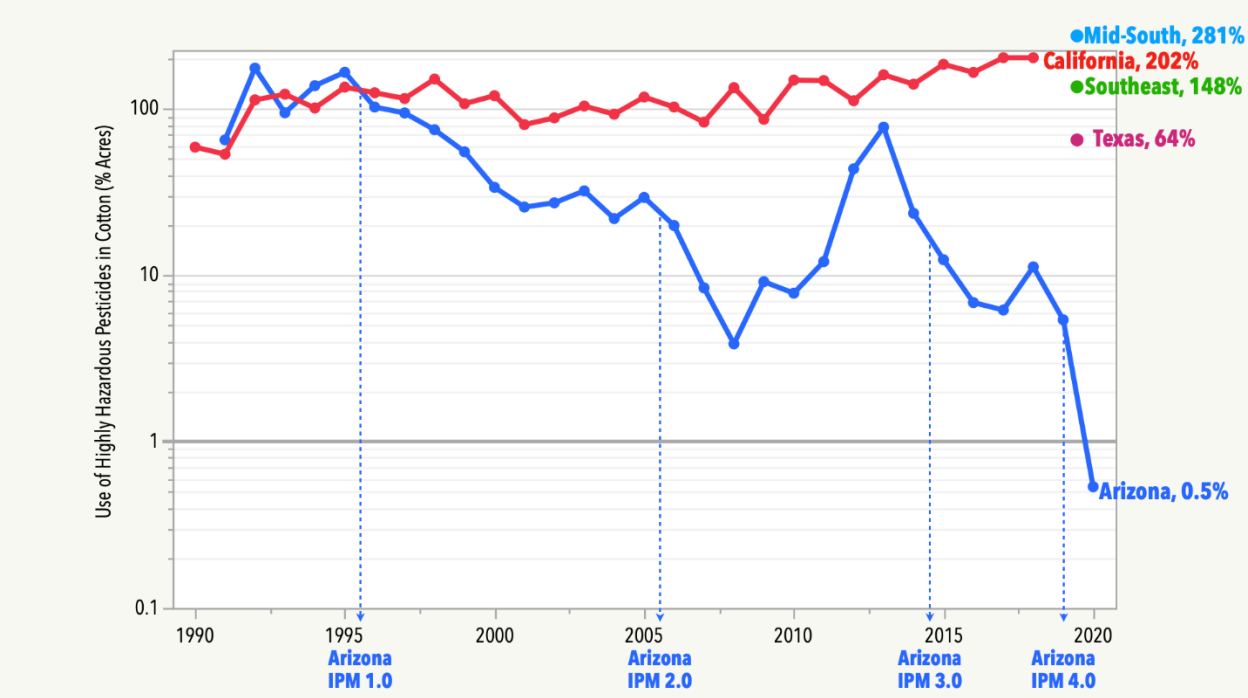


Figure J7. Use of highly hazardous pesticides in cotton as a percentage of acres treated, shown on a log scale for Arizona, California, Texas and Southeast and Mid-south states. Due to innovations spanning 25 years, today <1% of Arizona's cotton acres make use of any of seven highly hazardous pesticides (aldicarb, oxamyl, phorate, abamectin, bifenthrin, dicrotophos, and lambda-cyhalothrin) targeted for elimination by Better Cotton's sustainability standards. In contrast, California uses these same pesticides on over 200% of its acres, and the rest of the cotton belt remains highly dependent on one or more of these insecticides (historical use data available only for Arizona and California).

We educate growers and pest managers through decision-support tools that help them factor pesticide risks into their pest management decisions. Our Cotton Insecticide Use Guidelines (Appendix J5) include information on risks to aquatic life, wildlife, pollinators, and inhalation

risk alongside efficacy, resistance, and selectivity information for each pesticide. This empowers growers and pest managers to proactively preserve pollinators and natural enemies and to protect the environment.

Vegetable IPM

Dr. John Palumbo leads Vegetable IPM. His program provides insect pest management expertise to the produce industry centered around Yuma, Arizona. In 2020, Arizona fresh vegetables (lettuces, leafy greens, brassicas) and melons were valued at over $1.15 billion. IPM plays a critical role managing insect pests, weeds and plant diseases while balancing human health, environmental and economic risks to deliver product to market. The Vegetable IPM Team addresses these significant challenges in a fun and engaging way that makes growers and pest managers true partners in the program. The team maintains "constant contact" with stakeholders through bi-weekly Arizona Vegetable IPM Update newsletters delivered via email, smart phone and web, reaching over 1,000 growers, pest control advisors and others engaged in desert vegetable production in the Southwest region. Based on user surveys, 80% of growers and pest managers adopted reduced-risk pest management practices *because* of timely research and information from the Vegetable IPM program. 83% reported increased yields and 80% reported decreased use of broad-spectrum chemistries. 70% reported that our outreach helped them avoid economic losses through IPM. Adoption of reduced-risk IPM strategies saved average grower operations an estimated $480k to $1.5 million annually in insect management costs.

The Vegetable IPM program has facilitated a shift in the industry from broad-spectrum insecticides in the 1990s and early 2000s to selective materials which pose fewer risks to people and the environment. For example, with the exception of pyrethroids, broad spectrum and broadly toxic insecticides have been all but eliminated on head lettuce (Figs. J8 and J9), where selective reduced risk materials now account for over 60% of all reported insecticide sprays (53,795 acres reported in Fall 2022 and Spring 2023).

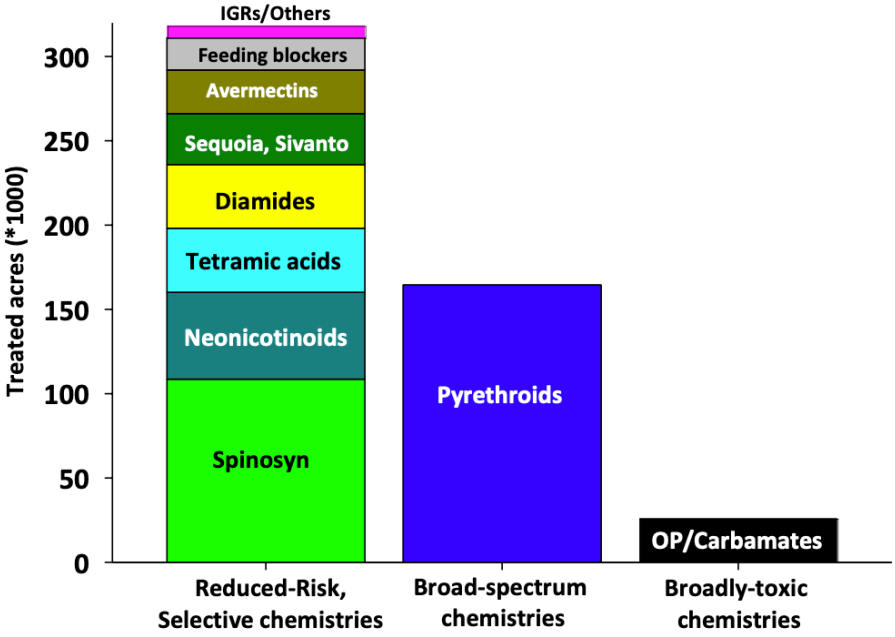


Figure J8. Insecticide use for seasonal insect control on lettuce, 2022-2023.

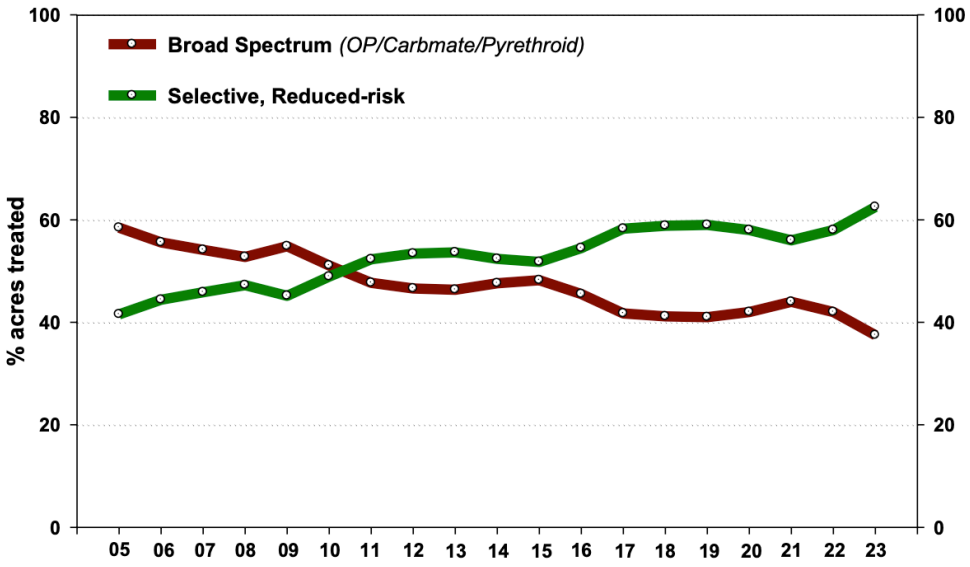


Figure J9. Percentage acreage treated with broad spectrum versus selective, reduced-risk insecticides on desert lettuce, 2005-2023.

The team continues screening new biopesticides and insecticide alternatives for organic production, determining how they fit into local IPM and resistance management programs. This

work has resulted in new insect management recommendations for certified organic lettuce, an important growing market.

In collaboration with local pest managers, growers and shippers, the team completed several research and educational outreach projects focused on better understand Impatiens Necrotic Spot Virus (INSV) and Western flower thrips in lettuce. Efforts in 2022 led to more clearly determining the epidemiology of INSV infection in the desert, defining seasonal thrips dynamics and developing new IPM guidelines for cultural and chemical management.

Guayule IPM

Arizona faces the challenge of climate change. Water-strapped Central Arizona needs cropping alternatives that provide economic success for growers while also reducing greenhouse gas emissions and water use. Guayule is a desert-adapted shrub grown for rubber production and other uses, currently in development by Bridgestone America. Guayule's potential as a low water use alternative to traditional field crops could provide climate benefits in carbon sequestration, reduced greenhouse gas emissions, reduced tillage and lower insecticide use. However, guayule seedlings are vulnerable to attack by the large flea beetle, *Systena blanda*, which can kill plants and significantly reduce stands.

The Ellsworth lab is developing cultural and chemical controls for this flea beetle. Five years ago, his research led to the development of a seed treatment that limits losses to this flea beetle. His research supported the registration of this product under the state of Arizona's Special Local Needs program, making it available to the guayule industry of this state. Without this control measure in place, it would have been unlikely that this crop could be commercially developed further. Recently, his program contributed to the successful awarding of a USDA Climate Smart grant to the University of Arizona. This $35M grant will help incentivize the uptake by growers of this climate-smart crop on at least 4,000 acres in central Arizona over the next five years and likely more than 25,000 acres over the next ten years. As part of this effort, the team will identify and measure hypothesized environmental co-benefits including reduced regional densities of Lygus bugs, a key pest of cotton, and increase regional densities of key generalist arthropod predators. As well, they hope to document increased habitat for and supply of native solitary bees.

<u>Community IPM</u>

Community IPM focuses on supporting the needs of communities, including issues of public health, food safety, and community resilience.

Public Health IPM

Our Public Health IPM Team (Fig. 3) is led by Drs. Dawn Gouge and Kathleen Walker with participation from Dr. Ellsworth (Entomology), Dr. Channah Rock (Environmental Science), and Drs. Mona Arora and Kacey Ernst (College of Public Health) and includes long-term program investments in housing and school environmental health, vector control programs for mosquito and tick management, as well as food safety programs that target agricultural producers in tribal

communities. The latter effort led by Department of Entomology AiE Dr. Shujuan Li and Dr. Rock.

Arizona is home to 22 tribal nations, more than any other state. Many tribal members live in remote areas with minimal access to medical facilities and advice. There is a documented critical need to provide education and resources within tribal communities to reduce threats from public health pests, risks of pesticide exposure and environmental risks of pesticides, and to improve food safety. Since the Public Health IPM Team was formed, contacts with tribal members have increased over 500%. We estimate that 249,000 residents in tribal communities have benefited from our public health IPM program on approximately 42,604 square miles of reservation lands. From 2018 to 2020, we directly reached 18,286 participants in meetings, workshops and conferences, demonstrations, and outreach events. Surveys from 2019 (n = 326) indicated up to 75% increase in knowledge of IPM, public health pests and pesticide safety. A majority of tribal collaborators have indicated they will use IPM to improve their lives and communities.

These programs form true and enduring partnerships with diverse tribal communities, based on their unique needs and respected customs, beliefs, and sovereignty. For example, a recent grant-funded project led by Walker focused on developing a sustainable tick surveillance program to combat Rocky Mountain spotted fever (RMSF), a serious disease transmitted in Arizona by the brown dog tick. Since 2002, there have been more than 375 human cases of RMSF with 21 fatalities, mostly children, in tribal communities in Arizona and many more in Mexico. Over the years of the project (2020 to 2023), partners at the Tohono O'odham Nation (TON) Vet Clinic, TON Community Health and the University of Arizona Department of Entomology have established an annual mobile rabies vaccination and tick prevention clinic that visits every village in the Nation. Over 5,000 animals have been vaccinated and treated with tick preventatives, and many have received treatment for other diseases such as mange and parvo. Both the mobile clinics and the UA/TON partnership are continuing with funds from additional grants and support from TON Council. In addition, Walker and team were awarded a $500,000 grant from the Centers for Disease Control to conduct statewide assessment of ticks and tick-borne diseases. Similar efforts have provided outreach education, monitoring and testing programs for mosquito management across many tribal communities.

Since 2018, the IPM team has partnered with 15 of Arizona's 22 federally recognized Native American Nations (Appendix J6) and has reached nearly 250,000 residents through its programs, trainings, and information. At least four tribes have adopted integrated pest management within their disease-prevention programs, protecting over 24,300 tribal residents from illnesses such as Rocky Mountain Spotted Fever and West Nile virus that can be spread from brown dog ticks and mosquitoes, respectively. Outreach on School IPM has also been impactful across many tribal communities. Africa Dorame-Avalos, Pesticide Program Manager with the Inter Tribal Council of Arizona said of our programs, "The biggest impact is that our [members] want to learn more. They want to expand it to other communities, not just in schools, but in homes. People want more education and assistance on implementing more of these principles."

https://cales.arizona.edu/news/uarizona-partnership-tribal-communities-knocks-out-pests-not-environment

Gouge and Walker lead the "Healthy and Safe Homes" initiative within the Advancing Health Equity, Addressing Disparities (AHEAD AZ) project. This is a UA Center for Rural Health program funded by the Centers for Disease Control and Prevention (CDC), through the Arizona Department of Health Services (ADHS) and is part of the national initiative to address COVID-19 health disparities among populations at high risk for COVID-19. Building on existing relationships, Gouge and Walker engage tribal school and housing managers and local environmental health leaders to identify and address Indoor Air Quality (IAQ) and IPM needs in tribal homes and education facilities. Tribal environmental health leaders from the Tohono O'odham Nation together with indoor air quality experts from the Institute for Tribal Environmental Professionals and UA faculty have embarked on a community needs assessment (completed), professional development events, community environmental health assessments, resident outreach (planned), and corrective action and evaluation. Exercises and demonstrations of environmental health improvements as a component of public health, within a One Health framework are emphasized.

Gouge and Walker also lead a 4-year NIH funded pilot project (NARCH 12) partnering with the Cocopah Tribe to increase the tribe's capacity to monitor and mitigate risks associated with vector-borne diseases. At the beginning of the second year, we have increased mosquito surveillance and testing for West Nile virus. Plans to initiate tick surveillance for the first time in the community are underway.

The Public Health IPM Team's newest effort builds on existing relationships with tribes to deliver food safety programs to tribal growers, based on the IPM model, in collaboration with Dr. Channah Rock from the UA Environmental Sciences department. Arizona has the largest concentration of American Indian farms in the United States. According to USDA, nearly 21 million farm acres in Arizona are tended to by producers on tribal land. In 2012, these farms sold near $67 million worth of agricultural products. Native farmers are exempt from the Food and Drug Administration (FDA) training and certifications which are required for non-tribal professionals, but they are not exempt from the marketplace. These new programs have the potential to protect millions of consumers from food-borne illness and to foster the economic success of tribal growers and communities.

School IPM Inside and Out

Our School IPM "Inside and Out" program is aimed at reducing student and staff exposure to harmful pests and pesticides through effective building and landscape pest management in K-12 schools. These programs have reduced pesticide applications an average of 71% and pest complaints by 78% and led to measurable improvements in air quality, affecting over 300,000 students statewide. In 2020, we worked at nine school sites in eight partner districts. Partner schools serve as hubs to expand our outreach programs to other school districts and community audiences. Since 2018, Department of Entomology AiE Dr. Shaku Nair has coordinated the

annual Arizona School IPM Conference, which has delivered education on indoor and outdoor pest management, pesticide safety and public health topics. In 2020, the conference was adapted for online delivery, with 146 participants, nearly triple the previous year. 89% of participants reported increased IPM knowledge and 91% said they would use the information in their jobs or daily life. Our School and Home IPM Newsletter reaches about 1,500 people in Arizona and over 5,000 nationwide 8 times/yr. Our online Extension publications average 2,000 annual page-views and downloads. Team members significantly contribute to nationally beneficial efforts including creation of EPA-funded Pest Defense School IPM training modules, which has provided training to over 8,000 school staff nationwide since 2020. In Arizona, our program has reached over 20,000 people through presentations, publications, online information and high traffic outreach events.

Dr. Gouge is lead author on a recent publication, "Improving Environmental Health in Schools," which was published in Current Problems in Pediatric and Adolescent Health Care, Vol. 53, Issue 4. The article highlights common environmental challenges in schools and opportunities for improvement through a holistic "Integrated Environmental Management" approach, which incorporates IPM, indoor air quality, green cleaning, pesticide and chemical safety, food safety, fire prevention, building legacy pollutant management, and drinking water quality.

Stop Pests in Housing
Dr. Gouge has led long-term projects in elderly and/or disabled subsidized housing. Pest management services were minimized throughout the COVID-19 pandemic which has had serious impacts on the living conditions. Currently, a HUD-funded one-year impact assessment and IPM intervention effort is underway, and we are currently completing data collection on pest infestation reduction and resident wellbeing.

<u>IPM Assessment</u>
Our unique IPM Assessment Leadership Team, led Dr. Al Fournier, provides centralized common-pool resources to support needs assessment, websites and communication networks, and evaluation across all IPM programs and teams. The identification and prioritizing of IPM stakeholder needs serves as the foundation of all IPM program planning, ensuring the most effective allocation of limited resources, better program relevance and competition for extramural support, and increased documentation of impacts.

Pesticide Use Database. In cooperation with the Arizona Department of Agriculture and a stakeholder advisory committee, we developed the APMC Pesticide Use Database (1991 – present). The rigorously quality-assured data include all agricultural applications submitted by statutory requirement, representing the range of practices across over 120 different crops, with more than a million use records spanning 30+ years. These data (e.g., Figs. J6 & J7) are used to document impacts of our IPM programs, for research and education, and to support responses to calls for public comment on pesticide registration reviews on behalf of stakeholders.

Crop Pest Losses and Impact Assessment. Few agricultural industries actively measure even the most basic metrics of economic, environmental, or human health status. The Crop Pest Losses Signature Program of the Western IPM Center engages stakeholders to assess the current state of their industry, including yield losses to pests, pesticide use, and economic outcomes. Annual surveys for cotton and lettuce are administered by Dr. Ellsworth and Dr. Palumbo, respectively, developing data which complements our pesticide use data by revealing participant perceptions of pest impacts and intentions behind pesticide applications (i.e., target pests). We compile detailed information on yield impacts and control costs of insect, disease and weed pests during a series of annual interactive, face-to-face and/or virtual workshops in Arizona and adjacent low desert regions of California. The workshops also help us identify pest management needs and emerging issues that inform Extension program planning. These data (e.g., Figs. J5, J6, J8 and J9) are valuable for assessment of program impacts, education and outreach.

Since the 2009 Academic Program Review, we discontinued a pest losses survey on melons and elevated the program to a Signature Program of the Western IPM Center and supported the development of crop assessments in the Pacific Northwest, including cranberry, hazelnut, cherry, potato, mint, and onion. We supported collaborators at Oregon State University, who have analyzed the data and developed a series of "Pest Impact Reports" (Extension publications). This detailed process provides unique and actionable insights to improve pest management and economic and environmental outcomes.

<u>Pesticide Research & Education</u>

Pesticide Risk Assessment: Research, Education & Mitigation.
The APMC Pesticide Use Database combined with US-EPA risk assessment data is instrumental in understanding patterns of pesticide use and potential risks to workers, pollinators, other non-target organisms, and the environment. This approach, along with expert interviews, was the basis of the Better Cotton Initiative project described in the Cotton IPM section (Fig. J7). Similar risk analyses using EPA data informed pesticide recommendations to growers in our Cotton Insecticide Use Guidelines (Appendix J5). The flow is from research to education to mitigation of real pesticide risks to people and the environment in the field. In addition, Fournier and Ellsworth collaborated with Dr. Melissa Furlong (UA College of Public Health, Environmental Health Sciences) in a study she leads funded by the National Institute of Environmental Health Sciences. This project examines Arizona pesticide use patterns of certain insecticides in relation to child birth weights and other publicly available data. The results were recently submitted to the American Journal of Epidemiology.

Regional IPM Network, Arid Southwest
The Arizona Pest Management Center (APMC) maintains a vital information network for the arid southwest region (Arizona, New Mexico, Nevada, and the desert regions of California), culminating in evidence-based testimony to our regional and federal partners, especially the US-Environmental Protection Agency, with a focus on responding to pesticide registration reviews. This expert testimony involves pesticide use data from the APMC Pesticide Use Database and

Crop Pest Losses surveys from our region, as well as detailed input from growers, pest managers, industry professionals, Extension personnel and scientists. Our involvement is important to ensuring that EPA's regulatory decisions and scientific models of risk incorporate accurate data and an understanding of grower practices and needs. One prominent stakeholder, referring to a specific set of EPA public comments we developed, stated in an unsolicited letter to the Dean that we had "created a professional and scholarly set of comments that…the industry could reference in our supporting comments to the federal agency. This was very helpful to our industry." In another example where State Attorneys General were commenting on specific pesticide practices, another stakeholder cited the importance of our pesticide risk research in an unsolicited correspondence, "I imagine there are times researchers must feel a little unsure if a project will be meaningful and I wanted to make sure you knew how important your work has been to the industry."

With Dr. Fournier as Director of the Southwest Regional IPM Network, we represent one of four sub-regions for which the Western IPM Center coordinates stakeholder comments on pesticide registration reviews (the others are California, the Pacific Northwest, and the Pacific Islands). A 2022 analysis of 85 comments submitted to EPA on behalf of Western agricultural stakeholders found that nearly 90% of comments provided substantive data that were considered in EPA's registration review process (Fig. J10). This included 20% of comments that resulted in revisions to EPA risk models or otherwise altered regulatory decisions in ways that addressed grower's concerns while mitigating risks to protect human health and the environment. The majority of comments analyzed (48) supported the economic interests of Arizona agriculture and urban pest management while providing scientific information to support effective public policy.

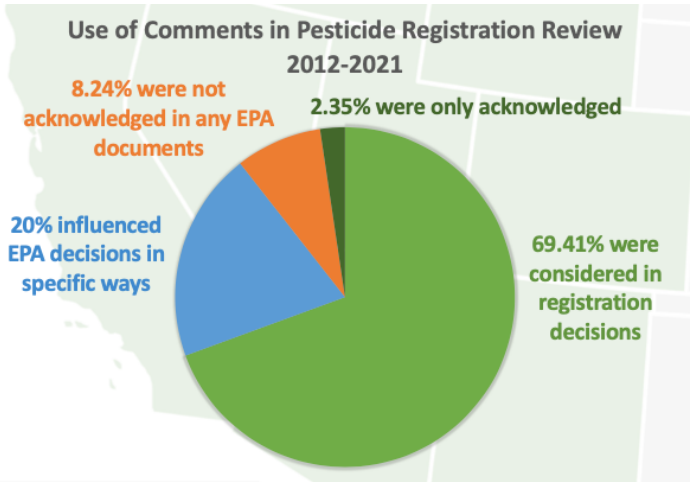


Figure J10. Analysis of EPA responses to 85 comments submitted by Regional IPM Network Coordinators in the West. Based on information in EPA registration review documents. This shows the extent to which information provided was considered by EPA during registration review.

Pesticide Safety Education
In the 2009 Academic Program Review, we reported a "distributed approach" to pesticide safety education following personnel loss after cuts to the federally funded Pesticide Safety Education Program (PSEP). Since then, a full-time dedicated person has been restored to this position. This was accomplished from 2014 to 2018 with 50% funds from the USDA EIP foundational grant to the APMC that were leveraged with other resources. Since 2019, Ms. Jennifer Weber (Associate in Extension), has coordinated this program as a collaboration between UA Cooperative Extension and the Arizona Department of Agriculture.

K. COLLABORATION WITH OTHER UNITS

Extensive collaboration occurs between the Department of Entomology and the EIS GIDP. The Department of Entomology as well as EIS GIDP students and faculty collaborate with the six additional units across three colleges that actively participate in the EIS GIDP: School of Natural Resources & the Environment in CALES; Departments of Ecology & Evolutionary Biology, Geography, Molecular & Cellular Biology, and Neuroscience in the College of Science; and the Department of Epidemiology & Biostatistics in the College of Public Health. Faculty at the Maricopa Agricultural Center (MAC) have an extensive collaborative network (Fig. J4). We also promote collaboration via our leadership. For example, Rachel Doty (ENTO Business Manager Sr.) chairs the ALVSCE Staff Council, Molly Hunter chairs the Graduate Interdisciplinary Programs Advisory Council, and Bruce Tabashnik chairs the CALES unit leaders team.

SECTION L: FACULTY PLANNING

Department of Entomology

The faculty's collective view is that the future of the Department of Entomology is bright, particularly because of the seven faculty hires in the past eight years (Section E.5). We plan to continue to deliver outstanding research, instruction, Extension, and outreach in entomology that improves the lives of the people of Arizona and the world. Key factors driving this success will continue to be the exceptional quality of the department members, their dedication, and their collegial interactions.

Entomology & Insect Science GIDP

Faculty membership growth. At the time of the last APR in 2014, EIS had 33 faculty members in 10 departments in four colleges. We still have memberships in most of these departments, but there's no question that the active membership in EIS beyond the Department of Entomology has shrunk since our last review, and this is why we chose to highlight an active membership of 12 additional faculty and EIS associates (USDA scientists) with faculty in five additional UA departments (Fig. A3). The reason for the shrinkage is partly a sub-discipline shift in Neuroscience to faculty studying mammals. Neuroscience was historically home of some of our most involved members, and some are now retired. Some of the shrinkage was clearly due to the pandemic era

when many people reduced their activities beyond their home departments and the community-building social events stopped or went online.

We therefore plan to increase active recruiting of new EIS faculty members within and beyond the Department of Entomology. Since the last review, we have gained more active participation from Epidemiology (Kacey Ernst and Heidi Brown). We have also recently recruited Keith Maggert, a *Drosophila* cell biologist who recently moved departments from the College of Medicine to Molecular and Cell Biology. Further, two new faculty are joining the Department of Entomology, Natasha Tigreros and Paulina Maldonado-Ruiz, who are both in the process of joining EIS. Dr. Maldonado, a tick physiological ecologist, is a GIDP Shared Hire, with the GIDP Administration providing partial salary for the first three years to support interdisciplinary teaching and mentoring. Four-five more faculty active in collaborations or graduate committee membership in our program will be asked to join in the next year.

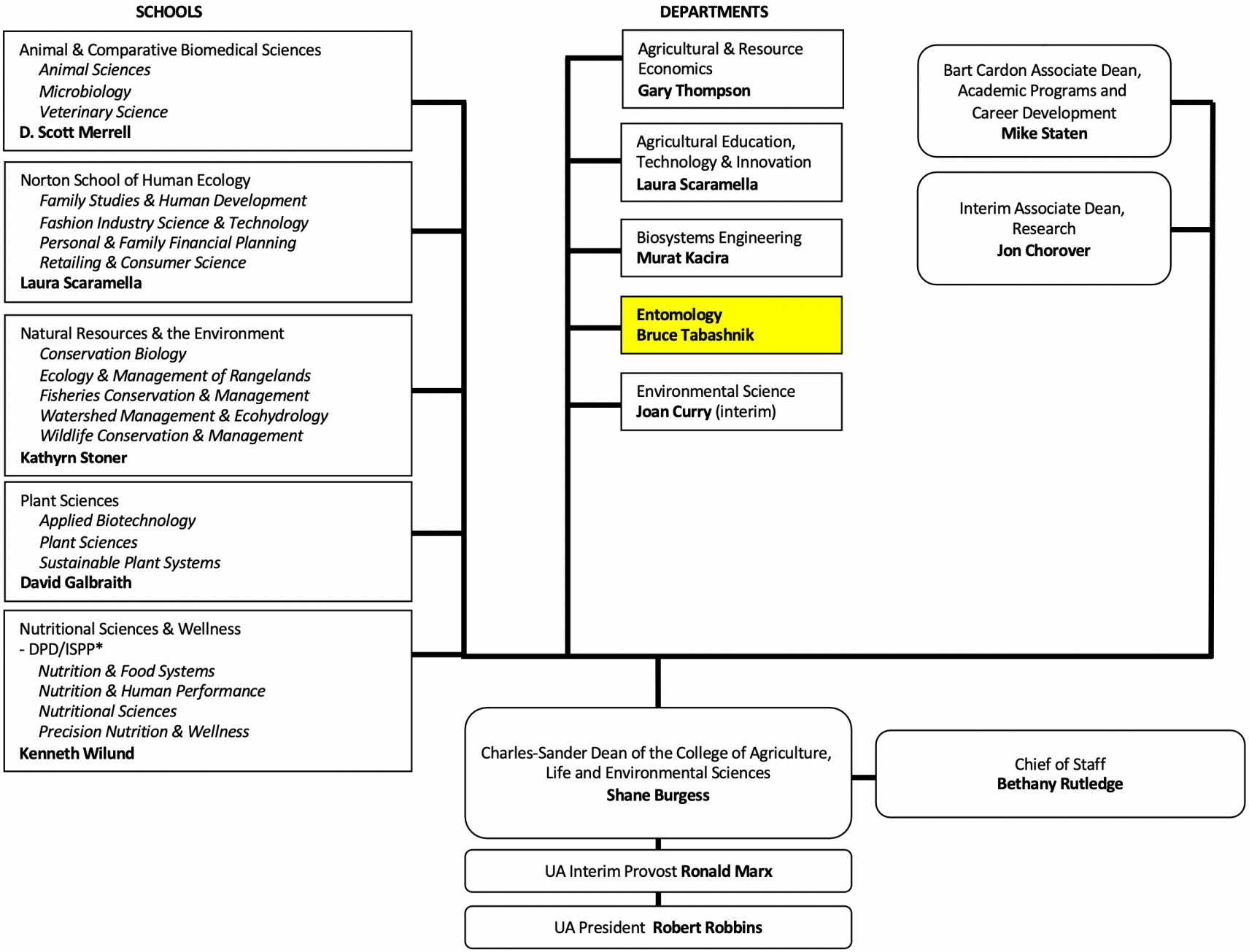
Policy changes and retreat. In a recent meeting of the EIS Advisory Committee evaluating student progress reports (July ’23), and a subsequent meeting of the EIS Executive Committee (Aug ’23), some observations and suggestions for changes of policy were considered. A new program assessment plan was adopted by the EC (see section I.4). Other possible changes were discussed. These included small changes to speaking requirements, allowing flexibility in when (pre- or post-comprehensive exam) and where (on or off campus) the requirements are met). We also need to consider an adjustment of program course requirements, because one class (EIS 520 Insect Systems Biology) has not had sufficient enrollment to be taught in several years, and it is currently one of the three courses designated a “core course;” and students are required to take two of three. By default, then, all the students take the remaining two courses: EIS 517 Insect Systematics and EIS 544 Insect Ecology. A possible solution is to have all students take the two remaining core courses and one additional EIS course taught regularly, for example, EIS 532 Comparative Immunology, EIS 507 Medical and Veterinary Entomology, EIS 532 Agroecology, or EIS 501 Ecological Physiology. This is just one obvious topic for discussion.

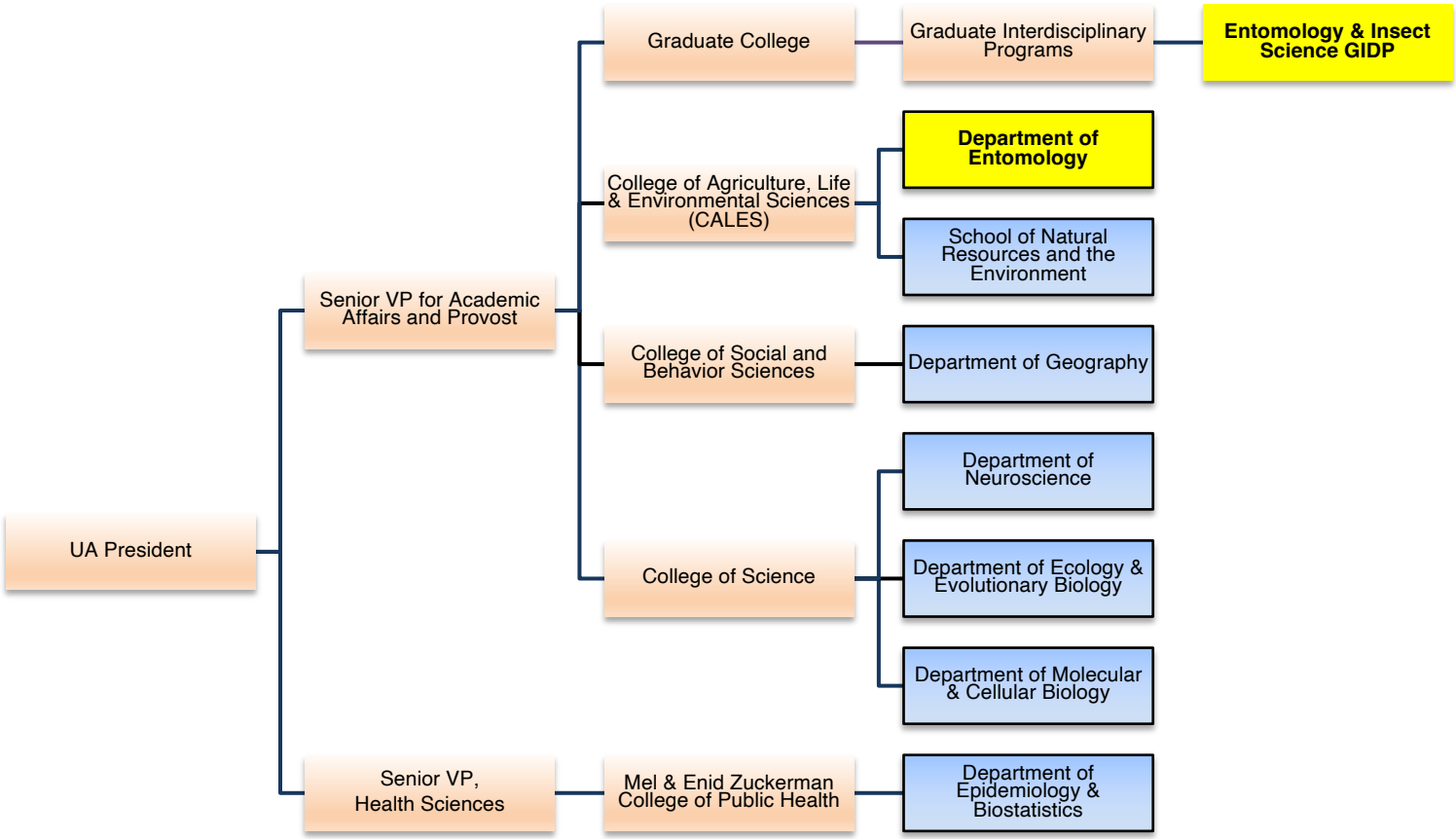
We have had great success in the past in adopting new program policy from off-campus retreats of faculty and students. Program retreats were adopted since our last review. In mixed faculty and student tables of 3 and 4, policy issues are discussed, consensus views shared, and actionable items then brought at a later meeting of the EIS Executive Committee for a vote. We had three retreats (two at the UA Southern Arizona Experiment Station cabin in the Santa Rita mountains, one at Appleton Whittell Research ranch of the Audubon Society in Elgin, AZ), and planned to have one in Spring of 2020 before everything was shut down. There is a need for another one. We plan to devote a program lunch this fall to a few items for discussion and plan an off-campus retreat in the spring of 2024. For the latter, the agenda will be open to faculty and student input.

The future of EIS GIDP. To echo the Department of Entomology’s statement above, the quality and commitment of students and faculty of EIS promise a bright future. While we face some financial headwinds (e.g., Table G3), our students are diverse in identity and interests, finish their degrees at high rates (Table I5), and advance to careers or further education made possible by their EIS degree (see Table I6).

updated 8/9/2023

Appendix A1
The University of Arizona
COLLEGE OF AGRICULTURE, LIFE and ENVIRONMENTAL SCIENCES
(Morrill Act, 1862)





Appendix A2. University of Arizona Organization Chart Highlighting the Entomology & Insect Science GIDP and the Department of Entomology. The seven units with active EIS member faculty are outlined in black.

Appendix B1.

ENTOMOLOGY 2025 STRATEGIC PLAN

October 30, 2019

Purpose

Improve the quality of life of the people of Arizona and the world by generating, disseminating, and applying information about insects.

2025 Vision (each component below is reflected in a specific strategic goal)

1. The quality and impact of our research will be recognized in Arizona, nationally & globally.
2. Our IPM programs will be implemented in Arizona and other regions worldwide and will promote better health, protect the environment, and boost the economy.
3. We will engage undergraduate students with active-learning courses and mentoring to help them succeed in the fourth industrial revolution (4IR).
4. The graduate program in Entomology & Insect Science (EIS) will attract the best students; students completing EIS degrees will be in high demand by employers.
5. Our outreach programs will educate, delight, and connect community members with Entomology, CALS, and the University of Arizona.
6. The UA Insect Collection will be the best source of specimens from the Sonoran Desert Region and a global center for specimen-based insect research.
7. Our programs will be well supported by private donors, as well as by governmental agencies.

Mission

- Conduct outstanding research to better understand insects and their impact on humanity
- Provide distinguished education in insect biology
- Provide innovative solutions to address critical issues such as food security and vector-borne diseases
- Develop and deploy the most advanced technologies and progressive IPM programs in the world to minimize the negative impacts of insects and maximize their positive impacts
- Provide outstanding outreach programs about insects accessible to all community members

Shared Values

- Respect for all people
- Collaboration among department members
- Collaboration within & across disciplines with others in CALS, UA, and other institutions
- Put knowledge to work to improve lives
- Serve our profession and the people of Arizona and the world
- Excellence in all pursuits
- Passion for achieving positive outcomes
- Work hard and have fun doing what we love to do
- Provide value for resources invested in Entomology
- Develop programs with local and global relevance
- Take advantage of our desert environment & position in the front line of climate change

1. RESEARCH STRATEGIC GOAL: Increase Entomology research productivity 30% by 2025.

A. Current situation and gap between current and desired situation

Outstanding, cutting-edge research is our hallmark and the core strength that underlies excellence in our instruction, Extension and outreach. We aim to capitalize on this core strength to increase Entomology research productivity 30% by 2025. Our internationally recognized research must rise to meet the challenges of climate change and a rapidly increasing human population. These challenges demand innovative interdisciplinary research to lead the way in combating crop pests, biomedical pests, invasive species, and the decline in biodiversity.

B. Strategies to achieve goal

1. Target critical global issues with research led by our faculty and their collaborators
2. Retain current faculty who have outstanding research productivity
3. Recruit new faculty with outstanding research productivity
4. Increase research productivity of current faculty
5. Enhance collaborations in the Dept. and with others (UA, national, and international)
6. Strengthen research infrastructure including support staff and facilities

C. Actions **Time Period (Fiscal Years)**

- Continue building interdisciplinary teams to address global challenges 2020-25
- Reward faculty achievement with merit raises and promotions..... 2020-25
- Nominate faculty for awards to recognize their outstanding achievements 2020-25
- Enhance mentoring of faculty by head and outstanding peers..... 2020-25
- Encourage and reward productive team efforts 2020-25
- Recruit faculty in areas with strong extramural funding prospects: mitigating .. 2020-25
  effects of climate change on biodiversity, pollinators, and food security;
  invasive species; insect genomics and bioinformatics;
  and insects of biomedical importance.
- Obtain more funding from international sources 2020-25

D. Inputs needed to achieve the goal

- 6 tenure-track faculty lines (0.80 FTE research, 0.20 teaching): $510K salary per year + ERE; startup of $1.8M
- Research support staff: 12 FTE, $480K salary per year + ERE
- Repair or replace shared research equipment: $20K per year

E. Objective metrics that will be used to track progress towards attaining goal

- Extramural research funding per faculty research FTE per year
- Publications listed in Web of Science per faculty research FTE per year
- Citations per departmental publication in Web of Science
- Faculty honors and awards

Note: We expect 4-5 current tenure-track faculty will leave the department by 2024. Thus, filling the 6 requested faculty lines would slightly increase the number of tenure-track faculty.

2. IPM STRATEGIC GOAL: By FY25, greatly enhance effectiveness of Integrated Pest Management (IPM) research, education, and Extension programs in Arizona for teaching students and stakeholders, and for addressing health, environmental, and economic problems caused by pests.

A. Current situation:

- Cooperative Extension and research programs in IPM have garnered national and international recognition for their development and deployment of new strategies with large impacts on the economy, environmental protection, & society (e.g., > $500 million saved since 1996 in Arizona alone).
- Key IPM faculty have left in the past decade (Dennehy, Byrne, Baker) and 2-4 of the remaining five Extension faculty are likely to leave by 2025.
- An internationally recognized graduate IDP in Entomology & Insect Science, with undergrads and graduate students actively engaged in fully integrated research/Extension programs giving them practical experience addressing real-world challenges.
- Capacity to create a premier U.S. center for IPM research, education, and Extension is incomplete, but would attract major funding, the best scientists, science, and students of IPM, and would generate solutions to society's pressing needs for safe and secure food, fiber, and healthy environments.

Desired situation:

- A world-class student-centered graduate and undergraduate IPM educational program (IDP) that capitalizes on the high profile research and Extension programs currently in place.
- Stable funding for students engaged in interdisciplinary problem-solving programs.
- An interdisciplinary synergistic approach that enables a fully collaborative environment across unit boundaries and enhances our effectiveness at winning major grants and having major impacts.
- Establish the UA as a premier center for IPM research, education, and Extension that impacts the future of the science and its application and implementation, and supplies the workforce needed to educate a generation of students that will face daunting food security, safety, and environmental challenges posed by pests and pest-related risks.

Gaps:

- New IPM teaching personnel are needed to develop the interdisciplinary curriculum that provides the third leg of our integrated research, education, and Extension IPM center.
- Investments have been made to establish cooperative teams including numerous units from within and external to CALS that work collaboratively with broad national networks, but the human assets employed to coordinate and link multiple groups across the state are funded solely by grants and contracts, thus program stability is constantly under threat.
- New IPM research and Extension personnel to fuel innovation in science and implementation.

B. Strategies to achieve goal

1. Recruit and retain outstanding faculty, other appointed personnel & classified staff in IPM.
2. Create a fertile environment for the development of translational sciences needed to support IPM.
3. Leverage resources from gifts/grants/contracts to support staffing needs (50% share of each).
4. Partner with allied colleges (e.g., Public Health, Pharmacy, Medicine, etc.), departments and units with similar interests to develop an IPM curriculum and to forge strong interdisciplinary relationships in research and Extension (Entomology (lead), Biosystems Engineering, Agricultural & Resource Economics, School of Natural Resources & the Environment, Plant Sciences,

Environmental Science, Experiment Station (MAC, YAC, SAC, CAC), County, and statewide Tribal Cooperative Extension Offices).

5. Develop courses (Gen Ed IPM, Advanced Topics in IPM, structural IPM, Medical & Veterinary IPM).
6. Establish new Extension IPM programs to meet stakeholder needs (e.g., Greenhouse, Small Farms, Commercial Horticultural IPM).
7. Establish stable funding for graduate student Extension assistantships & undergraduate research & Extension internships.

C. Actions **Time Period (Fiscal Years)**

Secure 50% CALS/State funding of salary + ERE for highly productive appointed personnel who are now 100% grant funded ……2021-25
Hire IPM faculty (80% research:20% teaching) & 1 research specialist..... 2021
Offer 100 level IPM Gen Ed course 2021
Offer specialized 400/500 level IPM courses (e.g., Biocontrol, Urban IPM)……2022
Hire IPM faculty (80% Extension:20% teaching) & 1 research specialist..... 2022
Establish three IPM RA/TAships..... 2022
Hire IPM faculty (80% Extension:20% research) & 0.5 Extension educator 2023
Establish two IPM Extension Assistantships 2021
Hire IPM faculty (80% Extension:20% research) & 0.5 Assistant in Extension 2024

D. Inputs needed to achieve the goal

- Research/teaching faculty in IPM (2; $170K salary per year + ERE)
- Classified staff (2 @ 3 years each; $390K total)
- Graduate assistantships (2 RA/TAs; $50K/yr)
- Cross unit agreements to mentor students
- Extension/research faculty in IPM (2; $170K salary per year + ERE)
- Assistant/Associate in Extension (appointed, 4 @ 0.5 FTE; $130K salary per yr + ERE)
- Extension assistantships (2 Ext. Asst.; $50K/yr)
- Undergrad summer internships (2@ 0.5; $4K/yr)
- One-time startup cost for 4 IPM faculty $800K

E. Objective metrics that will be used to track progress towards attaining goal

- Number of IPM undergraduate and graduate students recruited to & graduated from IDP programs
- Number and amounts of grants awarded to IPM faculty
- Number and % of IPM graduates placed in career-track positions (near 100%)
- Number of professional continuing education units offered (CEUs) and delivered (No. of participants)
- Economic and social impacts of our IPM programs ($ saved, pesticide use reductions)
- Increased security and safety of food and fiber supply produced in Arizona
- Number of peer-reviewed publications created each year
- Number of awards and honors received by IPM faculty
- Successful and continuing leverage of staff resources (classified staff > 3yrs; 2@0.5 Extension educators)
- Interest in and extramural support for fellowships, internships, assistantships, and endowments

Notes

The investment in human capital is a ca. $500K per year with one time costs of another $390K in staff support. Leveraged returns on this investment will easily be 3-fold & costs mostly offset by IDC returns to University [average annual grants (realistic, initially): $250K/yr/faculty or $1M/yr; average IDC rate %30 or $300K/yr; (ideally and over time) $3M/yr total with ca. $1M/yr in IDC].

- Federal re-organization of IPM funding under a consolidated "Crop Protection" line of the USDA will increase visibility and funding for this vital program, and increase and standardize IDC to 30% equivalent to an effective rate of 42.65% of TDC (from previous 0–22% depending on sub-program).
- USDA's National Institute for Food and Agriculture (NIFA) has created the Agriculture and Food Research Initiative (AFRI) competitive grants program that now rewards large, collaborative, team-based, and integrated (research, education, Extension) projects. Many awards are in the millions of dollars and at least 30% of funds from this program will be allocated to the Extension components. IPM, as a practical science that can fully articulate with Extension implementation programs, will have many new opportunities for funding through this program. A premiere IPM center for research, education, and Extension at UA would be ideally positioned to capture major resources from this program. Current IDC cap at 30% for this program, but many believe that future authorizations of this program will increase this cap in the future. http://www.csrees.usda.gov/business/awards/indirect_cost.html

3. UNDERGRADUATE ENGAGEMENT STRATEGIC GOAL: Increase the yearly undergraduate student credit hours taught 30% by FY2025.

A. Current situation and gap between current situation and desired situation

The Department of Entomology more than doubled the yearly undergraduate student credit hours (SCH) it teaches during the past decade, but would like to do more to provide students with a common foundation of competencies and skills to help them succeed in the 4IR. Accordingly, we aim to increase SCH taught 25% by FY2022. We have increased the number of undergraduate students mentored by faculty in our research labs, which strengthens the students' critical thinking skills, engages them in cutting edge research, and makes them more employable. Because of the exceptional benefits of this mentoring, we also seek to expand our impact in this area.

B. Strategies to achieve goal

1. Increase the percentage of undergraduate courses taught through active learning to 60% by FY2021 and 75% by FY2022.
2. Increase faculty mentoring of undergraduate students in Entomology laboratories
3. Implement a certificate program in Entomology
4. Develop a minor in Entomology

C. Actions **Time Period (Fiscal Years)**

- Support faculty to incorporate active learning in their courses..... 2020-25
- Appoint a departmental coordinator for undergraduate research…… 2020-21
- Revise certificate program proposal (if needed) after receiving UA feedback….2020-21
- Produce and submit proposal for minor in Entomology……..2020-21
- Reward faculty for undergraduate teaching and mentoring……..2020-25

D. Inputs needed to achieve the goal

- Faculty effort in incorporating active learning in their courses
- Faculty effort in mentoring students in their laboratories
- Approval by UA of the certificate proposal we submitted in 2016, with potential revisions by faculty to meet new guidelines, if needed

E. Objective metrics that will be used to track progress towards attaining goal

- Undergraduate SCH taught per academic year
- Percentage of undergraduate courses taught through active learning
- Number of undergraduate students mentored by faculty per year in Entomology laboratories
- Presentations by undergraduate students at scientific meetings
- Awards won by undergraduate students
- Journal articles coauthored by undergraduate students

4. GRADUATE PROGRAM STRATEGIC GOAL: Double the stable funding for Entomology & Insect Science (EIS) graduate students by FY25.

A. Current situation and gap between current situation and desired situation

The Graduate Interdisciplinary Program in Entomology & Insect Science (EIS) is nationally recognized as excellent and attracts outstanding students. In the past 15 years, 94% of students completing MS or PhD degrees in our graduate programs (EIS and its previously separate parent programs Entomology and Insect Science) obtained positions related to their graduate training. Enrollment in EIS has remained stable at ~30 students, with the largest single year intake (10) in AY19-20. Yet, funding for students is unpredictable, which threatens future recruiting and the long-term success of the program. Although faculty grants support some students, the largest single funding source now is via TAs for undergrad courses that we do not control (i.e., Introductory Biology courses in the College of Science). We are grateful for CALS support for GAs, but this has declined in the past few years from about 3 to 1 GA per year. In recent years, larger enrollment classes taught by our faculty have modestly increased our CALS funded TAs. To attain the desired situation of a standing enrollment of 30 or more fully funded EIS students, we aim to double funding from stable sources.

B. Strategies to achieve goal

1. Increase support of RAs via increased faculty research grants (see Research Goal)
2. Improve online interface with potential students and the general public
3. Build enrollment in frequently taught general education courses to earn TA support according to the CALS formula (each 60 students = 0.25 TA).
4. Solicit donors for endowments for student-invited speakership (Hagedorn) and student cash award to honor Genevieve Comeau (in progress)
5. Build support for first and second year students to apply for outside graduate fellowships (NSF, NIH, USDA)
6. Shift recruiting strategy to prioritize PhD over MS students to align with the new CALS first year funding formula providing 0.5 GA per 3-year rolling average number of first year PhD students (and none for MS students).

C. Actions **Time Period (Fiscal Years)**

- Increase donor base and obtain donations for supporting students 2020-25
- Develop the spring EIS seminar as a short research proposal writing seminar 2020-21
- Increase enrollment in frequently taught general education courses to earn TA support according to the CALS formula (each 60 students = 0.25 TA)……2020-25

D. Inputs needed to achieve the goal

- Faculty effort in increasing extramural grant funding with support for RAs
- Faculty effort in recruiting and mentoring EIS PhD students
- Efforts of department members and Advisory Board to develop donor base for student endowments: Attractive brochures, displays for Insect Festival, and websites
- Faculty teaching effort in large undergraduate courses
- CALS/UA increase in funding per year for GAs from current $27K to $66K
- CALS/UA support of TAs for 4 large undergrad courses, $60K per year

E. Objective metrics that will be used to track progress towards attaining goal

- Funding of EIS students from faculty research grants, CALS RA and TA support and endowments
- Fully funded EIS students (total number and %)
- EIS degrees granted per year
- Increased proportion of EIS PhD students enrolled per year
- Papers published by EIS students
- Presentations by EIS students at scientific meetings
- Awards won by EIS students
- Job placement of EIS graduates

- **Note:** Core and joint Entomology faculty are the major advisors for nearly all EIS students.

5. OUTREACH STRATEGIC GOAL: Double the number of people served each year by FY25 through sustainable outreach programs to meet public demand for insect information, to support K-12 science education, and to connect underserved communities to UA Entomology and CALS.

A. Current situation and gap between current situation and desired situation

We deliver outreach via 3 main programs: Insect Discovery, the Arizona Insect Festival, and the UA Insect Collection (UAIC). Insect Discovery serves ca. 2,000 K-8 students yearly and teaches ca. 25 UA undergraduate and graduate students how to communicate science to the public. More than half of the students served are from low-income and minority communities. Since the first Arizona Insect Festival in 2011, this festival has grown to an annual event attracting over 3,000 visitors and involving more than 250 participants from within the university as well as the community. During the past year, associates of the UAIC delivered 25 presentations on insects to community groups and responded to 3,000 insect identification inquiries from the public. Despite the success of our current outreach programs, an enormous community demand remains for information about insects and for insect-related science enrichment for K-12 education. Moreover, these programs are supported largely by temporary extramural funding. To solve the problem of unstable funding and to capitalize on the opportunity to connect better with the community, we aim to obtain long-term funding and double the number of people served by Entomology outreach programs.

B. Strategies to achieve goal

1. Provide opportunities for graduate students to increase expertise in outreach through paid positions, courses, and seminars
2. Enhance communication statewide among all UA insect-related outreach activities
3. Increase awareness and participation in Entomology outreach activities in low income and minority communities.
4. Establish endowments for Insect Discovery and the Insect Festival
5. Train K-12 teachers how to use insects to teach science
6. Develop online insect outreach materials to reach beyond the local community

C. Actions **Time Period (Fiscal Years)**

- Contact UA faculty statewide to coordinate insect-related outreach programs 2020-21
- Catalog K-12 insect outreach resources online including links to programs 2020-21
- Recruit more undergraduate students to Insect Discovery preceptor course 2020-23
- Invite community organizations and businesses to sponsor the Insect Festival 2020-24
- Collaborate with TenWest and other organizations to publicize the Insect Festival, with special focus on Spanish-language media..... 2020-25
- Enhance UAIC and Insect Discovery websites..... 2020-21
- Provide teacher training in using insects and insect collecting methods 2020-25
- Develop a graduate course in communicating science and public outreach 2021-22

D. Inputs needed to achieve the goal

- Funding for 2 new semesters of Outreach TAships per year (0.5 FTE) - $32K per year
- Increased undergraduate volunteer involvement for course credit
- Faculty, student, and staff participation in annual Insect Festival
- Financial support for Insect Festival - $20K per year until endowment is established

E. Objective metrics that will be used to track progress towards attaining goals

- Number of people served by Insect Discovery, Insect Festival, and UAIC
- Number of children in Title 1 and high minority enrollment schools participating in Insect Discovery.
- Number of visitors to the Arizona Insect Festival from zip codes in low-income, high minority neighborhoods
- Number and amounts of funded grants supporting outreach
- Number and amounts of donations supporting insect outreach as well as years of support (develop long-term sponsors)
- Number of insect-related K-12 programs statewide included in online outreach catalog
- Number of new collaborations among insect outreach programs
- Impact of Insect Discovery and other insect outreach programs on K-12 student learning based on teacher questionnaires

6. INSECT COLLECTION STRATEGIC GOAL: Make the University of Arizona's Insect Collection the world's best source of arthropod data and specimens from the Sonoran Desert Region, and a global center for insect research

A. Current situation and gap to desired situation

The 2 million specimens in the University of Arizona Insect Collection (UAIC) are a unique treasure for research, extension, education, and outreach focusing on biodiversity of the Sonoran Desert Region. Over the past six years we have: (1) moved the entire pinned collection into modern facilities, (2) improved visiting researcher facilities, (3) initiated an endowed visiting researcher program, (4) established a specimen-level database, Symbiota Collections of Arthropod Network (SCAN), which provides specimen-level data online via a Virtual Network linked to other arthropod collections around the world, (5) established a new lab within the footprint of the UAIC dedicated to extracting DNA from museum specimens, and (6) established an endowment designated to cover non-salary operating expenses for the collection.

We are well positioned to develop large-scale specimen-based projects related to biodiversity, pest management, invasive species, and/or the effects of climate change. Such projects will use the specimens in the UAIC to develop species occurrence maps and identification tools, including high-resolution images and species-specific DNA sequence data. In doing so, we will ultimately generate a new collection of total genomic DNA extracted from specimens curated in the UAIC. We will focus our initial efforts on two projects.

Project 1. Insects of Agricultural Importance in Arizona. We will network with UA Extension faculty and the USDA identifiers in Phoenix, Nogales, and Yuma to help us determine which species are of greatest concern to agriculture in Arizona and for which molecular-based identification tools would be most useful. [estimated 50 species and 1,000 specimens]

Project 2. Native Bees of the Sonoran Desert Region. With over 700 species of native bees, the Sonoran Desert Region is home to one of the highest diversities of bee species *in the world*. We need these important pollinators, and in many cases we don't even know their names. The UAIC maintains thousands of native bee specimens, representing 5 families, 65 genera, and approximately 520 species, many of which have been specialist-identified. The UAIC collection and the associated identification tools we are building will help researchers and conservationists to track and monitor the health of native bees of the Sonoran Desert Region. [estimated 520 species and 6,000 specimens]

These projects, and others like them, will position the UAIC as a leader in museum sciences, the Department as a global center for specimen-based insect research, and the University as a lead collaborator with other local education and agricultural institutions (USDA, Pima Community College, Arizona-Sonora Desert Museum).

B. Strategies to achieve goal

1. We will expand the collection to include at least one specimen of every species in our two target groups (noted above).
2. We will enhance the UAIC by re-curating all specimens of the target species, following updated taxonomy. In the process, all specimen-level data, including georeferences, will be published in the SCAN database.
3. One specimen of every species in our target groups will be documented with high-resolution imagery. Total genomic DNA will be extracted from that specimen, archived in the collection, and aliquots of DNA will be made available to researchers upon request.
4. The barcode region of the mitochondrial gene COI will be PCR-amplified and sequenced for every target species. The DNA barcode will be published and made freely available to researchers, students, and the general public on the Barcode of Life Database (BOLD).
5. We will engage future scientists at the UA, Pima Community College, and Tucson Unified School District in the generation of DNA barcodes through course-based research experiences for undergraduates and high school students.
6. We will revive our established UAIC board of advisors to help guide transitions, connect with the larger community of systematists, and select annual Visiting Arthropod Systematists from applications.
7. Connect UA students, faculty, and staff with the local community of retired systematists and active amateur entomologists
8. Obtain funding from grants and donations to support needed personnel

C. Actions **Time Period (Fiscal Years)**

- Specimen-level work as described above 2020-21
- Update the UAIC website 2020-21
- Expand the UAIC website to include these project descriptions and outputs 2020-21
- Target systematists to apply for the Visiting Arthropod Systematist program 2020-25
- Work with programmers to link SCAN and BOLD 2020-21
- Enlist UAIC volunteers to help with UAIC projects 2020-25
- Apply for funding to cover needed personnel 2020-24

D. Inputs needed to achieve the goals

- Project Coordinator or postdoc ($50K per year), 1.0 FTE (via fundraising efforts, internal grants at UA, and external NSF-ADBC or NSF-CSBR grant ($300K, proposal in prep).
- Graduate Research Assistantship for collection support ($20K per year) 0.5 FTE. Hiring graduate students will allow us to attain our goals while simultaneously training the next generation of museum specialists.

E. Objective metrics that will be used to track progress towards attaining goal

- Number of specimens re-curated, databased, published online.
- Number of UAIC specimen-related barcodes published online.

- Size of the UAIC Genomic collection and the number of loan requests received.
- Use of collection for local entomology meetings, sorting events by students, and outreach
- Number of research articles published using the UAIC.
- Amount of extramural resources obtained for projects.
- Number and scope of inter-institutional, regional, national, and international requests of UAIC and collaborations formed.

7. DEVELOPMENT GOAL: Raise $2M from private donors to support our programs by FY25.

A. Current situation and gap between current situation and desired situation

The Department of Entomology fulfills UA's Land Grant mission by offering economically important research, extension and outreach to our state's stakeholders in agriculture, urban pest management, biodiversity conservation, and education. We are unique in UA and CALS because we focus on insects, which generate tremendous public interest. However, we receive little direct financial support from the public. We will connect with the community in new ways to increase stakeholders' financial support of Entomology & CALS.

B. Strategies to achieve goal

1. Increase visibility to stakeholders and all citizens of the state & region.
2. Connect with the community through events such as the Arizona Insect Festival, programs such as Insect Discovery, and resources such as the UA Insect Collection (UAIC).
3. Double the number of engaged alumni (e.g., service, advocacy, giving).
4. Increase alumni giving rate.
5. Maintain and enhance our high Department profile in local and national news.

C. Actions **Time Period (Fiscal Years)**

- Work with the CALS Development Office to seek funding for our programs (Insect Discovery, EIS grad program, UAIC, Insect Festival, etc.). 2020-25
- Invigorate the Department **Advisory Board** to connect with the community and be our advocates in diverse circles within the State (medicine, agriculture, pest management, etc.). ... 2020-25
- **Renovate** the Entomology classroom (Forbes 412) and main business office (Forbes 410) to project a more modern image to visitors. 2020-22
- Work with CALS to build **appealing exhibits** in the main lobby of Forbes, in the Student Union, and elsewhere on campus to highlight the accomplishments and activities of the Department and other CALS Departments. 2020-25
- Enhance the **department website** with development goals and ways for stakeholders to become involved with departmental activities. 2020-21
- Hold regularly scheduled support-raising events such as the Insect Festival, insect-themed social events, and high-end events with invited supporters and potential new supporters. 2020-25

D. Inputs needed to achieve the goal

- Effort by faculty and other Department members to support development
- Effort by Entomology Advisory Board
- Part-time Entomology Development Coordinator who will increase our profile, organize fund-raising events, and garner new resources: $30K per year
- Collaboration from CALS Development Office
- Funds for physical renovations, exhibit development, and IT support: $15K per year

E. Objective metrics that will be used to track progress towards attaining goal

- Funds raised per year

Appendix B2. Relationship of ENTO Strategic Priorities to the UA Strategic Plan
ENTO's strategies to achieve our goals are listed below each of ENTO's seven Strategic Goals. The following page shows these how these strategies (identified there as S1-S8) and the related ENTO goals align with the UA Strategic Plan.

GOAL 1: Research
Strategies

1. Target critical global issues with research led by our faculty & their collaborators
2. Retain current faculty who have outstanding research productivity
3. Recruit new faculty with outstanding research productivity
4. Increase research productivity of current faculty
5. Enhance collaborations in the Dept. and with others (UA, national & international)
6. Strengthen research infrastructure including support staff and facilities

GOAL 2: Integrated Pest Management (IPM)
Strategies

1. Recruit & retain outstanding IPM faculty, appointed personnel & classified staff
2. Create a fertile environment for translational sciences needed to support IPM
3. Leverage resources from gifts/grants/contracts to support staffing needs (50% share of each)

GOAL 3: Undergraduate Engagement
Strategies

1. Increase the percentage of undergraduate courses taught through active learning to 60% by FY2021 and 75% by FY2022
2. Increase faculty mentoring of undergraduate students in Entomology laboratories

GOAL 4: Entomology & Insect Science (EIS) Graduate Program
Strategies

1. Increase support of RAs via increased faculty research grants
4. Solicit donors for endowments for student-invited speakership (Hagedorn) and student cash award to honor Genevieve Comeau (in progress)
5. Build support for first and second year students to apply for outside graduate fellowships (NSF, NIH, USDA)

GOAL 5: Outreach
Strategy

1. Establish endowments for Insect Discovery and the Insect Festival

GOAL 6: University of Arizona Insect Collection
Strategy

8. Obtain funding from grants and donations to support needed personnel

GOAL 7: Development
Strategies

3. Double the number of engaged alumni (e.g., service, advocacy, giving).
4. Increase alumni giving rate.

THE UNIVERSITY OF ARIZONA

		Pillar 1					Pillar 2							Pillar 3				Pillar 4			Pillar 5			
		The Wildcat Journey Driving Student Success for a Rapidly Changing World					**Grand Challenges** Tackling Critical Problems at the Edges of Human Endeavor							**The Arizona Advantage** Advancing our Land Grant Mission to Drive Social, Cultural, and Economic Impact				**UA Global - Redefining International** The UA will set the standard for a global university in the digital age			**Institutional Excellence** Ensuring UA lives its values and innovative culture … for a high performing enterprise			
	Entomology	Student Body	Engagement	Persistence & Completion	Student-Centered Teaching & Learning	Post-Graduate Outcomes	Funding	Space University	Physical Sciences	Social Sciences	Capabilities	Talent	Impact	Communities	Destination Arizona	Arts & Culture	Innovation & Partnerships	Global Impact	Global Education	Global Engagement	Values-Driven University	Service Excellence	Streamlining Solutions	Leading Sustainability
	College Strategic Goals																							
1	Unit Goal 1: Increase Entomology research productivity 30% by 2025.						**S1-S6**					**S2-S3**	**S5**								**S2**			
2	Unit Goal 2: By FY25, greatly enhance effectiveness of Integrated Pest Management (IPM) research, education, and Extension programs for teaching students and stakeholders, and for solving health, environmental, and economic problems caused by pests.						**S1-S3**				**S1-S4**	**S1-S2**		**S1-S4**							**S1**			**S1-S4**
3	Unit Goal 3: Increase the yearly undergraduate student credit hours taught 30% by FY25.			**S2**	**S1**																			
4	Unit Goal 4: Double the stable funding for Entomology & Insect Science (EIS) graduate students by FY25.		**S4**				**S1, S5**																	
5	Unit Goal 5: Double the number of people served each year by FY25 through sustainable outreach programs to meet public demand for insect information, to support K-12 science education and to connect underserved communities to UA Entomology and CALS.		**S4**																					
6	Unit Goal 6: Make the University of Arizona's Insect Collection the world's best source of arthropod data and specimens from the Sonoran Desert Region and a global center for insect research		**S8**				**S8**																	
7	Unit Goal 7: Raise $2M from private donors to support our programs by FY25.		**S3-S4**																					

College of Agriculture & Life Sciences

Appendix C1. Courses for Entomology Minor & Certificate

Entomology Minor Checklist, 2022-2023

18 Total Units, 2.0 Minimum GPA
9 Upper-Division Units
6 Units Allowed of Transfer Units

Required Insect Biology (3 Units)
Required Prerequisites: MCB 181 & ECOL 182

___ **ENTO 415R:** Insect Biology

Research or Education (3 Units)

___ **ENTO 392, 492:** Directed Research
OR
___ **ENTO 299, 299H, 399, 499, 499H:** Independent Study
OR
___ **ENTO 498H, 498:** Honors Thesis, Senior Capstone
OR
___ **ENTO 393, 493:** Internship
OR
___ **ENTO 391, 391H, 491, 491H:** Preceptorship
OR
___ **ENTO 407:** Insect Discovery

Electives (12 Units)
All Courses 3 Units Unless Otherwise Noted

___ ****ENTO 160D1:** How Insects Shaped Human History
___ ****ENTO 170C2:** How Insects Conquered Earth
___ **ENTO 300:** Integrated Pest Management for Desert Cropping (Yuma Campus Only)
___ **ENTO 401:** Ecological Physiology
___ **ENTO 407:** Insect Discovery
___ ***ENTO 417:** Insect Systematics
___ **ENTO 432:** Comparative Immunology
___ **ENTO 436:** Agro Ecology
___ **ENTO 457:** Medical-Veterinary Entomology
___ **ENTO 468:** Integrated Pest Management
___ **ENTO 403R:** Biology Animal Parasites
___ **ENTO 497C:** Greenhouse Pest Management
___ ***ENTO 405:** Aquatic Entomology

*4 Units
** Can Double Dip with General Education Requirements
ENTO 407 can be used for Elective Credit OR Research/Education Credit, **NOT BOTH**

Entomology Certificate Checklist, 2022-2023

12 Total Units, 3.0 Minimum GPA
6 Upper-Division Units
6 Units Allowed of Transfer Credit

Required Insect Biology (3 Units)
Required Prerequisites: MCB 181 & ECOL 182

___ **ENTO 415R:** Insect Biology

Electives & Research (9 Units)
All Courses 3 Units Unless Otherwise Noted

___ **ENTO 160D1:** How Insects Shaped Human History
___ **ENTO 170C2:** How Insects Conquered Earth
___ **ENTO 300:** Integrated Pest Management for Desert Cropping (Yuma Campus Only)
___ **ENTO 401:** Ecological Physiology
___ **ENTO 407:** Insect Discovery
___ ***ENTO 417:** Insect Systematics
___ **ENTO 432:** Comparative Immunology
___ **ENTO 436:** Agro Ecology
___ **ENTO 457:** Medical-Veterinary Entomology
___ **ENTO 468:** Integrated Pest Management
___ **ENTO 403R:** Biology Animal Parasites
___ **ENTO 497C:** Greenhouse Pest Management
___ ***ENTO 405:** Aquatic Entomology
___ ****ENTO 392, 492:** Directed Research
___ ****ENTO 499, 499H:** Independent Study

*4 Units
**1-3 Units

ENTO 160D1 & ENTO 170C2 can only be used for certificate if they are not being used to fulfill General Education requirements
NO MORE THAN 4 UNITS of **ENTO 392, 492, 499, or 499H** may be used to fulfill certificate requirements

Appendix D1. 275 journal publications and 9 book chapters authored by members of the Department of Entomology and students in the Entomology & Insect Science Graduate Interdisciplinary Program at the University of Arizona (2016 - July 7, 2023; listed by Scopus July 7, 2023)

*At least one author was a student in the EIS GIDP

Journal Publications (275)

	Authors	Title	Year	Source title	Cited by
*	**Anderson K.E.; Rodrigues P.A.P.; Mott B.M.; Maes P.; Corby-Ha**	Ecological Succession in the Honey Bee Gut: Shift ir	**2016**	Microbial Ecology	44
*	**Asiimwe P.; Ellsworth P.C.; Naranjo S.E.**	Natural enemy impacts on Bemisia tabaci (MEAM1) c	**2016**	Ecological Entomology	11
	Carrière Y.; Fabrick J.A.; Tabashnik B.E.	Can Pyramids and Seed Mixtures Delay Resistance t	**2016**	Trends in Biotechnology	156
*	**Cass B.N.; Himler A.G.; Bondy E.C.; Bergen J.E.; Fung S.K.; Ke**	Conditional fitness benefits of the Rickettsia bacteria	**2016**	Oecologia	27
	Castagnola A.; Mulley G.; Davis N.; Waterfield N.; Stock S.P.	Transcript abundance of Photorhabdus insect-relate	**2016**	Toxins	3
	Cooney F.; Vitikainen E.I.K.; Marshall H.H.; van Rooyen W.; Sn	Lack of aggression and apparent altruism towards in	**2016**	Royal Society Open Science	3
*	**Corby-Harris V.; Meador C.A.D.; Snyder L.A.; Schwan M.R.; Ma**	Transcriptional, translational, and physiological signa	**2016**	J. Insect Physiology	30
	Corby-Harris V.; Snyder L.; Meador C.A.D.; Naldo R.; Mott B.; A	Parasaccharibacter apium, gen. Nov., sp. Nov., Impr	**2016**	J. Economic Entomology	61
	Corona M.; Libbrecht R.; Wheeler D.E.	Molecular mechanisms of phenotypic plasticity in soc	**2016**	Current Opinion in Insect Science	100
	Cui J.; Li S.; Spurgeon D.W.; Jia W.; Lu Y.; Gouge D.H.	Flight Capacity of *Sitophilus zeamais* Motschulsky in	**2016**	Southwestern Entomologist	0
	Davidowitz G.	Endocrine Proxies Can Simplify Endocrine Complexit	**2016**	Integrative & Comparative Biology	13
*	**Gebiola M.; Kelly S.E.; Hammerstein P.; Giorgini M.; Hunter M.**	"Darwin's corollary" and cytoplasmic incompatibility in	**2016**	Evolution	24
	Gómez R.A.; Reddell J.; Will K.; Moore W.	Up high and down low: Molecular systematics and in	**2016**	Molecular Phylogenetics & Evolutio	7
	Hood-Nowotny R.; Mayr L.; Saad N.; Seth R.K.; Davidowitz G.;	Towards Incorporating Insect Isotope Analysis Using	**2016**	Florida Entomologist	4
*	**Kusakabe A.; Contreras-Barragan B.A.; Simpson C.R.; Enciso J**	Application of partial rootzone drying to improve irrigat	**2016**	Agricultural Water Management	26
*	**Lanan M.C.; Rodrigues P.A.P.; Agellon A.; Jansma P.; Wheeler**	A bacterial filter protects and structures the gut micro	**2016**	ISME J.	85
	Larabee F.J.; Fisher B.K.; Schmidt C.A.; Matos-Maraví P.; Janc	Molecular phylogenetics and diversification of trap-ja	**2016**	Molecular Phylogenetics & Evolutio	27
	Levin E.; Mitra C.; Davidowitz G.	Fed males increase oviposition in female hawkmoths	**2016**	Animal Behaviour	19
	Lü S.; Jiang M.; Huo T.; Li X.; Zhang Y.	3-hydroxy-3-methyl glutaryl coenzyme A reductase: A	**2016**	Insect Molecular Biology	16
*	**Maes P.W.; Rodrigues P.A.P.; Oliver R.; Mott B.M.; Anderson K**	Diet-related gut bacterial dysbiosis correlates with imp	**2016**	Molecular Ecology	116
	Mitra C.; Reynoso E.; Davidowitz G.; Papaj D.	Effects of sodium puddling on male mating success,	**2016**	Animal Behaviour	17
*	**Orozco R.A.; Molnár I.; Bode H.; Stock S.P.**	Bioprospecting for secondary metabolites in the entc	**2016**	J. Invertebrate Pathology	14
	Palumbo J.C.; Perring T.M.; Millar J.G.; Reed D.A.	Biology, Ecology, and Management of an Invasive S	**2016**	Annual Review of Entomology	56
	Pape R.B.	The importance of ants in cave ecology, with new rec	**2016**	International J. Speleology	7
	Pietri J.E.; Pakpour N.; Napoli E.; Song G.; Pietri E.; Potts R.; C	Two insulin-like peptides differentially regulate malari	**2016**	Biochemical J.	17
	Resende L.P.A.; Zepon T.; Bichuette M.E.; Pape R.B.; Gil-Santa	Associations between Emesinae heteropterans and	**2016**	Neotropical Biology & Conservatio	6
*	**Russell A.L.; Leonard A.S.; Gillette H.D.; Papaj D.R.**	Concealed floral rewards and the role of experience	**2016**	Animal Behaviour	31

*	**Stanley D.A.; Russell A.L.; Morrison S.J.; Rogers C.; Raine N.E**	Investigating the impacts of field-realistic exposure to	**2016**	J. Applied Ecology	106
	Tabashnik B.E.	Tips for battling billion-dollar beetles	**2016**	Science	17
	Tassone E.E.; Zastrow-Hayes G.; Mathis J.; Nelson M.E.; Wu G	Sequencing, de novo assembly and annotation of a	**2016**	GigaScience	13
	Wang L.; Wan P.; Cong S.; Wang J.; Huang M.; Tabashnik B.E.;	Adult exposure to Bt toxin Cry1Ac reduces life span	**2016**	J. Economic Entomology	2
	Xiao Y.; Liu K.; Zhang D.; Gong L.; He F.; Soberón M.; Bravo A.	Resistance to Bacillus thuringiensis Mediated by an	**2016**	PLoS Pathogens	40
	Bear A.; Prudic K.L.; Monteiro A.	Steroid hormone signaling during development has a	**2017**	PLoS ONE	7
*	**Beck J.; McCain C.M.; Axmacher J.C.; Ashton L.A.; Bärtschi F.**	Elevational species richness gradients in a hyperdive	**2017**	Global Ecology & Biogeography	70
	Bockoven A.A.; Coates C.J.; Eubanks M.D.	Colony-level behavioural variation correlates with diff	**2017**	Molecular Ecology	14
	Carrière Y.; Antilla L.; Liesner L.; Tabashnik B.E.	Large-Scale Evaluation of Association between Phe	**2017**	J. Economic Entomology	5
	Carrière Y.; Degain B.; Liesner L.; Dutilleul P.; Palumbo J.C.	Validation of a Landscape-Based Model for Whitefly	**2017**	J. Economic Entomology	4
	Carroll M.J.; Brown N.; Goodall C.; Downs A.M.; Sheenan T.H.;	Honey bees preferentially consume freshlystored Pol	**2017**	PLoS ONE	47
	Castle S.; Palumbo J.; Merten P.; Cowden C.; Prabhaker N.	Effects of foliar and systemic insecticides on whitefly t	**2017**	Pest Management Science	19
*	**Charbonneau D.; Sasaki T.; Dornhaus A.**	Who needs 'lazy' workers? Inactive workers act as a	**2017**	PLoS ONE	39
	Ciezki K.; Murfin K.; Goodrich-Blair H.; Stock S.P.; Forst S.	R-type bacteriocins in related strains of Xenorhabdus	**2017**	FEMS Microbiology Letters	8
	Gebiola M.; Giorgini M.; Kelly S.E.; Doremus M.R.; Ferree P.M.	Cytological analysis of cytoplasmic incompatibility indu	**2017**	Proceedings of the Royal Society B	24
	Gebiola M.; Kelly S.E.; Velten L.; Zug R.; Hammerstein P.; Gior	Reproductive interference and fecundity affect comp	**2017**	Heredity	1
	Gebiola M.; Monti M.M.; Johnson R.C.; Woolley J.B.; Hunter M	A revision of the Encarsia pergandiella species complex	**2017**	Systematic Entomology	29
	Gibson C.M.	A big, bug science party	**2017**	Science	0
	Hatle J.D.; Awan A.; Nicholas J.; Koch R.; Vokrri J.R.; McCue M	Life-extending dietary restriction and ovariectomy ea	**2017**	Experimental Gerontology	5
	Hoekman D.; Levan K.E.; Ball G.E.; Browne R.A.; Davidson R.L	Design for ground beetle abundance and diversity sa	**2017**	Ecosphere	27
*	**Hunter M.S.; Asiimwe P.; Himler A.G.; Kelly S.E.**	Host nuclear genotype influences phenotype of a co	**2017**	J. Evolutionary Biology	16
*	**Leighton G.M.; Charbonneau D.; Dornhaus A.**	Task switching is associated with temporal delays in	**2017**	Behavioral Ecology	22
	Levin E.; Lopez-Martinez G.; Fane B.; Davidowitz G.	Hawkmoths use nectar sugar to reduce oxidative dar	**2017**	Science	52
	Levin E.; McCue M.D.; Davidowitz G.	More than just sugar: Allocation of nectar amino acid	**2017**	Proc. Royal Society B: Biological S	44
	Levin E.; McCue M.D.; Davidowitz G.	Sex differences in the utilization of essential & non-e	**2017**	J. Experimental Biology	15
*	**Lichtenstein J.L.L.; Chism G.T.; Kamath A.; Pruitt J.N.**	Intraindividual Behavioral Variability Predicts Foragin	**2017**	Scientific Reports	11
	Lingafelter S.W.; Tishechkin A.K.	Two new species of parandrinae (coleoptera: Ceraml	**2017**	Zootaxa	0
	Liu J.; Li Z.; Zhang H.; Du H.; Ding X.; Zhou Y.; Wu J.; Wong A.	Comparative study of the sublethal effects of indoxaca	**2017**	Journal of Asia-Pacific Entomology	2
	Liu L.; Gao M.; Yang S.; Liu S.; Wu Y.; Carrière Y.; Yang Y.	Resistance to Bacillus thuringiensis toxin Cry2Ab and	**2017**	Evolutionary Applications	27
	Lynch Z.R.; Schlenke T.A.; Morran L.T.; de Roode J.C.	Ethanol confers differential protection against genera	**2017**	PLoS ONE	13
*	**Mann E.; Stouthamer C.M.; Kelly S.E.; Dzieciol M.; Hunter M.S.;**	Transcriptome sequencing reveals novel candidate g	**2017**	mSystems	20
	McMullen J.G., II; McQuade R.; Ogier J.-C.; Pagès S.; Gaudriau	Variable virulence phenotype of Xenorhabdus bovie	**2017**	Microbiology (United Kingdom)	16
	McMullen J.G., II; Peterson B.F.; Forst S.; Blair H.G.; Stock S.P	Fitness costs of symbiont switching using entomopat	**2017**	BMC Evolutionary Biology	19

	Mehlferber E.C.; Benowitz K.M.; Roy-Zokan E.M.; McKinney E.C	Duplication and sub/neofunctionalization of Malvolio,	2017	G3: Genes, Genomes, Genetics	10
	Naranjo S.E.; Ellsworth P.C.	Methodology for developing life tables for sessile insec	2017	J. Visualized Experiments	15
	Ni M.; Ma W.; Wang X.; Gao M.; Dai Y.; Wei X.; Zhang L.; Peng Y	Next-generation transgenic cotton: pyramiding RNAi	2017	Plant Biotechnology J.	81
	Ocelotl J.; Sánchez J.; Gómez I.; Tabashnik B.E.; Bravo A.; So	ABCC2 is associated with Bacillus thuringiensis Cry1A	2017	Scientific Reports	46
*	Papaj D.R.; Buchmann S.L.; Russell A.L.	Division of labor of anthers in heterantherous plants:	2017	Arthropod-Plant Interactions	20
*	Patricia Stock S.; Kusakabe A.; Orozco R.A.	Secondary metabolites produced by heterorhabditis	2017	J. Nematology	22
	Ramírez D.M.; Vea L.; Field J.A.; Baker P.B.; Gandolfi A.J.; Mai	Transferable Training Modules: Building Environment	2017	Family & Community Health	2
	Reed D.A.; Ganjisaffar F.; Palumbo J.C.; Perring T.M.	Effects of Temperatures on Immature Development a	2017	J. Economic Entomology	17
	Robertson J.A.; Moore W.	Phylogeny of Paussus L. (Carabidae: Paussinae): ur	2017	Systematic Entomology	16
	Romero A.; Sutherland A.M.; Gouge D.H.; Spafford H.; Nair S.; I	Pest management strategies for bed bugs (Hemipter	2017	J. Integrated Pest Management	23
*	Russell A.L.; Buchmann S.L.; Papaj D.R.	How a generalist bee achieves high efficiency of poll	2017	Behavioral Ecology	36
*	Russell A.L.; Morrison S.J.; Moschonas E.H.; Papaj D.R.	Patterns of pollen and nectar foraging specialization	2017	Scientific Reports	41
	Tabashnik B.E.; Carrière Y.	Surge in insect resistance to transgenic crops and pr	2017	Nature Biotechnology	363
	Wan P.; Xu D.; Cong S.; Jiang Y.; Huang Y.; Wang J.; Wu H.; Wa	Hybridizing transgenic Bt cotton with non-Bt cotton c	2017	PNAS	73
	Benowitz K.M.; Sparks M.E.; McKinney E.C.; Moore P.J.; Moore	Variation in mandible development and its relationsh	2018	Ecology & Evolution	2
	Carrière Y.; Degain B.A.; Unnithan G.C.; Harpold V.S.; Heuberg	Effects of seasonal changes in cotton plants on the	2018	Pest Management Science	17
	Carrière Y.; Williams J.L.; Crowder D.W.; Tabashnik B.E.	Genotype-specific fitness cost of resistance to Bt tox	2018	Pest Management Science	11
	Coleman J.M.; Benowitz K.M.; Jost A.G.; Matzkin L.M.	Behavioral evolution accompanying host shifts in cac	2018	Ecology & Evolution	10
	Diaz F.; Allan C.W.; Matzkin L.M.	Positive selection at sites of chemosensory genes is	2018	BMC Evolutionary Biology	3
	Díaz F.; Lima A.L.A.; Nakamura A.M.; Fernandes F.; Sobrinho I	Evidence for introgression among three species of th	2018	Frontiers in Genetics	11
	Farrar J.J.; Ellsworth P.C.; Sisco R.; Baur M.E.; Crump A.; Four	Assessing compatibility of a pesticide in an IPM progra	2018	J. of Integrated Pest Management	8
	Gage S.L.; Kramer C.; Calle S.; Carroll M.; Heien M.; DeGrandi-	Nosema ceranae parasitism impacts olfactory learnin	2018	J. Experimental Biology	28
	Gao M.; Wang X.; Yang Y.; Tabashnik B.E.; Wu Y.	Epistasis confers resistance to Bt toxin Cry1Ac in the	2018	Evolutionary Applications	12
*	Hughes G.B.; Moore W.	Monophyly of the subfamily Neobisiinae (Pseudosco	2018	J. Arachnology	3
	Hust J.; Lavine M.D.; Worthington A.M.; Zinna R.; Gotoh H.; Niir	The Fat-Dachsous signaling pathway regulates grow	2018	J. Insect Physiology	9
	Jalali M.A.; Mehrnejad M.R.; Ellsworth P.C.; Ranjbar F.; Ziaadd	Predator performance: inferring predator switching be	2018	Pest Management Science	7
	Jin L.; Wang J.; Guan F.; Zhang J.; Yu S.; Liu S.; Xue Y.; Li L.;	Dominant point mutation in a tetraspanin gene assoc	2018	PNAS	83
	Karp D.S.; Chaplin-Kramer R.; Meehan T.D.; Martin E.A.; DeCle	Crop pests and predators exhibit inconsistent respon	2018	PNAS	366
	Mathew L.G.; Ponnuraj J.; Mallappa B.; Chowdary L.R.; Zhang	ABC transporter mis-splicing associated with resistan	2018	Scientific Reports	49
*	McManus R.; Ravenscraft A.; Moore W.	Bacterial associates of a gregarious riparian beetle w	2018	Frontiers in Microbiology	15
	Morris E.E.; Stock S.P.; Castrillo L.A.; Williams D.W.; Hajek A.I	Characterisation of the dimorphic Deladenus bedding	2018	Nematology	2
	Nielsen M.E.; Levin E.; Davidowitz G.; Papaj D.R.	Colour plasticity alters thermoregulatory behaviour in	2018	Animal Behaviour	2
*	Palting J.D.; Ferguson D.C.; Moore W.	A new species of hypoprepia from the mountains of	2018	ZooKeys	1

	Peña-Cardeña A.; Grande R.; Sánchez J.; Tabashnik B.E.; Bra	The C-terminal protoxin region of Bacillus thuringiens	**2018**	J. Biological Chemistry	24
*	**Pruitt J.N.; Wright C.M.; Lichtenstein J.L.L.; Chism G.T.; McEw**	Selection for Collective Aggressiveness Favors Socia	**2018**	Current Biology	18
	Roder A.C.; Stock S.P.	Influence of Xenorhabdus (Gamma-Proteobacteria: En	**2018**	J. Invertebrate Pathology	3
	Rothman J.A.; Carroll M.J.; Meikle W.G.; Anderson K.E.; McFre	Longitudinal Effects of Supplemental Forage on the	**2018**	Microbial Ecology	28
*	**Russell A.L.; Buchmann S.L.; De Sabino W.O.; Papaj D.R.**	Brawls bring buzz: Male Size Influences Competition	**2018**	J. Insect Science	4
*	**Russell A.L.; Mauerman K.B.; Golden R.E.; Papaj D.R.**	Linking components of complex signals to morpholog	**2018**	Animal Behaviour	9
*	**Schaller J.C.; Davidowitz G.; Papaj D.R.; Smith R.L.; Carrière Y**	Molecular phylogeny, ecology and multispecies aggr	**2018**	PLoS ONE	7
	Smith G.P.; Johnson C.A.; Davidowitz G.; Bronstein J.L.	Linkages between nectaring and oviposition preferer	**2018**	Ecological Entomology	11
	Song Z.-S.; Bartlett C.R.; O'Brien L.B.; Liang A.-P.; Bourgoin T.	Morphological phylogeny of Dictyopharidae (Hemipte	**2018**	Systematic Entomology	15
	Souvannaseng L.; Hun L.V.; Baker H.; Klyver J.M.; Wang B.; Pa	Inhibition of JNK signaling in the Asian malaria vecto	**2018**	PLoS Pathogens	20
*	**Stouthamer C.M.; Kelly S.; Hunter M.S.**	Enrichment of low-density symbiont DNA from minute	**2018**	J. Microbiological Methods	7
*	**Vandervoet T.F.; Ellsworth P.C.; Carrière Y.; Naranjo S.E.**	Quantifying conservation biological control for manag	**2018**	J. Economic Entomology	20
	Wang L.; Ma Y.; Wan P.; Liu K.; Xiao Y.; Wang J.; Cong S.; Xu D	Resistance to Bacillus thuringiensis linked with a cad	**2018**	Insect Biochemistry & Molecular Bi	29
	Wilson J.K.; Tseng A.S.; Potter K.A.; Davidowitz G.; Hildebranc	The effects of the alkaloid scopolamine on the perfo	**2018**	Arthropod-Plant Interactions	4
	Wilson J.K.; Woods H.A.; Kessler A.	High levels of abiotic noise in volatile organic compou	**2018**	Oecologia	6
	Wolfin M.S.; Raguso R.A.; Davidowitz G.; Goyret J.	Context dependency of in-flight responses by Mandu	**2018**	J. Experimental Biology	7
	Wone B.W.M.; Pathak J.; Davidowitz G.	Flight duration and flight muscle ultrastructure of unfe	**2018**	Arthropod Structure & Developmer	4
	Zimmerman J.R.	A Synopsis of Oak Gall Wasps (Hymenoptera: Cynipi	**2018**	J. the Kansas Entomological Socie	7
	Akbar W.; Gowda A.; Ahrens J.E.; Stelzer J.W.; Brown R.S.; Bo	First transgenic trait for control of plant bugs and thri	**2019**	Pest Management Science	23
	Allan C.W.; Matzkin L.M.	Genomic analysis of the four ecologically distinct cac	**2019**	BMC Genomics	10
	Anderson J.A.; Ellsworth P.C.; Faria J.C.; Head G.P.; Owen M.D	Genetically engineered crops: Importance of diversified	**2019**	Frontiers in Bioengineering & Biotec	70
	Benowitz K.M.; Amukamara A.U.; Mckinney E.C.; Moore A.J.	Development and the effects of extended parenting	**2019**	Ecological Entomology	5
	Benowitz K.M.; Coleman J.M.; Matzkin L.M.	Assessing the architecture of Drosophila mojavensis	**2019**	G3: Genes, Genomes, Genetics	5
	Benowitz K.M.; McKinney E.C.; Cunningham C.B.; Moore A.J.	Predictable gene expression related to behavioral va	**2019**	Behavioral Ecology	7
	Bernaba M.; Power E.; Campion J.; Gotzek D.; Schmidt J.O.; K	Unconscious Woman in Shock and Covered with Ant	**2019**	American J. Medicine	0
	Bernays E.A.	An unlikely beginning: A fortunate life	**2019**	Annual Review of Entomology	1
*	**Bondy E.C.; Hunter M.S.**	Determining the egg fertilization rate of Bemisia taba	**2019**	J. Visualized Experiments	2
	Carrière Y.; Degain B.; Unnithan G.C.; Harpold V.S.; Li X.; Taba	Seasonal Declines in Cry1Ac and Cry2Ab Concentra	**2019**	J. Economic Entomology	17
	Carrière Y.; Yelich A.J.; Degain B.A.; Harpold V.S.; Unnithan G	Gossypol in cottonseed increases the fitness cost of	**2019**	Crop Protection	10
	De Luca P.A.; Buchmann S.; Galen C.; Mason A.C.; Vallejo-Mar	Does body size predict the buzz-pollination frequenc	**2019**	Ecology & Evolution	28
*	**Doremus M.R.; Kelly S.E.; Hunter M.S.**	Exposure to opposing temperature extremes causes	**2019**	PLoS Pathogens	14
*	**Duong D.A.; Espinosa-Artiles P.; Orozco R.A.; Molnár I.; Patric**	Draft Genome Assembly of the Entomopathogenic B	**2019**	Microbiology Resource Announcer	3
	Ferro K.; Peuß R.; Yang W.; Rosenstiel P.; Schulenburg H.; Kur	Experimental evolution of immunological specificity	**2019**	PNAS	32

*	**Gowda V.; Gronenberg W.**	Brain composition and scaling in social bee species di	**2019**	Apidologie	9
	Hagler J.R.; Mostafa A.M.	A Gut Analysis Technique for Pinpointing Egg-Speci	**2019**	J. Insect Science	3
*	**Hun L.V.; Luckhart S.; Riehle M.A.**	Increased Akt signaling in the fat body of Anopheles	**2019**	J. Insect Physiology	8
	Jalali M.A.; Mehrnejad M.R.; Ellsworth P.C.; Riddick E.	Inferring Biological Control Potential of Adult Predato	**2019**	J. Economic Entomology	1
	Kelemen E.P.; Cao N.; Cao T.; Davidowitz G.; Dornhaus A.	Metabolic rate predicts the lifespan of workers in the	**2019**	Apidologie	12
*	**Kusakabe A.; Peterson B.F.; Rivera Orduño B.; Stock S.P.**	Ecological characterization of Heterorhabditis sonore	**2019**	Zoology	6
*	**Leitner N.; Charbonneau D.; Gronenberg W.; Dornhaus A.**	Peripheral sensory organs vary among ant workers b	**2019**	Behavioural Processes	3
	Li S.; Hussain F.; Unnithan G.C.; Dong S.; UlAbdin Z.; Gu S.; Ma	A long non-coding RNA regulates cadherin transcript	**2019**	Pesticide Biochemistry & Physiolog	19
*	**Miguelena J.G.; Baker P.B.**	Effects of Urbanization on the Diversity, Abundance,	**2019**	Environmental Entomology	9
	Moore A.J.; Benowitz K.M.	From phenotype to genotype: the precursor hypothe	**2019**	Current Opinion in Insect Science	5
	Moore W.; Di Giulio A.	Out of the burrow and into the nest: Functional anat	**2019**	PLoS ONE	3
	Muzzi M.; Moore W.; Di Giulio A.	Morpho-functional analysis of the explosive defensiv	**2019**	Micron	10
	Ni X.; Cottrell T.E.; Buntin G.D.; Li X.; Wang W.; Zhuang H.	Monitoring of brown stink bug (Hemiptera: Pentatomi	**2019**	Insect Science	4
*	**Oduwole O.A.; Ameh S.; Esu E.S.; Oringanje C.M.; Meremikwu**	Assessing agreement of hemoglobin and three- fold	**2019**	Nigerian J. Clinical Practice	2
	Prudic K.L.; Timmermann B.N.; Papaj D.R.; Ritland D.B.; Oliver	Mimicry in viceroy butterflies is dependent on abunda	**2019**	Communications Biology	10
	Roder A.C.; Wang Y.; Butcher R.A.; Stock S.P.	Influence of symbiotic and non-symbiotic bacteria on	**2019**	J. Experimental Biology	5
	San-Blas E.; Campos-Herrera R.; Dolinski C.; Monteiro C.; And	Entomopathogenic nematology in Latin America: A b	**2019**	J. Invertebrate Pathology	16
	Schulz N.K.E.; Sell M.P.; Ferro K.; Kleinhölting N.; Kurtz J.	Transgenerational developmental effects of immune	**2019**	Frontiers in Physiology	15
	Stock S.P.	Partners in crime: symbiont-assisted resource acquisi	**2019**	Current Opinion in Insect Science	15
	Stock S.P.; Campos-Herrera R.; El-Borai F.E.; Duncan L.W.	Steinernema khuongi n. sp. (Panagrolaimomorpha, S	**2019**	J. Helminthology	13
*	**Stouthamer C.M.; Kelly S.E.; Mann E.; Schmitz-Esser S.; Hunte**	Development of a multi-locus sequence typing syster	**2019**	BMC Microbiology	7
	Tabashnik B.E.; Carrière Y.; Gassmann A.	Global Patterns of Resistance to Bt Crops Highlightin	**2019**	J. Economic Entomology	110
	Tyler Flockhart D.T.; Larrivée M.; Prudic K.L.; Ryan Norris D.	Estimating the annual distribution of monarch butterf	**2019**	Facets	7
	von Arx M.; Moore A.; Davidowitz G.; Arnold A.E.	Diversity and distribution of microbial communities in	**2019**	PLoS ONE	17
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	Wang L.; Wang J.; Ma Y.; Wan P.; Liu K.; Cong S.; Xiao Y.; Xu D	Transposon insertion causes cadherin mis-splicing ar	**2019**	Scientific Reports	24
	Wang Y.; Quan Y.; Yang J.; Shu C.; Wang Z.; Zhang J.; Gatehou	Evolution of asian corn borer resistance to Bt Toxins	**2019**	Toxins	11
	Wilson J.K.; Ruiz L.; Davidowitz G.	Dietary protein and carbohydrates affect immune fun	**2019**	Physiological & Biochemical Zoolo	26
	Wilson J.K.; Ruiz L.; Duarte J.; Davidowitz G.	The nutritional landscape of host plants for a special	**2019**	Ecology & Evolution	17
*	**Yanahan A.D.; Moore W.**	Impacts of 21st-century climate change on montane	**2019**	Diversity & Distributions	14
	Zhang M.; Wei J.; Ni X.; Zhang J.; Jurat-Fuentes J.L.; Fabrick J	Decreased Cry1Ac activation by midgut proteases as	**2019**	Pest Management Science	20
*	**Attygalle A.B.; Xu S.; Moore W.; McManus R.; Gill A.; Will K.**	Biosynthetic origin of benzoquinones in the explosive	**2020**	Science of Nature	9
*	**Baker P.B.; Miguelena J.G.**	Field distance effects of fipronil and chlorfenapyr as	**2020**	Sociobiology	1

	Behrens-Bradley N.; Smith S.; Beatty N.L.; Love M.; Ahmad N.;	Kissing Bugs Harboring Trypanosoma cruzi, Frequen	2020	American J. Medicine	14
	Benowitz K.M.; Coleman J.M.; Allan C.W.; Matzkin L.M.	Contributions of cis- And trans-Regulatory Evolution	2020	Genome Biology & Evolution	5
*	Bockoven A.A.; Bondy E.C.; Flores M.J.; Kelly S.E.; Ravenscraft	What Goes Up Might Come Down: the Spectacular Sp	2020	Microbial Ecology	10
	Carrière Y.; Brown Z.; Aglasan S.; Dutilleul P.; Carroll M.; Head	Crop rotation mitigates impacts of corn rootworm resi	2020	PNAS	21
	Carrière Y.; Brown Z.S.; Downes S.J.; Gujar G.; Epstein G.; On	Governing evolution: A socioecological comparison c	2020	Ambio	46
	Carrière Y.; Degain B.A.; Harpold V.S.; Unnithan G.C.; Tabashr	Gene Flow between Bt and Non-Bt Plants in a Seed	2020	J. Economic Entomology	12
	Clark S.E.; Magrane E.; Baumgartner T.; Bennett S.E.K.; Bogar	6&6: A Transdisciplinary Approach to Art-Science Co	2020	BioScience	6
*	Comeau G.; Zinna R.A.; Scott T.; Ernst K.; Walker K.; Carrière	Vertical transmission of zika virus in aedes aegypti pr	2020	American J. Tropical Medicine & H	5
*	Corby-Harris V.; Deeter M.E.; Snyder L.; Meador C.; Welchert A	Octopamine mobilizes lipids from honey bee (Apis me	2020	J. Experimental Biology	9
*	Dalenberg H.; Maes P.; Mott B.; Anderson K.E.; Spivak M.	Propolis envelope promotes beneficial bacteria in the	2020	Insects	17
*	Doremus M.R.; Stouthamer C.M.; Kelly S.E.; Schmitz-Esser S.;	Cardinium Localization During Its Parasitoid Wasp Ho	2020	Frontiers in Microbiology	6
	Fabrick J.A.; LeRoy D.M.; Unnithan G.C.; Yelich A.J.; Carrière	Shared and Independent Genetic Basis of Resistanc	2020	Scientific Reports	8
	Fabrick J.A.; Mathew L.G.; LeRoy D.M.; Hull J.J.; Unnithan G.C	Reduced cadherin expression associated with resista	2020	Pest Management Science	14
*	Fattorini S.; Mantoni C.; Bergamaschi D.; Fortini L.; Sánchez F.	Activity Density of Carabid Beetles along an Urbanisa	2020	Acta Zoologica Academiae Scienti	1
*	Francois C.L.; Davidowitz G.	Genetic color polymorphism of the whitelined sphinx	2020	J. Insect Science	2
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*	Gutiérrez E.H.J.; Walker K.R.; Ernst K.C.; Riehle M.A.; Davidow	Size as a proxy for survival in Aedes aegypti (Diptera	2020	J. Medical Entomology	4
	Huang J.; Xu Y.; Zuo Y.; Yang Y.; Tabashnik B.E.; Wu Y.	Evaluation of five candidate receptors for three Bt to	2020	Insect Biochemistry & Molecular Bi	30
	Jaworski C.C.; Allan C.W.; Matzkin L.M.	Chromosome-level hybrid de novo genome assemblie	2020	Molecular Ecology Resources	8
	Keaton Wilson J.; Ruiz L.; Davidowitz G.	Within-host competition drives energy allocation trade	2020	PeerJ	2
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	Khallaf M.A.; Auer T.O.; Grabe V.; Depetris-Chauvin A.; Ammag	Mate discrimination among subspecies through a cor	2020	Science Advances	21
*	Klein B.A.; Busby M.K.	Slumber in a cell: Honeycomb used by honey bees f	2020	PeerJ	1
	Klotz S.A.; Schmidt J.O.	Autochthonous Chagas Disease: How Are These Inf	2020	American J. Medicine	3
	Li J.; Aidlin Harari O.; Doss A.-L.; Walling L.L.; Atkinson P.W.;	Can CRISPR gene drive work in pest and beneficial	2020	Evolutionary Applications	10
	Luckhart S.; Riehle M.A.	Midgut Mitochondrial Function as a Gatekeeper for M	2020	Frontiers in Cellular & Infection Mic	5
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	Muñoz-Valencia V.; Kähkönen K.; Montoya-Lerma J.; DÍaz F.	Characterization of a New Set of Microsatellite Marke	2020	J. Economic Entomology	1
*	Oduwole O.A.; Oringanje C.M.; Oduola A.O.; Nwachuku N.S.; M	Species composition of Anopheles (Diptera: Culicida	2020	J. Medical Entomology	1
	Pinkerton M.G.; Thompson S.M.; Hodges A.C.; Leppla N.C.; Pal	Laboratory Rearing of Bagrada hilaris (Hemiptera: Pent	2020	Florida Entomologist	0
	Rahimian R.; Shirazi F.M.; Schmidt J.O.; Klotz S.A.	Honeybee Stings in the Era of Killer Bees: Anaphyla	2020	American J. Medicine	10
	Ravenscraft A.; Thairu M.W.; Hansen A.K.; Hunter M.S.	Continent-Scale Sampling Reveals Fine-Scale Turno	2020	Frontiers in Microbiology	4

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	Tabashnik B.E.; Carrière Y.; Brewer M.	Evaluating Cross-resistance between Vip and Cry To	**2020**	J. Economic Entomology	34
	Tabashnik B.E.; Liesner L.R.; Ellsworth P.C.; Unnithan G.C.; Fa	Transgenic cotton and sterile insect releases synergi	**2020**	PNAS	51
	Wang J.; Jin H.; Schlenke T.; Yang Y.; Wang F.; Yao H.; Fang C	Lipidomics reveals how the endoparasitoid wasp Pte	**2020**	Biochimica et Biophysica Acta - Mc	5
	Wang J.; Ma H.; Zhao S.; Huang J.; Yang Y.; Tabashnik B.E.; W	Functional redundancy of two ABC transporter protei	**2020**	PLoS Pathogens	50
	Wang J.; Xu D.; Wang L.; Cong S.; Wan P.; Lei C.; Fabrick J.A.;	Bt resistance alleles in field populations of pink bollw	**2020**	Pest Management Science	9
	Wang L.; Ma Y.; Wei W.; Wan P.; Liu K.; Xu M.; Cong S.; Wang J	Cadherin repeat 5 mutation associated with Bt resist	**2020**	Scientific Reports	8
	Barrett M.; Schneider S.; Sachdeva P.; Gomez A.; Buchmann S	Neuroanatomical differentiation associated with alter	**2021**	J. Comparative Physiology A: Neu	6
*	**Bordini I.; Ellsworth P.C.; Naranjo S.E.; Fournier A.**	Novel insecticides and generalist predators support co	**2021**	Biological Control	16
	Carrière Y.; Degain B.A.; Tabashnik B.E.	Effects of gene flow between Bt and non-Bt plants in	**2021**	Pest Management Science	11
*	**Corby-Harris V.; Bennett M.M.; Deeter M.E.; Snyder L.; Meador**	Fatty acid homeostasis in honey bees (Apis mellifera	**2021**	Apidologie	3
	Davidowitz G.	Habitat-centric versus species-centric approaches to	**2021**	Current Opinion in Insect Science	3
*	**Degrandi-Hoffman G.; Corby-Harris V.; Carroll M.; Toth A.L.; Ga**	The importance of time and place: nutrient compositi	**2021**	Insects	12
	Deng Z.; Zhang Y.; Li Y.; Huang K.; Chen X.; Zhang M.; Huang J	Identification and characterization of the masculinizin	**2021**	International J. Molecular Sciences	1
	Diaz F.; Allan C.W.; Markow T.A.; Bono J.M.; Matzkin L.M.	Gene expression and alternative splicing dynamics a	**2021**	BMC Genomics	3
	Diaz F.; Kuijper B.; Hoyle R.B.; Talamantes N.; Coleman J.M.; M	Environmental predictability drives adaptive within- ar	**2021**	Functional Ecology	6
	Fabrick J.A.; LeRoy D.M.; Mathew L.G.; Wu Y.; Unnithan G.C.; Y	CRISPR-mediated mutations in the ABC transporter g	**2021**	Scientific Reports	12
*	**Harrington K.; Carrière Y.; Mostafa A.M.**	Re-evaluating the Economic Injury Level for Alfalfa W	**2021**	J. Economic Entomology	4
*	**Hun L.V.; Cheung K.W.; Brooks E.; Zudekoff R.; Luckhart S.; Ri**	Increased insulin signaling in the Anopheles stepher	**2021**	Insect Biochemistry & Molecular Bi	2
	Janzen T.; Diaz F.	Individual-based simulations of genome evolution wit	**2021**	Methods in Ecology & Evolution	0
	Kavanaugh D.H.; Maddison D.R.; Simison W.B.; Schoville S.D.;	Phylogeny of the supertribe nebriitae (Coleoptera, ca	**2021**	ZooKeys	6
	Klotz S.A.; Smith S.L.; Schmidt J.O.	Kissing bug intrusions into homes in the southwest u	**2021**	Insects	2
	Li S.; Chen S.; Xie X.; Dong S.; Li X.	Identification of wild-type cyp321a2 and comparison	**2021**	Insects	3
	Lue C.-H.; Buffington M.L.; Scheffer S.; Lewis M.; Elliott T.A.; Li	DROP: Molecular voucher database for identification	**2021**	Molecular Ecology Resources	12
	Mortimer N.T.; Fischer M.L.; Waring A.L.; Pooja K.R.; Kacsoh B	Extracellular matrix protein N-glycosylation mediates	**2021**	PNAS	2
*	**Oringanje C.; Delacruz L.R.; Han Y.; Luckhart S.; Riehle M.A.**	Overexpression of activated ampk in the anopheles s	**2021**	Genes	6
	Qi L.; Dai H.; Jin Z.; Shen H.; Guan F.; Yang Y.; Tabashnik B.E.;	Evaluating Cross-Resistance to Cry and Vip Toxins in I	**2021**	Frontiers in Microbiology	4
	Sabino W.O.; Alves-dos-Santos I.; Queiroz E.P.; de Faria L.B.;	Nesting biology of Centris (Paracentris) burgdorfi (Ap	**2021**	J. Apicultural Research	3
	Sames W.J.; Mann J.G.; Kelly R.; Evans C.L.; Varnado W.C.; B	Distribution of culex coronator in the USA	**2021**	J. the American Mosquito Control A	4
	Schmidt J.O.	Everybody loves stinging insects!	**2021**	American Entomologist	2
	Simão-Gurge R.M.; Thakre N.; Strickland J.; Isoe J.; Delacruz I	Activation of anopheles stephensi pantothenate kina	**2021**	Biomolecules	2
	Van Den Berg J.; Prasanna B.M.; Midega C.A.O.; Ronald P.C.;	Managing Fall Armyworm in Africa: Can Bt Maize Sus	**2021**	J. Economic Entomology	14
	Wang J.; Yan Z.; Xiao S.; Wang B.; Fang Q.; Schlenke T.; Ye G	Characterization of a cell death-inducing endonuclea	**2021**	Pest Management Science	2

	Yang F.; Kerns D.L.; Little N.S.; Santiago González J.C.; Tabas	Early warning of resistance to bt toxin vip3aa in helic	**2021**	Toxins	11
	Zhao S.; Jiang D.; Wang F.; Yang Y.; Tabashnik B.E.; Wu Y.	Independent and Synergistic Effects of Knocking ou	**2021**	Toxins	15
	Benowitz K.M.; Allan C.W.; Degain B.A.; Li X.; Fabrick J.A.; Tab	Novel genetic basis of resistance to Bt toxin Cry1Ac i	**2022**	Genetics	5
*	**Brophy M.; Riehle M.A.; Mastrud N.; Ravenscraft A.; Adamson**	Genetic Variation in Rhipicephalus sanguineus s.l. Ti	**2022**	International J. Environmental Res	2
*	**Brophy M.; Walker K.R.; Adamson J.E.; Ravenscraft A.**	Tropical and Temperate Lineages of Rhipicephalus s	**2022**	J. Medical Entomology	0
	Cavallaro M.C.; Medeiros M.J.; Halloran S.; Millar J.G.	Identification and Bioassays of Sex-Specific Compou	**2022**	J. Economic Entomology	1
	Cavallaro M.C.; Sanders C.J.; Hladik M.L.	Measured efficacy, bioaccumulation, and leaching of	**2022**	Pest Management Science	0
	Contreras H.L.; Goyret J.; Pierce C.T.; Raguso R.A.; Davidowit	Eat, Drink, Live: Foraging behavior of a nectarivore w	**2022**	J. Insect Physiology	2
	Davidowitz G.; Bronstein J.L.; Tigreros N.	Flight-Fecundity Trade-offs: A Possible Mechanistic L	**2022**	Frontiers in Plant Science	0
	de A. Caetano C.; de O. Sabino W.; Cordeiro G.D.; Buchmann S	Scientific note about the negative impacts of male co	**2022**	Apidologie	0
	Diaz F.; Allan C.W.; Chen X.; Coleman J.M.; Bono J.M.; Matzkin	Divergent evolutionary trajectories shape the postma	**2022**	Communications Biology	0
*	**Doremus M.R.; Stouthamer C.M.; Kelly S.E.; Schmitz-Esser S.;**	Quality over quantity: unraveling the contributions to c	**2022**	Heredity	3
	Fabrick J.A.; Heu C.C.; LeRoy D.M.; DeGain B.A.; Yelich A.J.; U	Knockout of ABC transporter gene ABCA2 confers re	**2022**	Scientific Reports	1
*	**Gutiérrez E.H.J.; Riehle M.A.; Walker K.R.; Ernst K.C.; Davidow**	Using body size as an indicator for age structure in fi	**2022**	Parasites & Vectors	0
*	**Hunter M.S.; Umanzor E.F.; Kelly S.E.; Whitaker S.M.; Ravenscr**	Development of Common Leaf-Footed Bug Pests Dep	**2022**	Applied & Environmental Microbiolo	3
	Hurtado J.; Revale S.; Matzkin L.M.	Propagation of seminal toxins through binary expres	**2022**	Scientific Reports	1
*	**Ikagawa R.M.; Moore W.**	Molecular phylogeny and revision of species groups	**2022**	ZooKeys	0
	Isoe J.; Petchampai N.; Joseph V.; Scaraffia P.Y.	Ornithine decarboxylase deficiency critically impairs nitr	**2022**	FASEB J.	0
*	**Jankauski M.; Ferguson R.; Russell A.; Buchmann S.**	Structural dynamics of real and modelled Solanum st	**2022**	J. the Royal Society Interface	6
*	**Joy T.; Chen M.; Arnbrister J.; Williamson D.; Li S.; Nair S.; Bro**	Assessing Near-Infrared Spectroscopy (NIRS) for Eva	**2022**	Insects	4
	Kelly S.E.; Moore W.; Hall W.E.; Hunter M.S.	Hiding in plain sight: Cryptic enemies are found on co	**2022**	Ecology and Evolution	0
*	**Kusakabe A.; Wang C.; Xu Y.-M.; Molnár I.; Stock S.P.**	Selective Toxicity of Secondary Metabolites from the	**2022**	Microbiology Spectrum	8
	Moore W.; Scarparo G.; Di Giulio A.	Foe to frenemy: predacious ant nest beetles use mu	**2022**	Current Opinion in Insect Science	1
	Naranjo S.E.; Cañas L.; Ellsworth P.C.	Mortality dynamics of a polyphagous invasive herbivo	**2022**	Pest Management Science	0
*	**Palting J.D.; Moore W.**	Molecular phylogeny of Lichen Tiger Moths (Lepidop	**2022**	ZooKeys	0
*	**Shaible T.M.; Matzkin L.M.**	Physiological and life history changes associated witl	**2022**	Biology open	0
	Smith G.P.; Davidowitz G.; Alarcón R.; Papaj D.R.; Bronstein J	Sex differences in the foraging behavior of a genera	**2022**	Insect Science	4
	Smith G.P.; Davidowitz G.; Raguso R.A.; Bronstein J.L.	Proboscis curling in a pollinator causes extensive pol	**2022**	Ecological Entomology	2
	Tabashnik B.E.; Unnithan G.C.; Yelich A.J.; Fabrick J.A.; Denn	Responses to Bt toxin Vip3Aa by pink bollworm larva	**2022**	Pest Management Science	1
	Thakre N.; Simão Gurge R.M.; Isoe J.; Kivi H.; Strickland J.; De	Manipulation of pantothenate kinase in Anopheles s	**2022**	Insect Biochemistry & Molecular Bi	0
*	**Wagner D.L.; Matson T.A.; Palting J.D.**	A New Norape from the Southwestern United States	**2022**	J. the Lepidopterists' Society	0
	Wang X.; Shi T.; Tang P.; Liu S.; Hou B.; Jiang D.; Lu J.; Yang Y	Baseline susceptibility of Helicoverpa armigera, Plutella	**2022**	Insect Science	2
	Yang F.; Kerns D.L.; Little N.; Brown S.A.; Stewart S.D.; Catcho	Practical resistance to Cry toxins and efficacy of Vip3	**2022**	Pest Management Science	5

	Barrett M.; Fischer B.; Buchmann S.	Informing policy and practice on insect pollinator decli	**2023**	Frontiers in Ecology and Evolution	0
*	**Bordini I.; Naranjo S.E.; Fournier A.; Ellsworth P.C.**	Spatial scale of non-target effects of cotton insecticide	**2023**	PLoS ONE	0
	Britton S.; Davidowitz G.	The effect of diet on melanin pigmentation in animals	**2023**	Functional Ecology	0
	Carrière Y.; Tabashnik B.E.	Fitness Costs and Incomplete Resistance Associated	**2023**	Insects	0
	Cruz A.R.; Davidowitz G.; Moore C.M.; Bronstein J.L.	Mutualisms in a warming world	**2023**	Ecology Letters	0
*	**Deeter M. E.; Snyder L.A.; Meador C.; Corby-Harris V.**	Accelerated abdominal lipid depletion from pesticide	**2023**	J. Experimental Biology	0
	Fabrick J.A.; Li X.; Carrière Y.; Tabashnik B.E.	Molecular Genetic Basis of Lab- and Field-Selected I	**2023**	Insects	4
	Guan F.; Dai X.; Hou B.; Wu S.; Yang Y.; Lu Y.; Wu K.; Tabashn	Refuges of conventional host plants counter domina	**2023**	iScience	0
	Guan F.; Dai X.; Yang Y.; Tabashnik B.E.; Wu Y.	Population Genomics of Nonrecessive Resistance to	**2023**	J. Economic Entomology	1
	Hammer T.J.; Kueneman J.; Argueta-Guzmán M.; McFrederick	Bee breweries: The unusually fermentative, lactobacilli-	**2023**	Frontiers in Microbiology	0
	Moreyra N.N.; Almeida F.C.; Allan C.; Frankel N.; Matzkin L.M.;	Phylogenomics provides insights into the evolution o	**2023**	Molecular Phylogenetics & Evoluti	1
	Pfeiler E.; Nazario-Yepiz N.O.	On the proposed replacement neotype of Telegonus	**2023**	Systematics & Biodiversity	0
	Robinson S.D.; Deuis J.R.; Touchard A.; Keramidas A.; Mueller	Ant venoms contain vertebrate-selective pain-causin	**2023**	Nature Communications	0
	Tabashnik B.E.; Carrière Y.; Wu Y.; Fabrick J.A.	Global perspectives on field-evolved resistance to tra	**2023**	J. Economic Entomology	0
	Tabashnik B.E.; Fabrick J.A.; Carrière Y.	Global Patterns of Insect Resistance to Transgenic B	**2023**	J. Economic Entomology	6
	Taylor W.T.T.; Librado P.; Icu M.H.T.; Gover C.S.C.; Arterberry	Early dispersal of domestic horses into the Great Pla	**2023**	Science	1
	Tigreros N.; Kozhoridze G.; Davidowitz G.; Ziv Y.	Influence of the direct and indirect effects of habitat	**2023**	Landscape Ecology	0
					4649

Book Chapters (9)

	Carrière Y.; Fabrick J.A.; Tabashnik B.E.	Advances in managing pest resistance to Bt crops: F	2016	Advances in Insect Control & Resi	13
	Luján R.; Cupp E.W.	Human onchocerciasis: New immunodiagnostic assay	2018	Biotechnology for Biological Contro	0
	Schmidt J.O.	Arthropod toxins and venoms	2018	Medical & Veterinary Entomology	2
*	**Bondy E.C.; Hunter M.S.**	Sex ratios in the haplodiploid herbivores, Aleyrodidae	2019	Advances in Insect Physiology	4
	Tigreros N.; Davidowitz G.	Flight-fecundity tradeoffs in wing-monomorphic insect	2019	Advances in Insect Physiology	36
*	**Doremus M.R; Hunter M.S.**	The saboteur's tools: Common mechanistic themes a	2020	Advances in Insect Physiology	10
	Mazza A.; Brousseau R.; Tabashnik B.; Masson A.L.	Receptor binding studies on lipid vesicles using the b	2021	Quantitive Analysis Of Biospec	0
	Carrière Y.; Onstad D.W.	The role of landscapes in insect resistance managen	2022	Insect Resistance Management: B	1
	Davis S.; Schlenke T.	Behavioral defenses against parasitoids: Genetic an	2022	Animal Behavior & Parasitism	2

Appendix D2. 24 extramural grants and contracts awarded to UA Department of Entomology for $7.9M in fiscal year 2023 (July 1, 2022 to June 30, 2023).

Lead PI [a]	Title	Source	Start Date	End Date	Amount to UA Entomology
Ellsworth, Peter	Resistance Monitoring	Bayer Crop Science	04/11/2023	01/31/2024	$21,775
Ellsworth, Peter	Improving Insect Management Strategies in Arizona Cotton	Cotton Incorporated	01/01/2023	12/31/2023	$21,000
Ellsworth, Peter	Selectivity of Cotton Insecticides Drive Eco-toxicological Gains & Improve Arizona Cotton	Cotton Incorporated	01/01/2023	12/31/2023	$60,000
Ellsworth, Peter	Acquisition of Goods & Services	United States Department of Agriculture	09/01/2022	08/31/2023	$50,888
Ellsworth, Peter [b]	A Western Integrated Pest Management Center Led by California, Arizona, Oregon, & Utah	United States Department of Agriculture	09/01/2022	08/31/2026	$360,000
Ellsworth, Peter [c]	Building a Climate Smart Domestic Rubber Industry & a Solution for Growers to a Water	United States Department of Agriculture	04/14/2023	04/01/2028	$1,243,134
Gouge, Dawn [d]	Advancing Vector-borne Disease Surveillance in American Indian Communities	National Institutes of Healt	09/01/2022	07/31/2023	$115,125
Gouge, Dawn [e]	Promoting Integrated Pest Management in Affordable Housing	US Department of Housing & Urban	11/24/2022	11/23/2023	$45,098
Hunter, Martha [f]	Symbiont Transmission Constraints & Consequences in an Orchard Bug Pest	United States Department of Agriculture	05/01/2023	04/30/2026	$646,180
Ikagawa, Raine (EIS Student)	Molecular Phylogeny of Brachinine Bombardier Beetles Utilizing Ultraconserved Elements	The Coleopterists Society	08/01/2022	07/31/2023	$5,000
Li, Xianchun	Bench Fees for Mahreen Hanif (visiting student)	Higher Education Commission (Pakistan)	03/01/2023	08/31/2023	$3,500
Matzkin, Luciano	Development of Functional Genomics Tools in Cactophilic Drosophila	National Science Foundation	10/01/2022	09/30/2026	$1,155,403
Matzkin, Luciano	Sequencing & Annotation of the Western Tarnished Plant Bug (*Lygus hesperus*) Genome	United States Department of Agriculture	08/01/2022	07/31/2024	$34,850
Moore, Wendy	Facilitating Collections-Based Research on Insect Pollinators of the Sonoran Desert Region	National Science Foundation	02/01/2023	01/31/2026	$477,610
Palumbo, John	Development of Monitoring Tool for Managing Tospovirus Damage to Lettuce	Arizona Department of Agriculture	10/03/2022	09/30/2024	$57,286
Palumbo, John	Thrips & INSV Management in Desert Lettuce	Arizona Iceberg Lettuce Research Council	09/01/2022	08/31/2023	$25,986
Palumbo, John	Areawide Monitoring of Lettuce Insects in Yuma	Arizona Iceberg Lettuce Research Council	09/01/2022	08/31/2023	$6,443
Palumbo, John	Insecticide Alternatives in Melons	California Melon Research Advisory	03/01/2023	02/29/2024	$13,082
Palumbo, John [g]	Survey of Potential Reservoirs of Impatients Necrotic Spot Virus	Arizona Department of Agriculture	10/18/2022	09/30/2023	$47,229
Palumbo, John [g]	Monitoring the Vector-mediated Movement of INSV into Arizona & Secondary Distribution	Arizona Iceberg Lettuce Research Council	09/01/2022	08/31/2023	$5,150
Riehle, Michael [h]	How to Starve a Parasite: Manipulating CoA Biosynthesis to Control *Plasmodium*	National Institutes of Health	04/13/2023	03/31/2027	$2,472,491
Tabashnik, Bruce	Sustaining Efficacy of Bt Cotton Against Lepidopteran Pests	Cotton Incorporated	02/01/2023	12/31/2023	$32,500
Tabashnik, Bruce	Acquisition of Goods & Services	United States Department of Agriculture	09/01/2022	08/31/2023	$16,829
Walker, Kathleen [i]	Genetic Variation & Endosymbiont Diversity of *Rhipicephalus sanguineus*	Centers for Disease Control	07/01/2022	06/30/2027	$987,337
				Total	**$7,903,895**

[a] Leads the entire project except in 4 cases indicated by superscripts c-e & i (see footnotes below).
[b] Total $1M including $640K to co-PIs not in UA ENTO
[c] Ellsworth is co-PI, total $35M including $34M to collaborators not in UA ENTO
[d] Gouge is co-PI, total $1.1M including $1M to collaborators not in UA ENTO
[e] Gouge is co-PI, total $1.33M including $1.29M to collaborators not in UA ENTO
[f] Total listed includes $96K subaward to co-PI at University of Texas
[g] PI is Samuel Discua Duarte, a postdoc supervised by Dr. Palumbo
[h] Total listed includes $1.2M subaward to collaborator at University of Idaho
[i] Walker is co-PI, total $2M including $1M to collaborators not in UA ENTO

Appendix E1. Rubric for Self-Assessing Entomology Teaching Quality

Indicate the self-assessment rating with a brief rationale in the appropriate cell.			Criteria for Assessing Teaching Quality
Exemplary	**Developing**	**Needs Development**	
High quality reflected by strong SCS scores (Figs. E1, E2) & strong peer evaluations			**Expectations for Teaching Quality**: A department is EXEMPLARY for this criterion if it has established a set of expectations for high-quality teaching at all levels of the curriculum that are clearly conveyed to all instructors. Expectations are based upon effective teaching practices demonstrated to improve student learning outcomes. All instructors are held to these expectations to the extent that is appropriate to the classes they teach and the terms of their appointments.
Teaching excellence is emphasized as part of recruiting. Several faculty participate in FLCs.			**Support for Teaching Development**: A department is EXEMPLARY for this criterion if it has in place standard processes for encouraging professional development towards high quality teaching across the whole unit. These processes include the provision of clear information about and ready access to resources, inside and outside the department that can help all instructors develop the quality of their teaching. All these processes are aligned with the department's established expectations for teaching quality. Avenues for development may include, but need not be limited to, peer coaching, consultations with UCATT, and support for attending workshops and conferences focused on enhancing the quality of teaching.
Evaluating teaching is a key part of recruiting, annual reviews, as well as P&T reviews.			**Evaluation of Teaching**: A department is EXEMPLARY for this criterion if it has an established and transparent process for evaluating teaching quality for all instructors. The evaluation criteria are tightly linked to the department's established set of expectations for teaching quality. The evaluation process includes, but is not limited to, student evaluations, peer evaluation of teaching, and instructor self- reflection. Evaluating teaching quality is a key part of annual reviews as well as promotion and tenure reviews.
High quality reflected by strong SCS scores (Figs. E1, E2) & strong peer evaluations			**Applying Findings to Teaching Improvements**: A department is EXEMPLARY for this criterion if it has an ongoing process that includes steps in which teaching evaluations are reviewed and incorporated into department plans for both programmatic and individual goals improvement. All steps of this application phase are linked to the department's established set of expectations for teaching quality.

Appendix E2. Student Course Survey Questions and Categories

Assessment
1. I received feedback on course work/assignments that helped me learn.
2. I received feedback on my course work/assignments throughout the semester.

Instruction
3. I was encouraged to analyze and/or apply the concepts and skills taught in this course.
4.The course material and activities (D2L site, assigned readings, presentations, etc.) helped me learn in this course.
5. The course presentations, materials, procedures, and deadlines were clearly organized.

Learning
6. I feel I learned the subject matter well enough to help another student in this course.
7. The learning goals for this course were clear to me.
8. This course expanded my knowledge and skills in this subject matter.
9. This course helped me to connect the concepts and skills we learned to the world around me.

Interactions
10. I regularly/frequently had the opportunity to ask questions about concepts and skills in this course.
11. I was treated with respect in this course.
12. In this course, I was encouraged to participate through class activities, projects, and/or assignments.

Appendix E3. Student Survey Scores for Undergraduate (ENTO) Courses, 2020-Spring 2023

Course	Term	Enrolled	Responded	Assessment	Instruction	Learning	Interactions
160	Summer 2020	5	3	100%	100%	100%	100%
160	Summer 2020	17	7	83%	89%	88%	90%
160	Fall 2020	21	13	100%	100%	96%	92%
160	Fall 2020	97	60	98%	96%	91%	93%
160	Spring 2021	45	23	98%	96%	95%	99%
160	Fall 2021	186	117	91%	88%	86%	93%
160	Spring 2022	114	75	87%	92%	92%	93%
160	Summer 2022	17	3	100%	89%	100%	100%
160	Fall 2022	157	88	90%	89%	87%	90%
160	Spring 2023	132	59	87%	92%	86%	91%
170	Fall 2020	103	40	83%	90%	86%	97%
170	Spring 2021	27	4	50%	75%	75%	82%
170	Spring 2021	165	29	83%	92%	91%	93%
170	Summer 2021	12	6	100%	83%	88%	100%
170	Fall 2021	82	24	83%	81%	77%	86%
170	Spring 2022	193	53	82%	98%	92%	95%
170	Fall 2022	135	30	80%	78%	79%	89%
170	Spring 2023	95	20	73%	75%	81%	87%
300	Fall 2020	23	11	100%	100%	100%	100%
300	Fall 2022	22	8	100%	100%	100%	100%
401	Fall 2020	2	2	100%	100%	100%	100%
407	Spring 2022	20	9	100%	96%	100%	100%
407	Spring 2023	25	7	100%	100%	100%	100%
415	Fall 2020	26	12	92%	94%	94%	100%
415	Fall 2021	26	13	89%	97%	98%	100%
415	Fall 2022	24	12	100%	100%	98%	100%
417	Fall 2020	6	5	100%	100%	100%	100%
417	Fall 2022	5	4	75%	83%	81%	100%
432	Fall 2020	27	17	94%	90%	74%	92%
432	Fall 2021	25	11	100%	85%	82%	100%
432	Fall 2022	12	4	100%	100%	94%	100%
436	Spring 2021	12	3	100%	100%	100%	100%
436	Spring 2022	9	4	63%	92%	88%	100%
436	Spring 2023	12	5	100%	100%	100%	100%
457	Spring 2021	19	12	92%	94%	98%	100%
457	Spring 2022	27	14	89%	95%	96%	98%
457	Spring 2023	25	11	100%	100%	98%	100%
468	Fall 2020	20	8	94%	96%	91%	92%
468	Fall 2021	24	4	50%	58%	75%	67%
468	Fall 2022	17	5	80%	100%	100%	100%

Appendix E4. Student Survey Scores for Graduate (EIS) Courses, 2020-Spring 2023

Course	Term	Enrolled	Responded	Assessment	Instruction	Learning	Interactions
501	Fall 2020	7	5	100%	100%	100%	100%
517	Fall 2020	24	16	97%	79%	94%	100%
517	Fall 2022	8	7	86%	91%	89%	100%
532	Fall 2019	10	9	100%	100%	92%	100%
532	Fall 2020	3	2	100%	100%	100%	100%
532	Fall 2021	1	1	100%	100%	100%	100%
532	Fall 2022	3	2	100%	100%	100%	100%
536	Spring 2021	10	5	100%	93%	90%	100%
536	Spring 2022	7	2	100%	100%	100%	100%
536	Spring 2023	6	4	100%	92%	100%	100%
544	Fall 2019	15	10	50%	80%	83%	93%
544	Fall 2021	12	6	92%	83%	92%	100%
553	Fall 2020	17	8	88%	100%	97%	100%
557	Spring 2022	5	1	100%	100%	100%	100%
557	Spring 2023	6	3	100%	100%	100%	100%
596	Fall 2019	21	14	50%	88%	91%	100%
596	Fall 2020	10	6	83%	100%	100%	100%
596	Spring 2021	10	6	100%	100%	96%	100%
596	Fall 2021	10	4	75%	100%	100%	100%
596	Spring 2022	13	5	60%	73%	95%	100%
596	Fall 2022	8	5	80%	93%	100%	100%
596	Spring 2023	7	3	100%	100%	100%	100%

Appendix E5. Curriculum Vitae of the 18 Core Entomology Faculty

Yves Carrière

Education

1986 MSc. Laval University, Sainte-Foy, QC, Canada
1991 PhD. Simon Fraser University, Burnaby, BC, Canada

Experience

1992-1993 NSERC Postdoctoral Fellow, McGill University
1994-1995 FCAR Postdoctoral Fellow, McGill University
1996-1998 Adjunct Professor. Department of Plant Sciences, Laval University
1998-2003 Assistant Professor, Department of Entomology, The University of Arizona
2003-2006 Associate Professor, Department of Entomology, The University of Arizona
2006-present Professor, Department of Entomology, The University of Arizona

Selected Recent Synergistic Activities, Honors, and Awards

2015-17 Invited Participant, SESYNC Pursuit: Socio-ecological governance of resistance evolution (NSF funded)
2017 Fellow, Entomological Society of America (ESA)
2020 Panel Member, USDA Office of Scientific Quality Review (OSQR). National Program Crop and Quarantine
2021 Plant-Insect Ecosystem Integrated Pest Management Team Award, Entomological Society of America
2021 Panel Member, USDA-NIFA Biotechnology Risk Assessment Grants (BRAG) Program
2023 Lifetime Achievement Award in Entomology, ESA, Plant-Insect Ecosystems Section

Selected Publications (55 since 2016, total 241; Google scholar citations: 17,494; *h*-index: 66)

Carrière Y. and D. W. Onstad. 2023. The role of landscapes in insect resistance management. Pp. 329-380. In: D. W. Onstad & L. M. Knolhoff, eds., Insect Resistance Management: Biology, Economics & Prediction, 3rd Ed. Academic Press. Elsevier, UK.

Carrière, Y., Tabashnik, B.E. 2023. Fitness costs and incomplete resistance associated with delayed evolution of practical resistance to Bt crops. Insects. 14: 214.

Benowitz, K. M., Allan C. W., Degain, B. A., Li, X., Fabrick, J. A., Tabashnik, B. E., Carrière, Y., and Matzkin, L. M. 2022. Novel genetic basis of resistance to Bt toxin Cry1Ac in *Helicoverpa zea*. Genetics. 221: iyac037

Joy, T., Chen, M., Arnbrister, J., Williamson, D., Li, S., Nair, S., Brophy, M., Madera Garcia, V., Walker, K., Ernst, K., Gouge, D., Carrière Y., and M. A. Riehle. 2022. Assessing near-infrared spectrophotometry (NIRS) for evaluation of *Aedes aegypti* population age structure in Arizona. Insects. 13: 360.

Tabashnik, B. E., L. R. Liesner, P. C. Ellsworth, G.C. Unnithan, J. A. Fabrick, S. E. Naranjo, X. Li, T. J. Dennehy, L. Antilla, R.T. Staten, and Y. Carrière. 2021. Genetically engineered cotton synergizes eradication of the pink bollworm a century after its invasion of the United States. Proceedings of the National Academy of Sciences USA. 118: e2019115118

Van den Berg, J., B. M. Prasanna, C. A. O. Midega, P. C. Ronald, Y. Carrière, and B. E. Tabashnik. 2021. Managing fall armyworm in Africa: Can Bt maize sustainably improve control? Journal of Economic Entomology. 114: 1934-1949.

Carrière, Y., Brown, Z. S., Downes, S. J., Gujar, G., Epstein, G., Omoto, C., Storer, N. P., Mota-Sanchez, D., Søgaard Jørgensen, P., and Carroll, S. P. 2020. Governing evolution: a socio-ecological comparison of resistance management for insecticidal transgenic Bt crops among four countries. AMBIO. 49: 1-16.

Carrière, Y., Brown, Z., Aglasan, S., Dutilleul, P., Carroll, M., Head, G., Tabashnik, B. E. Søgaard Jørgensen, P., and Carroll, S. P. 2020. Crop rotation mitigates impacts of corn rootworm resistance to transgenic Bt corn. PNAS. 117: 18385-18392.

Carrière, Y., Degain, B. A., Yelich, A. J., Unnithan, G. C., Harpold, V. S., Kim, J. H., Mathew, J. G., Head, G. P., Rathore, K. S., Fabrick, J. A., and Tabashnik, B. E. 2019. Gossypol in cottonseed increases the fitness cost of resistance to Bt cotton in pink bollworm. Crop Protection. 126: 104914126.

Søgaard Jørgensen, P., Aktipis, A., Brown, Z., Carrière, Y., et al. 2018. Antibiotic and pesticide susceptibility and the anthropocene operating space. Nature Sustainability. 1: 632-641.

Tabashnik, B. E. and Carrière Y. 2017. Surge in insect resistance to transgenic crops and prospects for sustainability. Nature Biotechnology. 35: 926-935.

Carrière Y., Fabrick, J. A. and Tabashnik, B. E. 2016. Can pyramids and seed mixtures delay resistance to Bt crops? Trends in Biotechnology. 34: 291-302.

Goggy Davidowitz

Education

Hebrew University of Jerusalem, Israel	Biology	B.Sc.	1986
Hebrew University of Jerusalem, Israel	Zoology	M.Sc.	1989
University of Arizona	Ecology & Evolutionary Biology	Ph.D.	1998

Experience

2018-present	Affiliated Faculty, Controlled Environment Agriculture Center
2018-present	Full Professor, Department of Entomology, University of Arizona (UA)
2013-2018	Associate Professor, Department of Entomology, UA
2009-2013	Assistant Professor, Department of Entomology, UA
2011-present	Joint Faculty Member, Dept. of Ecology and Evolutionary Biology, UA
2007-2008	Program Director, Division of Integrative Organismal Systems, National Science Foundation
1999-2002	Research Associate, Department of Biology, Duke University

Synergistic Activities, Honors and Awards

2023	Fellow, American Association for the Advancement of Science
2018	University Distinguished Scholar, UA
2017	Visiting Eminent Ecologist, Kellogg Biological Station, Michigan State University
2011-2017	NSF CAREER Award ($972,000)
2009-2018	Associate Editor, Functional Ecology

Patents Pending

2022 Grasshopper Harvesting System (PCT/US22/26786)
2021 Solar Tower to Dry Food Waste on a Large Scale (PCT/US21/48651).

Selected Publications (88 total)

Cruz, A. R., **Davidowitz, G**., Moore, C., Bronstein, J. L. (2023). Mutualisms in a Warming World. *Ecology Letters* 26:1432-1451.

Britton S. and **G. Davidowitz** (2023). The effects of diet on melanin pigmentation in animals. *Functional Ecology* 37:206-217.

Davidowitz, G., J. Bronstein, N. Tigreros (2022). Flight-fecundity tradeoffs, a possible mechanistic link in plant-herbivore-pollinator systems. *Frontiers in Plant Science* 13:843506.

Slagle M. L., **G. Davidowitz** (2022). Substrate composition effect on growth of *Cotinis mutabilis* larvae: a case for detritivore scarabs in the insect agriculture industry. *Journal of Insects as Food and Feed* 8:937-949

Davidowitz G. (2021). Habitat-centric versus species-centric approaches to edible insects for food and feed. *Current Opinion in Insect Science* 48:37-43.

Johnson, C.A., G. P. Smith K. Yule, **G. Davidowitz**, J. L. Bronstein, and R. Ferriere (2021). Coevolutionary transitions from antagonism to mutualism explained by the Co-Opted Antagonist Hypothesis. *Nature Communications* 12:1-11.

Tigreros N., and **G. Davidowitz** (2019). Flight-fecundity tradeoffs in wing-monomorphic insects. *Advances in Insect Physiology* 0065-2806.

Levin, E., G. Lopez-Martinez, B. Fane, **G. Davidowitz**. (2017). Hawkmoths use nectar sugar to reduce oxidative damage from flight. *Science* 355:733-735.

Davidowitz, G., D.A. Roff, H. F. Nijhout. (2016). Synergism and antagonism of proximate mechanisms enable and constrain the response to simultaneous selection on body size and development time: an empirical test using experimental evolution. *The American Naturalist* 188: 499-520.

Von Arx M., J. Goyret, **G. Davidowitz**, and R.A. Raguso. (2012). Floral humidity as a reliable sensory cue for profitability assessment by nectar-foraging hawkmoths. *Proceedings of the National Academy of Sciences USA* 109: 9471-9476.

Stillwell, R.C., W. Blanckenhorn, T. Teder, **G. Davidowitz**, and C.W. Fox. (2010). Sex differences in phenotypic plasticity of body size and variation in sexual size dimorphism – from physiology to ecology. *Annual Review of Entomology* 55:227-245

Riffell, J.A., R. Alarcón, L. Abrell, **G. Davidowitz**, J. L. Bronstein, and J. G. Hildebrand. (2008). Behavioral consequences of innate preferences and olfactory learning in hawkmoth-flower interactions. *Proceedings of the National Academy of Science USA* 105:3404-3409.

Peter C. Ellsworth

Education

Ph.D.	Entomology (Minor: Crop Science), North Carolina State University, 1990
M.S.	Entomology, University of Missouri at Columbia, 1985
B.S.	Entomology (Minor: Latin), University of New Hampshire, 1981

Experience

2013 – present	**Co-Director**, Western Regional IPM Center, USDA-NIFA at UC-Davis
2004 – present	**IPM Coordinator**, Cooperative Extension, University of Arizona
2003 – present	**Director** of the Arizona Pest Management Center (APMC), Univ. of Arizona
2002 – present	**Full Specialist / Professor**, IPM, Dept. of Entomology, University of Arizona
2009 – 2019	**Pesticide Coordinator**, Pesticide Safety Education Program, University of Arizona
1996 – 2002	**Associate Specialist / Professor**, IPM, Department of Entomology, University of Arizona
1991 – 1996	**Assistant Specialist / Professor**, IPM, Department of Entomology, University of Arizona

Synergistic Activities, Honors and Awards (recent & selected)

2022 Cooperative Extension Faculty of the Year, University of Arizona
2022 USDA AFRI Critical Agricultural Research & Extension Panel Manager (12 panelists / 45 proposals / $6.9M)
2022 USDA CPPM Applied Research & Development Program Panel Manager (18 panelists / 63 proposals / $5M)
2021 Perry L. Adkisson Distinguished Speaker Award, Texas A&M University
2021 IPM Team Award for the Arizona Pink Bollworm Project, Entomological Society of America
2021 Recognition Award for Excellence in Cotton IPM, Corteva Agriscience and the National Cotton Council
2016 Outstanding Advisory Council Member Award, Central Arizona College
2014 Award for Excellence in IPM, Entomological Society of America & Syngenta Crop Protection
2014 Award for Excellence in Integrated Pest Management, Pacific Branch Entomological Society of America
2012 Pesticide Environmental Stewardship Program Gold Tier Shining Star Award to APMC from US EPA
2011 Distinguished Achievement Award in Extension, Pacific Branch of the Entomological Society of America
2010 Outstanding Journal Article Award, Western Agricultural Economics Association
2009 Harold Gunderson Memorial Lecture in Entomology, Iowa State University
2009 APMC Team Program Award, Honorable Mention, Western Region Extension Directors
2002 Faculty Member of the Year, 'Ag' 100 Council of Alumni of CALS, University of Arizona

Publications (books, book chapters, key recent journal and Extension articles)

Asiimwe, P, CR Brown, PC Ellsworth, DD Reisig, L Bertho, C Jiang, A Schapaugh, G Head, L Burzio. 2023. Transgenic cotton expressing Mpp51Aa2 does not adversely impact beneficial non-target Hemiptera in the field. Crop Protection (*in press*).

Bordini I, Naranjo SE, Fournier A, Ellsworth PC. 2023. Spatial scale of non-target effects of cotton insecticides. PLOS ONE 18(5): e0272831.

Naranjo SE, Cañas, L, Ellsworth PC. 2022. Mortality dynamics of a polyphagous invasive herbivore reveal clues in its agroecosystem success. Pest Management Science 78:

Tabashnik, BE, LR Liesner, PC Ellsworth, GC Unnithan, JA Fabrick, SE Naranjo, X Li, TJ Dennehy, L Antilla, RT Staten, Y Carrière. 2021. Transgenic cotton and sterile insect releases synergize eradication of pink bollworm a century after it invaded the United States. PNAS. 118.

Bordini IC, Ellsworth PC, Naranjo SE, Fournier AJ. 2021. Novel insecticides and generalist predators support conservation biological control in cotton. Biol. Control, 154.

Naranjo, SE, GB Frisvold, PC Ellsworth. 2019, Economic Value of Arthropod Biological Control. Chapter 4, In, The Economics of Integrated Pest Management of Insects. Onstad, DW & PR Crain, eds. CABI, pp. 49–85.

Reisig, D, PC Ellsworth, E Hodgson. 2019, The Roles of Soft Technologies and Cooperative Extension in Solving Wicked IPM Problems. Chapter 9, Ibid. pp. 155–178.

Akbar, W, Gowda, …Ellsworth, PC, Godfrey, LD and Clark, TL (2019), First transgenic trait for control of plant bugs and thrips in cotton. Pest. Manag. Sci. https://doi.org/10.1002/ps.5234

Anderson JA, Ellsworth PC, Faria JC, Head GP, Owen MDK, Pilcher CD, Shelton AM, Meissle M. Genetically Engineered Crops: Importance of Diversified Integrated Pest Management for Agricultural Sustainability. Frontiers in bioengineering and biotechnology 2019;7 24. https://doi.org/10.3389/fbioe.2019.00024

Vandervoet, T.F., P.C. Ellsworth, Y. Carrière, S.E. Naranjo. 2018. Quantifying Conservation Biological Control for Management of Bemisia tabaci (Hemiptera: Aleyrodidae) in Cotton, Journal of Economic Entomology, Volume 111, Issue 3, 28 May 2018, pp. 1056–1068, https://doi.org/10.1093/jee/toy049

Farrar, James, Peter C Ellsworth, et al.; Assessing Compatibility of a Pesticide in an IPM Program, Journal of Integrated Pest Management, V9(1), 1/1/2018, 3, https://doi.org/10.1093/jipm/pmx032

Ellsworth, P.C., A. Fournier, G. Frisvold and Naranjo, S.E. 2017. Chronicling the Socio-economic Impact of Integrating Biological Control, Technology, and Knowledge over 25 years of IPM in Arizona. In Proc. 5th Int'l. Symposium on Biological Control of Arthropods, P.G. Mason et al. eds. CABI, Langkawi, Malaysia. Sept. 11–15, 2017. pp. 214–216. https://www.cabi.org/cabebooks/FullTextPDF/2017/20173267495.pdf

Alfred J. Fournier

Education

Ph.D.	Entomology, Purdue University, West Lafayette, IN. May 2005.
M.S.	Entomology (IPM track), University of Maryland, College Park, MD. May 1997.
B.S.	Biology, George Washington University, Washington, DC., May 1992.

Experience

2023 – present	**Associate Specialist & Associate Professor**, Entomology, University of Arizona
2018 – 2023	**Associate Specialist**, Entomology, University of Arizona
2012 – present	**Coordinator,** Southwestern IPM Network, Western IPM Center, University of California Davis
2011 – 2018	**Associate Specialist and Adjunct Scientist**, Entomology, University of Arizona
2007 – 2011	**Assistant Specialist and Adjunct Scientist**, Entomology, University of Arizona
2005 – present	**IPM Program Manager & Assoc. Director**, Arizona Pest Management Center, University of Arizona Cooperative Extension, Maricopa Agricultural Center, Maricopa, AZ

Synergistic Activities, Honors and Awards (recent & selected)

2023	USDA-NIFA, Applied Research and Development Program, grant panel member
2012	Gold Tier Shining Star Award, U.S. EPA to the Arizona Pest Management Center
2009	Award of Excellence, UA IPM Extension Program, Western Extension Directors' Association
2008	Outstanding Work & Dedication to Crop Protection Industry, Arizona Crop Protection Association
2007	Outstanding Contributions to National IPM in Schools Effort, U.S. Environmental Protection Agency

Selected Grants (funded)

2023 – 2024	**$99,990**. Ellsworth, P.C. & A.J. Fournier. Advancing US Cotton IPM. Better Cotton's Large Farm Growth and Innovation Fund.
2022 – 2026	**$360,000**. Ellsworth, P.C. & A.J. Fournier. A Western Integrated Pest Management Center Led by California, Arizona, Oregon, and Utah; Signature Program Area: Crop Pest Losses & Impact Assessment; Regional IPM Information Network.
2021 – 2024	**$854,873.** Ellsworth, P.C., A.J. Fournier. USDA-NIFA CPPM, Extension Implementation Program. The Arizona Pest Management Center: Supporting Adoption of High-Impact IPM Programs in Diverse Environments.
2021 – 2023	**$129,912.** Fournier, A.J., P.C. Ellsworth, W. Dixon, J. Peterson. USDA-AMS, Specialty Crops Block Grant Program. Pesticide Data Impacts Registration Review Outcomes for Specialty Crops.
2020 – 2023	**$747,964.** MacLean, M.F., A.J. Fournier, P. Beamer, A.F. Arellano, E.J. Bedrick. 2020. National Institute of Environmental Health Sciences. Prenatal Exposure to Pesticide Mixtures and Childhood ADHD. National Institute of Environmental Health Sciences.

Selected Publications

Furlong, M.A., K.C. Paul, K.L. Parra, A.J. Fournier, P.C. Ellsworth, M.G. Cockburn, A.F. Arellano, E. Bedrick, P.I. Beamer, B. Ritz. 2023. Pre-Conception and First Trimester Exposure To Pesticides And Associations With Stillbirth. American Journal of Epidemiology. 23 pp. (submitted 6/30/23)

Bordini, I., S.E. Naranjo, A.J. Fournier, P.C. Ellsworth. 2023. Spatial Scale of Non-Target Effects of Cotton Insecticides. PLOS ONE. 25 pp. https://doi.org/10.1371/journal.pone.0272831

Bordini IC, Ellsworth PC, Naranjo SE & Fournier AJ. 2021. Novel Insecticides and Generalist Predators Support Conservation Biological Control in Cotton. Biological Control, 154. https://doi.org/10.1016/j.biocontrol.2020.104502.

Farrar, J.J., P.C. Ellsworth, R. Sisco, M.E. Baur, A. Crump, A.J. Fournier, M.K. Murray, P.C. Jepson, C.M. Tarutani, K.W. Dorschner. 2018. Assessing Compatibility of a Pesticide in an IPM Program. Journal of Integrated Pest Management, 9(1): 3. https://doi.org/10.1093/jipm/pmx032

Crump, A., J. Farrar, A. J. Fournier, and P. C. Ellsworth. 2018. Employing California Pesticide Use Data for Evaluating Integrated Pest Management Programs and Informing Pesticide Policy and Regulation. In, Managing and analyzing pesticide use data for pest management, environmental monitoring, public health, and policy. American Chemical Society, Chapter 11, pp. 225-237. DOI: 10.1021/bk-2018-1283.ch011. (Invited)

Dawn Heather Gouge

Education

University of Wales, UK	Applied Biology	BSc 1990
University of Reading, UK	Entomology/Nematology	PhD 1994

Experience

2016-present	Professor and Specialist since July 2016 – present.
2007-2016	Associate Professor and Associate Specialist, Dept. of Entomology, University of Arizona.
2000-2007	Assistant Professor and Assistant Specialist, Dept. of Entomology, University of Arizona.
1998-2000	Assistant Professor, Dept. of Entomology, Texas A&M University
1995-1998	Postdoctoral Research Associate, USDA-ARS, Western Cotton Research Lab, AZ.

Selected Recent Synergistic Activities, Honors and Awards

2011-present	Editorial Board member, Entomological Society of America Journal of Integrated Pest Management.
2018	International IPM Award of Excellence – Practitioner Award, 9th International IPM Symposium, Denver, CO.
2018-2022	Steering Committee Co-Chair & Student & Early Career Scientist Co-chair, 10th International IPM Symposium 2022.
2022-present	Steering Committee Co-Chair, 11th International IPM Symposium 2025.
2022-present	U. S. Environmental Protection Agency, Pesticide Program Dialog Committee, Federal Advisory Committee Act Member.
2022	Beyond the Field and Into the Community. 10th International IPM Symposium, February 28-March 3, Denver, CO. Invited.

Selected recent publications

Gouge, D.H. 2023. Sonoran desert mosquitoes: a story about water, heat, housing and WNV. Wing Beats, Vol. 34:12-25.

Gouge, D. H., Lame, M. L., Stock, T. W., Rose, L. F., Hurley, J. A., Lerman, D. L., Nair, S., Nelson, M. A., Gangloff-Kaufmann, J., McSherry, L., Connett, J. F., Graham, L., and Green, T. A. 2023. Improving environmental health in schools. Current Problems in Pediatric and Adolescent Health Care. https://doi.org/10.1016/j.cppeds.2023.101407.

Selected active grants

Gouge, D. H., Li, S., Nair, S. October 2022 – November 2023. Promoting Integrated Pest Management in Affordable Housing. U.S. Department of Housing and Urban Development, $45,098.

Gouge, D. H., Walker, K. R., Li, S., Nair, S. September 2022 – August 2026. Advancing Vector-borne Disease Surveillance in American Indian Communities in Arizona. National Institutes of Health - Inter Tribal Council of Arizona, Inc. The Native American Research Centers for Health (NARCH) 12 Grant, $439,881.

Gouge, D. H., Walker, K. R. June 2023 – May 2024. Using K-12 Schools as Information Hubs to Improve Environmental Health. U.S. Centers for Disease Control and Prevention - State of Arizona, Department of Health Services. A part of the University of Arizona Center for Rural Health - Advancing Health Equity, Addressing Disparities Program, $241,760.

Martha S. Hunter

Education

Brown University	Biology	BA, 1980
Cornell University	Entomology	MS, 1987
Cornell University	Entomology	PhD, 1991

Experience

2007-present	Professor, Dept. of Entomology, University of Arizona.
2011-present	Joint Professor, Dept. of Ecology & Evolutionary Biology, University of Arizona.
2002-2007	Associate Professor, Dept. of Entomology, University of Arizona.
1996-2002	Assistant Professor, Dept. of Entomology, University of Arizona.
1993-1996	Assistant Research Scientist and Visiting Member of the Graduate Faculty, Dept. of Entomology, Texas A&M University.
1993	Postdoctoral Research Associate, Dept. of Entomology, Texas A&M University.
1991-1992	NATO Postdoctoral Research Fellow, & NSF International Programs Postdoctoral Fellow, Imperial College at Silwood Park, University of London.

Synergistic Activities, Honors and Awards

2010-present	**Chair**, Graduate Interdisciplinary Program in Entomology and Insect Science, University of Arizona
2015	**David E. Cox Faculty Teaching Award**, College of Agriculture and Life Sciences, University of Arizona
2016	**Honored Faculty**, Graduate Interdisciplinary Programs, University of Arizona
2017	**Fellow**, American Academy for the Advancement of Science (AAAS)
2018	**Fellow**, Japan Society for the Promotion of Science
2019	**Annual H.R. MacArthur Speaker**, Simon Fraser University, Vancouver, Canada.
2019	**Keynote speaker**, Yosemite Symbiosis Workshop.
2019	**Keynote speaker**, Eighth International Conference on Molecular Insect Science. Sitges, Spain.
2020	**Annual Al Royce Lecturer** University of California, Riverside, Department of Entomology,
2021	**Fellow**, Entomological Society of America
2022	**Eminent Researcher Award**, Division of Agriculture, Life and Veterinary Sciences and Cooperative Extension, University of Arizona

Current funding (2023)

2023-2026 Principal Investigator, USDA NIFA, *Symbiont transmission contstraints and consequences in the orchard bug pest* Leptoglossus zonatus. Co-PI Alison Ravenscraft. $646,180 total, $550,360 for the Hunter laboratory.

2020-2024 Principal Investigator, NSF IOS, *Collaborative Research: The saboteur's tools: Mechanisms for host reproductive manipulation by the bacterial arthropod symbiont* Cardinium hertigii. Other PIs: Stephan Schmitz-Esser and Manuel Kleiner, $1,200,000 total, $375,000 for the Hunter laboratory. June 15, 2020 – June 14, 2024.

Selected publications since 2016 (90 total)

Gebiola, M., S.E. Kelly, P. Hammerstein, M. Giorgini, and **M.S. Hunter** 2016. "Darwin's corollary" and cytoplasmic incompatibility induced by *Cardinium* may contribute to speciation in *Encarsia* wasps (Hymenoptera: Aphelinidae). *Evolution.* 70: 2447–2458.

Gebiola, M., M. Giorgini, S.E. Kelly, P. Feree, **M.S. Hunter** 2017. Cytological analysis of cytoplasmic incompatibility induced by *Cardinium* suggests convergent evolution with its distant cousin *Wolbachia. Proceedings of the Royal Society, Series B.* 284:20171433.

Doremus, M.R., S.E. Kelly and **M.S. Hunter** 2019. Exposure to opposing temperature regimes causes comparable effects on *Cardinium* density but contrasting effects on *Cardinium*-caused cytoplasmic incompatibility. *PLoS Pathogens.* 15: e1008022

Doremus, M.R., C.M. Stouthamer, S.E. Kelly, S. Schmitz-Esser, **M.S. Hunter** 2020. *Cardinium* localization during its parasitoid wasp host's development provides insights into cytoplasmic incompatibility. *Frontiers in Microbiology* 11: 606399

Hunter, M.S., E.F. Umanzor, S.E. Kelly, S.M. Whitaker, A. Ravenscraft 2022. Development of common leaf-footed bug pests depends on the presence and identity of their environmentally-acquired symbionts. *Applied and Environmental Microbiology* 88:e01778-21

Michele Lanan

Education

2004	BA Biology, Pomona College, Claremont CA
2010	PhD Insect Science and Entomology, University of Arizona

Experience

2010-2014	NIH Postdoctoral Excellence in Research and Teaching Fellow, University of Arizona
2014-2017	Herbert Reich Chair of the Natural Sciences, Deep Springs College, CA
2017-2022	Resident Research Scientist, American Museum of Natural History's Southwest Research Station, Portal AZ
2022-present	Assistant Professor of Practice, Department of Entomology, University of Arizona

Synergistic Activities, Honors and Awards

2009	NSF Graduate STEM Fellow in K-12 Education (GK-12)
2010-2014	NIH Postdoctoral Excellence in Research and Teaching Fellowship
2014	Academic Program Review Committee, Entomology Department, University of Arizona
2014-2017	Faculty Committee, Deep Springs College
2014-2017	Applications Committee, Deep Springs College
2016	Staff Hiring Committee, Deep Springs College
2020-2022	Conservation Chair, Secretary, Cochise County Cavers chapter of National Speleological Society
2019	Invited speaker, Institute for Evolution and Biodiversity, Münster, Germany
2021	Invited speaker, Rutgers University
2022-present	Member, Curriculum Committee, Department of Entomology, University of Arizona

Selected Publications

Sawh, I., Bae, E., Camilo, L., Lanan, M., Lucky, A., Menezes, H., Fiorentino, G., Sosiak, C., Khadempour, L., Barden, P. 2023. The first fossil replete ant worker establishes living food storage in the Eocene. Myrmecological News 33: 139-147.

Lanan, M., In Starr, C. K. 2019. Extrafloral Nectar, Encyclopedia of social insects. Springer Nature Living Reference.

Lanan, M., In Starr, C. K. 2019. Honeydew, Encyclopedia of social insects. Springer Nature Living Reference.

Lanan, M. C. Rodriguez, P. A., Agellon, A., Jansma, P., Wheeler, D. 2016. A bacterial filter protects and structures the gut microbiome of an insect. The ISME Journal 10 (8): 1866-1876.

Lanan, M. C. 2014. Spatiotemporal resource distribution and foraging strategies of ants (Hymenoptera: Formicidae). Myrmecological News, invited review 20: 53-70.

Fitzpatrick, G., Lanan, M. C., Bronstein, J. 2014. Thermal tolerance affects mutualist attendance in an ant-plant mutualism. Oecologia 176(1): 129-138.

Anderson, K. E., Carroll, M. J., Sheehan, T., Lanan, M. C., Mott, B. M., Maes, P., Corby-Harris, V. 2014. Hive-stored pollen of honey bees: many lines of evidence are consistent with pollen preservation, not nutrient conversion. Molecular Ecology 23: 5904-5917.

Lanan, M. C., Bronstein, J. 2013. An ants-eye view of an ant-plant protection mutualism. Oecologia 172(3): 779-790.

Lanan, M.C., Dornhaus, A., Jones, E., Waser, A., Bronstein J., 2012. The trail less traveled: individual decision-making and its effect on group behavior. PLoS ONE 7(10): e47976.

Lanan, M. C., Dornhaus, A., Bronstein, J., 2011. The function of polydomy: the ant Crematogaster torosa preferentially forms new nests near food sources and fortifies outstations. Behavioral Ecology and Sociobiology 65(5): 959-968.

Lanan, M. C., Bronstein, J. 2009. Review of: Bernhard Stadler and Tony Dixon (2008) Mutualism: Ants and Their Insect Partners. Myrmecological News 12: 138.

Xianchun Li

Education

2000-2003 PhD in Entomology, University of Illinois at Urbana-Champaign
1986-1990 MS in Insect Physiology & Toxicology, Nanjing Agricultural University, Nanjing, P. R. China
1980-1984 BS in Plant Protection, Southwest Agricultural University, Chongqing, P. R. China

Experience

2017-present Professor, Department of Entomology, University of Arizona.
2010-2017 Associate Professor, Department of Entomology, University of Arizona.
2004 -2010 Assistant Professor, Department of Entomology, University of Arizona.
2003-2004 Best Postdoctoral Fellowship, Banding & Best Department of Medical Research, U. of Toronto.
1997-2000 Visiting Scholar, Department of Entomology, University of Illinois at Urbana-Champaign.
1995-1997 Associate Professor, Department of Plant Protection, Nanjing Agricultural University
1990-1995 Lecturer, Department of Plant Protection, Nanjing Agricultural University
1984-1990 Assistant Professor, Department of Plant Protection, Nanjing Agricultural University.

Synergistic Activities, Honors and Awards

2022 Invited speaker, Pacific Branch Meeting, Entomological Society of America
2021 IPM Team Award, Entomological Society of America.
2021-present. Editorial Board Member, *Insects*
2012-present Editorial Board and Advisory Panel Member, *Nature Scientific Reports*
2012-2021 Editorial member, *Journal of Insect Science*

Current Grants

2021-2024 PI, NSF of China, Types and mechanisms of the combined action/cross-resistance of Bt toxins and plant allelochemicals. Total award: $378,125
2019-2023 Co-PI, Zhengzhou University, Molecular genetic mechanisms of host range difference among closely related sister species. Total award: $1,529,850.
2022-2024 PI, Syngenta, Susceptibilities of Cry1Ac and/or Cry2Ab-resistant and -susceptible corn earworm to Syngenta insecticidal lead proteins. Total award: $104,440.

Selected Recent Publications (total of 2 books, 5 book chapters, and 150 journal articles; h-index 39, 7123 citations)

Deng, Z., Ren, Y., Guo, L., Xie, X., Wang, L., & **Li, X**. (2023). Genome-wide analysis of G-quadruplex in *Spodoptera frugiperda*. *International Journal of Biological Macromolecules*, 226, 840-852.

Deng, Z., Zhang, Y., Gao, C., Shen, W., Wang, S., Ni, X., Liu, S., & **Li, X.** (2022). A transposon-introduced G-quadruplex motif is selectively retained and constrained to downregulate CYP321A1. *Insect Science*, 29(6), 1629-1642.

Pang, R., Xing, K., Yuan, L., Liang, Z., Chen, M., Yue, X., Dong, Y., Ling, Y., He, X., **Li, X.**, & Zhang, W. (2021). Peroxiredoxin alleviates the fitness costs of imidacloprid resistance in an insect pest of rice. *PLoS Biology*, 19(4), e3001190.

Tabashnik, B. E., Liesner, L. R., Ellsworth, P. C., Unnithan, G. C., Fabrick, J. A., Naranjo, S. E., **Li, X**., Dennehy, T. J., Antilla, L., Staten, R. T., & Carrière, Y. (2021). Transgenic cotton and sterile insect releases synergize eradication of pink bollworm a century after it invaded the United States. *PNAS*, 118(1).

Li, X., Deng, Z., & Chen, X. (2020). Regulation of insect P450s in response to phytochemicals. *Current Opinion in Insect Science*, 43, 108-116.

Wang, S., Zhang, M., Huang, J., Li, L., Huang, K., Zhang, Y., Li, Y., Deng, Z., Ni, X., & **Li, X**. (2020). Inductive and synergistic interactions between plant allelochemical flavone and Bt toxin Cry1Ac in *Helicoverpa armigera*. *Insect Science*.

Li, S., Hussain, F., Unnithan, G. C., Dong, S., UlAbdin, Z., Gu, S., Mathew, L. G., Fabrick, J. A., Ni, X., Carrière, Y., Tabashnik, B. E., & **Li, X.** (2019). A long non-coding RNA regulates cadherin transcription and susceptibility to Bt toxin Cry1Ac in pink bollworm, *Pectinophora gossypiella. Pesticide Biochemistry and Physiology*, 158, 54-60.

Zhang, S., Gu, S., Ni, X., & **Li, X**. (2019). Genome size reversely correlates with host plant range in *Helicovrerpa* species. *Frontiers in Physiology*, 10, 29.

Deng Z, Zhang S, Gu S, Ni X, Zeng W, **Li X.** (2018). Useful Bicistronic Reporter System for Studying Poly(A) Site-Defining cis Elements and Regulation of Alternative Polyadenylation. *Int J Mol Sci.* 19(1):279.

Wei, J., Liang, G., Wu, K., Gu, S., Guo, Y., Ni, X., & **Li, X**. (2018). Cytotoxicity and binding profiles of activated Cry1Ac and Cry2Ab to three insect cell lines. *Insect Science*, 25(4), 655-666.

L. Paulina Maldonado-Ruiz (scheduled to start January 2024 as Assistant Professor, Department of Entomology, UA)

Education

2010	BSc., Biochemistry and Pharmacology (Minor: Microbiology), Universidad Michoacana, Mexico
2015	MSc., Master in Health Sciences (Microbial Genetics), Universidad Michoacana, Mexico
2021	PhD., Entomology, Kansas State University, KS, USA

Experience

2021-present	Postdoctoral Research Associate. Department of Entomology, Kansas State University.
2018	Visiting scholar, Biology Centre of South Bohemia, Czech Republic
2015-2016	College Instructor/Lecturer. Universidad Montrer, College of Nutrition, Mexico
2015- 2015	Lab Technician. Microbial Molecular Genetics Laboratory, Universidad Michoacana
2015	Visiting Scholar. College of Veterinary Medicine, Kansas State University

Recent Synergic Activities, Honors and Awards

2023	**Seminar Speaker**. "Novel approaches to mitigate tick-associated illness," Department of Entomology, University of Arizona.
2023	**Associate editor.** Journal of Insect Science, Entomological Society of America (ESA)
2022	**Early Career Professional Award**. Henry and Sylvia Richardson Research Grant, ESA
2022	**Seminar Speaker.** "No guts, no glory! Tick gut microbiome and its implication for an innovative management strategy*"*. Department of Biology. Pittsburg State University. Pittsburg KS
2022	**Co-organizer.** Virtual Symposium "Arthropod-Microorganisms-Host interactions". Joint Annual Meeting of ESA, Entomological Society of Canada, and Entomological Society of British Columbia, Vancouver, Canada.
2022-present	**Member**, Departmental Seminar Committee. Department of Entomology, Kansas State University
2021-present	**Organizer of the Journal Club.** "Modern Entomological Studies". Kansas State University
2021	**Postdoc/Early Career Award**. American Society for Tropical Medicine and Hygiene
2020	**Graduate Student Mini-Grant**. Department of Entomology, Kansas State University
2016-2020	**Officer** for the student club (Popenoe Entomology Club). Outreach event coordinator (2016-2018), Vice president (2018), President (2018-2019).

Selected Publications since 2019 (12 total)

Maldonado-Ruiz, L.P., Reif, K.E., Ghosh, A., Foré, S., Johnson, R.L. and Park Y. (**submitted**). High levels of alpha-gal with large variations in the salivary glands of lone star ticks fed on human blood.

Holguin-Rocha, A.F., Calle-Tobon, A., Vásquez, G.M., Astete, H., Fisher, M.L. Tobon-Castano, A., Velez-Tobon, G., **Maldonado-Ruiz, L.P.,** Silver, K. Park, Y. and Berlin Londono-Renteria. **(2023).** Diversity of the bacterial and viral communities in the tropical horse tick, *Dermacentor nitens,* in Colombia" *Pathogens* 12, no. 7: 942.

Olajiga, O.M., **Maldonado-Ruiz, L.P**., Fatehi, S., Cardenas, J.C., Gonzalez, M.U., Gutierrez-Silva, L.Y., Londono-Renteria, B., and Park,Y. (**2022**). Association of dengue infection with anti-alpha-gal antibodies, IgM, IgG, IgG1, and IgG2. *Frontiers in immunology,* 13:1021016.

Maldonado-Ruiz, L.P., Kim D., and Park Y. (**2022**). Osmoregulatory physiology in Ixodidae ticks: An alternative target for management of ticks. *Journal of Asian-Pacific Entomology,* 61(1), 91-100.

Maldonado-Ruiz, **L.P.**, Boorgula, G.D., Kim, D., Fleming S. and Y. Park (**2022**). Tick intrastadial feeding and its role on IgE production in the Murine Model of Alpha-gal syndrome: The tick "transmission" Hypothesis*. Frontiers in Immunology,* 13, 844262,

Maldonado-Ruiz, **L.P.**, Davis, B.N. Park J.J. and Y. Park (**2022**). Dermal secretion physiology and thermoregulation in the lone star tick *Amblyomma americanum. Tick and Tick-borne disease,* 13 (4), 101962.

Soohoo-Hui, A., Li, Z., **Maldonado-Ruiz, L. P.**, Zhang, G., & Swale, D. R. (**2021**). Neurochemical regulation of *Aedes aegypti* salivary gland function. *Journal of Insect Physiology*, 129, 104193.

Maldonado-Ruiz, L. P., Neupane, S., Park, Y., & Zurek, L. (**2021**). The bacterial community of the lone star tick (*Amblyomma americanum*). *Parasites & Vectors*, 14(1), 49.

Maldonado-Ruiz, L. P., Park, Y., & Zurek, L. (**2020**). Liquid water intake of the lone star tick, *Amblyomma americanum*: Implications for tick survival and management. *Scientific Reports*, 10(1), 6000.

Maldonado-Ruiz, L. P., et al., (**2019**). Differential tick salivary protein profiles and human immune responses to lone star ticks (*Amblyomma americanum*) from the wild vs. a laboratory colony. *Frontiers in Immunology*, 10, 1996. doi:10.3389/fimmu.2019.01996.

Luciano Matias Matzkin

Education

University of California at Irvine	Biological Sciences	BS, 1996
State University of New York at Stony Brook	Ecology and Evolution	PhD, 2003

Experience

2017-present	Associate Professor, Dept. of Entomology, University of Arizona
2017-present	Joint Associate Professor, BIO5 Institute, University of Arizona
2017-present	Joint Associate Professor, Dept. of Ecology and Evolutionary Biology (EEB), University of Arizona
2014-2018	Adjunct Faculty Investigator, HudsonAlpha Institute for Biotechnology
2011-2017	Assistant Professor, Dept. of Biological Sciences, University of Alabama in Huntsville
2008-2011	Assistant Research Scientist, Dept. of Ecology, Behavior & Evolution, UC San Diego
2007-2008	Research Associate, Dept. of Ecology and Evolutionary Biology, University of Arizona
2003-2007	NIH Postdoctoral Excellence in Research and Teaching Fellow, EEB, University of Arizona

Synergistic Activities, Honors and Awards

2023-2027	PI, NIH grant: Investigating a novel role of ejaculate RNA in fertility, $2.5M total, $1.5M to UA
2023-2027	Sole PI, NSF grant: Development of functional genomics tools in cactophilic *Drosophila,* $1.15M
2022-present	Executive Committee Member, Ecosystem Genomics Graduate Interdisciplinary Program, UA
2021-2022	Member, Larry Sandler Award Selection Committee, Genetics Society of America,
2022	Outreach talk, UA Insect Festival, "Come fly with me: A look into the fantastic world of *Drosophila*"
2020	Invited participant, National Academies of Science, Engineering, and Medicine. Next Steps for Functional Genomics: A Workshop, Washington, D.C.
2017-present	Leader, interactive booth with cactophilic and transgenic *Drosophila* at UA Insect Festival
2018-present	Diversity, Equity & Inclusion Committees. Chair, Entomology Committee & Member, CALES Committee
2018-present	Associate Editor, Ecology and Evolution (Wiley)
2018-present	Editorial Board Member, Communications Biology (Springer Nature)
2018-present	Ad-hoc grant reviewer (10) for NSF, Austrian Science Fund and Fondation pour la Recherche Médicale
2017-present	Grant Panel Member: NSF, Enabling Discovery through Genomics 2023; USDA, Pests and Beneficial Species in Agricultural Production Systems 2022; NSF, Animal Behavior, 2017

Selected Publications (48 total)

Moreyra, N. N., Almeida, F. C., Carson, C. W., Frankel, N, **Matzkin, L. M.** and Hasson, E. 2022. Phylogenomics provides insights into the evolution of cactophily and host plant shifts adaptation in *Drosophila*. *Molecular Phylogenetics & Evolution* 178: 107653.

Shaible, T. M. and **Matzkin, L. M.** 2022. Physiological and life history changes associated with seasonal adaptation in the cactophilic *Drosophila mojavensis*. *Biology Open* 11 10: bio059610.

Diaz, F., Allan, C. W., Chen, X., Coleman, J. M., Bono, J. M. and **Matzkin, L. M.** 2022. Divergent evolutionary trajectories shape the postmating transcriptional profiles of conspecific and heterospecifically mated cactophilic *Drosophila* females. *Communications Biology* 5:842.

Hurtado, J., Revale, S., and **Matzkin, L. M.** 2022. Propagation of seminal toxins through binary expression gene drives can suppress polyandrous populations. *Scientific Reports* 12:6332.

Benowitz, K. M., Allan, C. W., Degain, B. A., Li, X., Fabrick, J. A., Tabashnik, B., Carriere, Y, and **Matzkin, L.M**. 2022. Novel genetic basis of resistance to Bt toxin Cry1Ac in *Helicoverpa zea*. *Genetics* 221:1.

Diaz, F., Kuijper, B., Hoyle, R. B., Coleman, J. M., Talamantes, N. and **Matzkin, L. M.** 2021. Environmental predictability drives adaptive within- and transgenerational plasticity of heat tolerance across life stages and climatic regions. *Functional Ecology* 35:153-166.

Khallaf, M.A., Auer, T.O., Grabe, V., Depetris-Chauvin, A. Ammagarahalli, B., Zhang, D., Lavista-Llanos, S., Kaftan, F., Weibflog, J., **Matzkin L. M.**, et al. 2020. A male pheromone promotes incipient isolation through conserved peripheral sensory pathways. *Science Advances* 625:eaba5279.

Allan, C. W. and **Matzkin, L. M.** 2019. Genomic analysis of the four ecologically distinct cactus host populations of *Drosophila mojavensis*. *BMC Genomics* 201:732.

Bono, J. M.†, **Matzkin, L. M.**†, Kelleher, E. S., Markow, T. A. 2011. Postmating transcriptional changes in reproductive tracts of con- and heterospecifically-mated *Drosophila mojavensis* females. *Proceedings of the National Academy of Sciences* 108:7878-7883. †Authors contributed equally.

Drosophila 12 Genomes Consortium **Matzkin, L. M.** co-author. 2007. Evolution of genes and genomes on the *Drosophila* phylogeny. *Nature* 450:203-218.

Tristan A. McKnight

Education

Ph.D. 2017.	Ecology and Evolutionary Biology	University of Michigan
B.S. 2011	Biology	Brigham Young University

Experience

2019-present	Assistant Professor of Practice, Dept. of Entomology, University of Arizona
2018, 2019	Adjunct Assistant Professor, First Year Program, St. Lawrence University

Synergistic Activities, Honors and Awards

2023-present	**Service**: Curriculum committee, College of Agriculture, Life & Environmental Sciences
2020-present	**Service**: General Education committees (dept & college) and curriculum refresh for ENTO 160D1
2022	**Outreach**: Invited Podcast Speaker, Humans & Wildlife Show, https://www.humansandwildlife.com/34-soviet-propaganda-and-the-potato-beetle
2019	**Outreach:** Arizona Insect Festival
2019	**Workshop instructor**: Cincinnati Museum Center Edge of Appalachia Preserve, Asilidae identification

Selected publications (since 2016)

COSEWIC. (in review) COSEWIC status report on Pacific Lasiopogon (*Lasiopogon pacificus*). Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 45 pp.

Cannings, R.A., Cohen, C.M., & **McKnight, T.A**. (2023). A list of English common names for the robber flies (Diptera: Asilidae) of North America north of Mexico. Robber Flies of the World. Website: https://www.robberfliesoftheworld.com/NA_CommonNames.php

McKnight, T.A. & Cannings, R.A. (2020) Molecular phylogeny of the genus *Lasiopogon* (Diptera: Asilidae) and a taxonomic revision of the bivittatus section. *Zootaxa*, 4835(1): 1–115.

Haab, K.A.*, **McKnight, T.A**. & McKnight, K.B. (2019) Phenology and ethology of adult *Lasiopogon slossonae* Cole and Wilcox robber flies (Diptera: Asilidae) in a New York riparian habitat. *Proceedings of the Entomological Society of Washington*, 121(4): 594–615.

Clement, R.A.*, Frandsen, P.B., **McKnight, T.A**. & Nelson, C.R. (2018) Fly family diversity shows evidence of livestock grazing pressure in Mongolia (Insecta: Diptera). *Journal of Insect Conservation*, 22 (2): 231–243.

McKnight, T.A. & Cannings, R.A. (2017) Description and phylogenetic classification of *Stackelberginia cerberus* sp. nov. (Diptera: Asilidae), comprising the first record of this genus from the Nearctic. *Zootaxa*, 4306 (4): 567–579.

*Undergraduate students supervised by Dr. McKnight.

Wendy Moore

Education

Vanderbilt University	General Biology	BS, 1991
College of Charleston	Marine Biology	MS, 1996
University of Arizona	Entomology	PhD, 2006

Professional Experience

2016–present	Associate Professor & Curator, Department of Entomology, University of Arizona (UA)
2010–2016	Assistant Professor & Curator, UA Insect Collection (UAIC), Department of Entomology, UA
2008–present	Research Associate, Arizona-Sonora Desert Museum. Tucson, AZ

Selected Synergistic Activities, Honors and Awards

2023	University of Arizona Provost Investment Fund Awardee, $200,000
2019–present	Tucson Bee Collaborative. Vertically Integrated Project. Founder/Organizer/Fundraiser.
2019–2021	NSF, HSI-Hispanic Serving Institutions, Division of Undergraduate Education. $297,159 (UA budget: $66,323)
2018-present	Development Liaison, Department of Entomology. Helped raise $1,131,183 including in-kind gifts and cash gifts to the department, excluding the cash gifts to my programs.
2018	One of three entomologists featured in the 30-minute documentary "INSECTA: Science that Stings."
2017–present	Developed Course-based Undergraduate Research Experiences (CUREs) to engage underserved students. 365 UA and Pima Community College students have participated to date.
2016–present	>$5.4 million in research grants, primarily from NSF (continual NSF funding as PI since 2008)
2016–present	Course development and delivery: Discovering Biodiversity (UA-CURE); Insect Systematics; Insect Biology; Secrets of Success: A Natural History of Terrestrial Arthropods; Presentation Skills: Critical Listening and Speaking
2016–present	75 individuals mentored including major advisor for 8 MS and 6 PhD students, primary mentor for 5 postdoctoral scientists
2010–present	Arizona Insect Festival. Event Founder/Organizer/Fundraiser. 5000 visitors annually.

Selected Publications (57 total including 5 books, 10 book chapters, 42 refereed journal articles, >6300 citations)

Brusca RC, G Giribet, W Moore. 2023. Invertebrates. Fourth Edition. New York: Oxford University Press. 1099 pp. [Best-selling textbook on invertebrate zoology in the world]

Ikagawa R and W Moore. 2022. Molecular phylogeny and revision of species groups of Nearctic bombardier beetles (Carabidae, Brachininae, *Brachinus* (*Neobrachinus*)). ZooKeys 1131, 155–171.

Kelly S, W Moore, WE Hall, M Hunter. 2022. Cryptic enemies of the economically- and culturally-important scale insect, cochineal (Hemiptera: Dactylopiidae). Ecology and Evolution 12 (8): e9151.

Palting JD and W Moore 2022. Molecular phylogeny of lichen tiger moths (Lepidoptera, Erebidae, Arctiinae, Lithosiini): a contribution toward classifying Western Hemisphere genera. ZooKeys 1108: 119–139.

Moore W, G Scarparo, A Di Giulio. 2022. Foe to Frenemy: predacious Ant Nest Beetles use multiple strategies to fully integrate into ant nests. Current Opinion in Insect Science, 52: 100921.

Attygalle AB, S Xu, W Moore, R McManus, A Gill, K Will. 2020. Biosynthetic origin of benzoquinones in the explosive discharge of the bombardier beetle *Brachinus elongatulus*. The Science of Nature 107:26

Yanahan AD and W Moore 2019. Impacts of 21st-century climate change on montane habitat in the Madrean Sky Island Archipelago. Diversity and Distributions 25 (10): 1625–1638.

Muzzi M, W Moore, A Di Giulio. 2019. Morpho-functional analysis of the explosive defensive system of basal bombardier beetles (Carabidae: Paussinae: Metriini). Micron 119: 24–38.

Moore W and A Di Giulio. 2019. Out of the burrow and into the nest: functional anatomy of three life history stages of *Ozaena lemoulti* (Coleoptera: Carabidae) reveals an obligate life with ants. PLoS ONE 14(1): e0209790.

Irwin ME and W Moore. 2019. Foundations of an IPM program: detection, identification, and quantification. In: Kogan M. & Heinrichs E. (eds), Integrated Management of Insect Pests: Current and Future Developments. Cambridge: Burleigh Dodds Science Publishing.

Hughes, GB and W Moore. 2018. Monophyly of the subfamily Neobisiinae (Pseudoscorpiones: Neobisiidae). Journal of Arachnology 46:481–487.

Schaller JC, G Davidowitz, DR Papaj, RL Smith, Y Carrière, W Moore. 2018. Molecular phylogeny, ecology, and multispecies aggregation behaviour of bombardier beetles in Arizona. PLoS ONE 13(10): e0205192.

McManus R, A Ravenscraft, and W Moore. 2018. Bacterial associates of a gregarious riparian beetle with explosive defensive chemistry. Frontiers in Microbiology 9:2361.

John C. Palumbo

Education

University of Arizona	Entomology	BS 1982
University of Arizona	Entomology	MS 1985
Oklahoma State University	Entomology	PhD 1989

Experience 2002-present, Extension Specialist/Professor, Dept of Entomology, University of Arizona (UA).
1996-2002 Asso. Extension Specialist/Assoc. Professor, Dept. of Entomology, UA
1990-1996 Asst. Extension Specialist/Asst. Professor, Dept. of Entomology, UA

Synergistic Activities, Honors, and Awards

Award for Excellence in Integrated Pest Management, *Entomological Society of America*, 2023
Award for Excellence in Integrated Pest Management, *Entomological Society of America, Pacific Branch*, 2023
Distinguished Outreach Faculty Award, *University of Arizona,* 2023
Outstanding Contribution to Agriculture Award, *California Association of Pest Control Advisors*, 2022
John Palumbo Endowed Chair in Integrated Pest Management, *University of Arizona, ALVSCE*, 2020
Outstanding Contribution to Agriculture Award, *Yuma County Farm Bureau Association*, 2015
Distinguished Achievement Award in Extension, *Entomological Society of America*, 2014
Distinguished Achievement Award in Extension, *Entomological Society of America*, *Pacific Branch*, 2014
UA/CALS Faculty Member of the Year Award, *Arizona Agriculture "100" Council*, 2011
Outstanding Contribution to Agric. Award, *California Association of Pest Control Advisors, Desert Chapter*, 2008
Distinguished Service Award, *Yuma Fresh Vegetables Association*, 2005
Distinguished Service to Agriculture Award, *Yuma County Farm Bureau Association*, 2001

Selected publications

1. Palumbo, J.C. and S. J. Castle. 2009. IPM for fresh-market lettuce production in the desert southwest: the produce paradox. Pest Management Sci., 65:1311-1320.
2. Ghidiu, G., T. Kuhar, J. Palumbo, and D. Schuster. 2012. Drip Chemigation of Insecticides as a Pest Management Tool in Vegetable Production. J. Integ. Pest Mngmt. 3(3): 2012.
3. Carriere, Y, B. Degain, K. A. Hartfield, K. D. Nolte, S. E. Marsh, C. Ellers-Kirk, W.J.D. Van Leeuwen, L. Liesner, P.Dutilleul and J. C. Palumbo. 2014. Assessing Transmission Of Crop Diseases By Insect Vectors in a Landscape Context. J. Econ. Entomol. 107: 1-10.
4. Carriere, Y., Degain, B., Leisner, L., Dutilleul, P., & Palumbo, J. C. 2017. Validation of landscape-based model for whitefly transmission of cucurbit yellow stunting disorder virus to fall melons. J. Econ Entomol. 110: 2002-2009.
5. Palumbo, J.C., T.M. Perring, J Millar, and D.A. Reed. 2016. Biology, Ecology and Management of an Invasive Stink Bug, Bagrada hilaris in North America, Annual Review of Entomology. Vol 61 (pp. 453–473).
6. Bundy, S., Perring, T., Reed, D., Palumbo, J. C., Grasswitz, T., & Jones, W. A. 2018. Bagrada hilaris (Burmeister). In J.E. McPherson (ed), Invasive Stink Bugs and Related Species (Pentatomidae): Biology, Higher Systematics, Semiochemistry, and Management.
7. Reed, D.A., Palumbo, J.C., Perring, T.M., May, C., 2013. *Bagrada hilaris* (Burmeister), a new stink bug attacking cole crops in the southwestern United States. J Integ. Pest Mangmt. 4(3) 2013.
8. Palumbo JC, Prabhaker N, Reed DA, Perring TP, Castle SJ, Huang T. 2015. Susceptibility of Bagrada hilaris (Hemiptera: Pentatomidae) to insecticides in laboratory and greenhouse bioassays, J. Econ. Entomol. 108: 672-682.
9. Pinkerton, Morgan, Sage M. Thompson, Amanda C. Hodges, Norman C. Leppla, John C. Palumbo. 2020. Laboratory rearing of *Bagrada hilaris* (Hemiptera: Pentatomidae) under quarantine conditions in Florida. Florida Entomol. Vol 103: 401-403
10. Sherbrooke, S., Y. Carriere, J.C. Palumbo. 2020. Evaluation of Trap Cropping for Control of Diamondback Moth (Lepidoptera: Plutellidae) in a Broccoli Production System, J. Econ. Entomol. Vol 113: 1864-1871.
11. Lawton, D, A.D. Huesth, G. G. Kennedy, […] and M. Zuefle, 2022. Pest population dynamics are related to a continental overwintering gradient. PNAS Vol. 119, No. 37:1-8.

Michael A. Riehle

Education

University of Wisconsin, Madison, WI	BS	1994	Entomology/Zoology
University of Wisconsin, Madison, WI	MS	1996	Entomology
University of Georgia, Athens, GA	PhD	2002	Entomology

Experience

2016-Present	Professor, Department of Entomology, University of Arizona
2005-Present	Professor, BIO5 Institute, University of Arizona
2010-Present	Professor, Entomology & Insect Science GIDP, University of Arizona
2010-2016	Associate Professor, Department of Entomology, University of Arizona
2005-2010	Assistant Professor, Department of Entomology, University of Arizona
2003-2004	Post-Doctoral Fellow, Department of Molecular Microbiology and Immunology, Johns Hopkins School of Public Health, Baltimore, MD
2002-2003	Research Associate, Department of Genetics, Case Western Reserve University, Cleveland, OH

Synergistic Activities, Honors and Awards

2005-Present	Member, Institutional Biosafety Committee, Chair 2016-present, University of Arizona
2012-Present	Executive Committee member, Entomology & Insect Science Graduate Interdisciplinary Program
2019-Present	Instructor, Biology of Vector Borne Diseases course, University of Idaho
2014-2023	Mentor, KEYS Research Internship program for high school students, University of Arizona
2019	Organizer: Eighth International Symposium on Molecular Insect Science, Sitges, Spain
2018	Fellow, American Association for the Advancement of Science (AAAS)
2014	Medical, Urban and Veterinary Entomology Award, Pacific Branch, Entomological Society of America
2010	Time magazine's 50 best inventions of 2010: Malaria-proof mosquito (#1 in Health & Medicine)
2006	New Scholar Award in Aging, Ellison Medical Foundation

Selected publications (57 total)

1. Ernst KC, Walker KR, Castro-Luque AL, Schmidt C, Joy TK, Brophy M, Reyes-Castro P, Díaz-Caravantes RE, Encinas VO, Aguilera A, Gameros M, Cuevas Ruiz RE, Hayden MH, Alvarez G, Monaghan A, Williamson D, Arnbrister J, Gutiérrez EJ, Carrière Y, Riehle MA. Differences in longevity and temperature-driven extrinsic incubation period correlate with varying dengue risk in the Arizona–Sonora desert region. Viruses. 15(4):851. (2023)
2. Thakre N, Gurge RM, Isoe J, Kivi H, Strickland J, Delacruz LR, Rodriguez AM, Haney R, Sadeghi R, Joy T, Chen M, Luckhart S, Riehle MA. Manipulation of pantothenate kinase in *Anopheles stephensi* suppresses pantothenate levels with minimal impacts on mosquito fitness. Insect Biochemistry and Molecular Biology. 149. (2022)
3. Joy T, Chen M, Arnbrister J, Williamson D, Li S, Nair S, Brophy M, Garcia VM, Walker K, Ernst K, Gouge DH, Carrière Y, Riehle MA. Assessing Near-Infrared Spectroscopy (NIRS) for evaluation of *Aedes aegypti* population age structure. Insects 13(4):360 (2022)
4. Hun LV, Cheung KW, Brooks E, Zudekoff R, Luckhart S, Riehle MA. Increased insulin signaling in the *Anopheles stephensi* fat body regulates metabolism and enhances the host response to both bacterial challenge and *Plasmodium falciparum* infection, Insect Biochemistry and Molecular Biology. (2021)
5. Simão-Gurge RM, Thakre N, Strickland J, Isoe J, Delacruz LR, Torrevillas BK, Rodriguez AM, Riehle MA, & Luckhart S. Activation of *Anopheles stephensi* pantothenate kinase and coenzyme A biosynthesis reduces infection with diverse *Plasmodium* species in the mosquito host. Biomolecules. (2021)
6. Oringanje, C., Delacruz, LR., Han, Y., Luckhart, S., & Riehle, MA. Overexpression of activated AMPK in the *Anopheles stephensi* midgut impacts mosquito metabolism, reproduction and *Plasmodium* resistance. Genes, 12(1), 119. (2021)
7. Comeau, G., Zinna, RA., Scott, T., Ernst, K., Walker, K., Carrière, Y., & Riehle, MA. Vertical transmission of Zika virus in *Aedes aegypti* produces potentially infectious progeny. American Journal of Tropical Medicine and Hygiene, 103(2), 876-883. (2020)
8. Hun, L., Luckhart, S. and Riehle, M.A. Increased Akt signaling in the fat body of *Anopheles stephensi* extends lifespan and increases lifetime fecundity through modulation of insulin-like peptides. Journal of Insect Physiology, p.103932. (2019)
9. Souvannaseng, L., Hun, L.V., Baker, H., Klyver, J.M., Wang, B., Pakpour, N., Bridgewater, J.M., Napoli, E., Giulivi, C., Riehle, M.A. and Luckhart, S. Inhibition of JNK signaling in the Asian malaria vector *Anopheles stephensi* extends mosquito longevity and improves resistance to *Plasmodium falciparum* infection. PLoS Pathogens, 14(11), p.e1007418. (2018)
10. Ernst, K.C., Walker, K.R.,…Carrière Y., and Riehle, M.A. *Aedes aegypti* (Diptera: Culicidae) Longevity and Differential Emergence of Dengue Fever in Two Cities in Sonora, Mexico. Journal of Medical Entomology, 54, 204-211. (2017)
11. Klionsky, Daniel J., et al. Guidelines for the use and interpretation of assays for monitoring autophagy. Autophagy 12.1: 1-222. (2016)
12. Neafsey D.E., et al. Highly evolvable malaria vectors: The genomes of 16 Anopheles mosquitoes. Science. 347(6217): 43 (2015)

Todd Schlenke

Education

1996-2001	Ph.D.	Zoology	UT Austin
1991-1995	B.S.	Integrative Biology	UC Berkeley

Experience

2016-present	Associate Professor	Entomology	University of Arizona
2013-2016	Associate Professor	Biology	Reed College
2006-2013	Assistant Professor	Biology	Emory University
2002-2005	Postdoc	Mol Biol and Genetics	Cornell University
2001-2002	Postdoc	Population Biology	UC Davis

Synergistic Activities, Honors, and Awards

2023	Research Poster Forum Award; Division of Agriculture, Life & Veterinary Sciences, & Cooperative Extension, UA
2020-present	NSF Early-concept Grant for Exploratory Research, Development of Functional Genetic Tools for Endoparasitoid Wasps
2020-present	Executive Committee, Genetics Graduate Interdisciplinary Program (GIDP)
2020	Chair, CALS Dean's Research Advisory Council
2019-present	Co-organizer, Arizona Insect Festival
2019-2020	Science Fair Judge, Davis Bilingual Elementary School
2019	Chair, CALS Post-Tenure Review Committee
2019	Invited Seminar, Zhejiang University, Host Parasite Interactions Using *Drosophila*
2018-2019	Co-organizer, Arizona PopGroup meeting on population genomics and adaptation
2018	Co-organizer, ESA workshop on *Drosophila*-Parasitoid Food Webs
2017-2020	Executive Committee, EIS GIDP
2017	Invited Seminar, Dartmouth College, Antagonistic Coevolution Between Hosts and Parasites
2014-present	Panelist for four NSF and two NIH grant panels
2014	Elected AAAS Fellow

Selected Publications

Extracellular matrix protein N-glycosylation mediates immune self-tolerance in *Drosophila* melanogaster; Mortimer NT, Fischer ML, Waring AL, Pooja KR, Kacsoh BZ, Brantley SE, Keebaugh ES, Hill J, Lark C, Martin J, Bains P, Lee J, Vrailas-Mortimer AD, **Schlenke TA***; PNAS* 118, e2017460118 (2021)

Lipidomics reveals how the endoparasitoid wasp *Pteromalus puparum* manipulates host energy stores for its young; Wang J, Jin H, **Schlenke TA**, Yang Y, Wang F, Yao H, Fang Q, Ye G; *Biochimica et Biophysica Acta - Molecular and Cell Biology of Lipids* 1865, 1-10 (2020)

Characterization of a cell death-inducing endonuclease-like venom protein from the parasitoid wasp *Pteromalus puparum* (Hymenoptera: Pteromalidae); Wang J, Yan Z, Xiao S, Wang B, Fang Q, **Schlenke TA**, Ye G; *Pest Management Science* 77, 224-233 (2020)

Fruit flies diversify their offspring in response to parasite infection; Singh ND, Criscoe DR, Skolfield S, Kohl KP, Keebaugh ES, **Schlenke TA**; *Science* 349, 747-750 (2015)

Parasitoid wasp venom SERCA regulates Drosophila calcium levels and inhibits cellular immunity; Mortimer NT, Goecks J, Kacsoh BZ, Mobley JA, Bowersock GJ, Taylor J, **Schlenke TA**; *PNAS* 110, 9427-9432 (2013)

Fruit flies medicate offspring after seeing parasites; Kacsoh BZ, Lynch ZR, Mortimer NT, **Schlenke TA**; *Science*, 339, 947-950 (2013)

Alcohol consumption as self-medication against blood-borne parasites in the fruit fly; Milan N, Kacsoh BZ, **Schlenke TA**; *Current Biology* 22, 488-493 (2012)

Bruce E. Tabashnik

Education

Stanford University	Biological Sciences	PhD, 1981
University of Michigan	Zoology	BS, 1975

Experience

1996-present	Head, Department of Entomology, University of Arizona
2015-present	Regents Professor, Department of Entomology, University of Arizona
1996-2014	Professor, Department of Entomology, University of Arizona
1983-1996	Assistant (1983-1987), Associate (1988-1991), and Full (1991-1996) Professor, Department of Entomology, University of Hawaii
1981-1983	Postdoctoral Scientist, Department of Entomology, Michigan State University

Selected Synergistic Activities, Honors and Awards

2023 Member, National Academy of Sciences
2021 Louis Malassis International Scientific Prize for Agriculture and Food, Distinguished Scientist, Agropolis Fondation
2021 Researcher of the Year Award, International Cotton Advisory Committee
2021 World Expert, Bacterial Toxins, Expertscape, top 0.005% of 216,325 authors worldwide (2011-21)
2021 IPM Team Award, Plant-Insect Ecosystems Section, Entomological Society of America
2020 Lifetime Achievement Award, Plant-Insect Ecosystems Section, Entomological Society of America
2019 Fellow, Royal Entomological Society, United Kingdom
2018 Award for Eradication of Pink Bollworm from the United States, U.S. Department of Agriculture
2015 Nan-Yao Su Award for Innovation and Creativity in Entomology, Entomological Society of America
2010 Fellow, American Association for the Advancement of Science
2007 Fellow, Entomological Society of America
1992 Award for Excellence in Integrated Pest Management, Entomological Society of America

Selected Publications (400 total including 312 in refereed journals, 31 book chapters, 1 edited book, and 1 patent; >34,600 citations, $h = 97$)

2023. Tabashnik, B. E., J. A. Fabrick and Y. Carrière. Global patterns of insect resistance to transgenic Bt crops: The first 25 years. J. Econ. Entomol. 116: 297-309.

2023. Fabrick, J. A., X. Li, Y. Carrière and B. E. Tabashnik. Molecular genetic basis of lab- and field-selected Bt resistance in pink bollworm. Insects 14: 201.

2023. Guan, F., X. Dai, B. Hou, S. Wu, Y. Yang, Y. Lu, K. Wu, B. Tabashnik and Y. Wu. Refuges of conventional host plants counter dominant resistance of cotton bollworm to transgenic Bt cotton. iScience 26: 106768.

2023. Guan, F., X. Dai, Y. Yang, B. E. Tabashnik and Y. Wu. 2023. Population genomics of nonrecessive resistance to Bt toxin Cry1Ac in *Helicoverpa armigera* from northern China. J. Econ. Entomol. 116: 310-320.

2022. Yang, F., D. L. Kerns, N. Little, S. A. Brown, …and B. E. Tabashnik. Practical resistance to Cry toxins and efficacy of Vip3Aa in Bt cotton against *Helicoverpa zea*. Pest Manag. Sci. 78: 5234-5242.

2021. Tabashnik, B. E., L. R. Liesner, P. C. Ellsworth, G. C. Unnithan, …and Y. Carrière. Transgenic cotton and sterile insect releases synergize eradication of pink bollworm a century after it invaded the United States. PNAS 118: e2019115118.

2017. Wan, P., D. Xu, S.-B. Cong, …Wu, L. Wang, K.-M. Wu, Y. Carrière, A. Mathias, X. Li and B. E. Tabashnik. Hybridizing transgenic Bt cotton with non-Bt cotton counters resistance in pink bollworm. PNAS 114: 5413-5418.

2017. Tabashnik, B. E. and Y. Carrière. Surge in insect resistance to transgenic crops and prospects for sustainability. Nature Biotechnology 35: 926-935.

Natasha Tigreros

Education

2013 Ph.D. in Biology, Tufts University
2007 M.S. in Biology, Eastern Illinois University
2002 B.S. in Biology, Universidad del Valle, Colombia

Experience

2023- Assistant Professor, Department of Entomology, University of Arizona
2021-2023 Research Scientist, Department of Entomology, University of Arizona
2017-2021 Postdoctoral Scholar, Department of Entomology, University of Arizona
2014- 2017 Postdoctoral Researcher, Department of Entomology, Cornell University
Fall 2013 Biostatistics Instructor, Tufts University
Summer 2013 Research Fellow, Harvard University
2002-2004 Associate Researcher, Center of Endangered Species, Colombia

Synergistic Activities, Honors and Awards

2021-2024 NSF Award – Division of Integrative Organismal Systems ($928,174): *How does nutrient acquisition within and across life stages modulate resource allocation tradeoffs?*
2021-present Outreach: Insect Discovery – Providing NSF funds and helping to coordinate with Native American 4H youth development students on the Hualapai Reservation
2022 Mentor – Women in STEM Mentorship Program, University of Arizona
2020 Member, Entomology DEI committee, University of Arizona

Selected Publications (19 total)

Tigreros, N., G Kozhoridze, G. Davidowitz, & Y. Ziv (2023) Influence of the direct and indirect effects of habitat fragmentation, via microclimate change, on animal locomotion. *Journal of Landscape Ecology* 38: 847–859.

Montovan, K., **N. Tigreros,** & J. Thaler (2022) Modeling size dependent fitness trade-offs of foraging in the presence of predators. *Journal of Theoretical Ecology* 15: 177-189.

Davidowitz, G., J. Bronstein & **N. Tigreros** (2022) Flight fecundity tradeoffs, a possible mechanistic link in plant-herbivore-pollinator systems. *Frontiers in Plant Science* 13: 1-9.

Tigreros, N., A.A. Agrawal & J. Thaler (2021) Genetic variation in parental effects contributes to the evolutionary potential of antipredator plasticity. *American Naturalist* 197: 164-175

Tigreros, N., R.H. Norris, & J. Thaler (2019) Maternal effects across life stages: larvae experiencing predation risk increase offspring provisioning. *Ecological Entomology* 44: 738-744

Tigreros, N. & G. Davidowitz (2019) Flight fecundity tradeoffs in wing-monomorphic insects. *Advances in Insect Physiology* 56: 1-41.

Tigreros, N., E. Wang & J. Thaler (2018) Prey nutritional state drives divergent behavioural and physiological responses to predation risk. *Functional Ecology* 32: 982-989.

Tigreros, N., R.H. Norris, E. Wang & J. Thaler (2017) Maternally induced intraclutch cannibalism: an adaptive response to predation risk? *Ecology Letters* 20: 487-494.

Kathleen R. Walker

Education

1991-1997	University of California - Ph.D. in Entomology.
1982-1987	Harvard/Radcliffe University - B.A. cum laude in Biology.

Experience

2019-present	Associate Specialist & Assoc. Professor, Dept. of Entomology, Univ. of Arizona
2014-2019	Assistant Specialist and Asst. Professor, Dept. of Entomology, Univ. of Arizona
2011-2013	Assistant Professor, Dept. of Entomology, University of Arizona
2006-2011	Senior Program Coordinator – Insect Discovery program, Univ. of Arizona
2002-2005	NIH Postdoctoral Researcher, Center for Insect Science, Univ. of Arizona
2000-2001	Diplomacy Fellow (AAAS), U.S. AID, Washington, DC
1998-2000	Environmental Science Fellow (AAAS), U.S. EPA, Washington, DC

Synergistic Activities, Honors and Awards

2006-present	Director, Insect Discovery Outreach/Extension Program
2011-present	Co-organizer, Arizona Insect Festival
2022-present	Leadership team member, Pacific Southwest Center of Excellence in Vector Biology
2019-present	Extension collaboration with Tohono O'odham Nation: Tick-borne disease prevention

Recent Federal Grants Awarded

2022-2027	Centers for Disease Control & Prevention (CDC), Centers of Excellence Grant *Pacific Southwest Center of Excellence in Vector Biology* (**PacVec**). UC Davis, primary institution. Walker PI of subaward of $987,337 to University of Arizona.
2022-2026	NIH, Native American Research Centers for Health. *Advancing Vector-borne Disease Surveillance in American Indian Communities*. Intertribal Council of Arizona, primary institution. D. Gouge PI and Walker co-PI of subaward of $439,881 to University of Arizona.
2017-2022	CDC, *Impacts of targeted larviciding and ULV adulticiding on the abundance and age structure of* Aedes aegypti *in south-central Arizona*. Walker PI, Co-PIs M. Riehle, K. Ernst, D. Gouge. Total funding $1,250,000.

Selected Recent Publications

Ernst KC, Walker KR, Castro-Luque AL, Schmidt C, Joy TK, Brophy M, Reyes-Castro P, Díaz-Caravantes RE, Encinas VO, Aguilera A, Gameros M, Cuevas Ruiz RE, Hayden MH, Alvarez G, Monaghan A, Williamson D, Arnbrister J, Gutiérrez EJ, Carrière Y, Riehle MA. Differences in Longevity and Temperature-Driven Extrinsic Incubation Period Correlate with Varying Dengue Risk in the Arizona-Sonora Desert Region. Viruses. 2023. Mar 26;15(4): 851.

Brophy M, Walker KR, Adamson JE, Ravenscraft A. 2022. Topical and Temperate Lineages of *Rhipicephalus sanguineus s.l.* Ticks (Acari: Ixodidae) Host Different Strains of *Coxiella*-like Endosymbionts. J Med Entomol. 59(6): 2022-2029.

Brophy M, Riehle MA, Mastrud N, Ravenscraft A, Adamson JE, Walker KR. 2022. Genetic variation in *Rhipicephalus sanguineus* s.l. ticks across Arizona. Int J Environ Res Public Health 1;19(7):4223.

Tarter K, Levy C, Yaglom H, Adams L, Plante L, Casal M, Gouge D, Rathman R, Stokka D, Weiss J, Venkat H, Walker K. 2019. Using citizen science to enhance surveillance of the mosquito vector *Aedes aegypti* in Arizona. J Am Mosq Control Assoc. 35:11-18.

Walker KR, Williamson D, Carrière Y, Reyes-Castro P, Haenchen S, Hayden M, Jeffrey Gutierrez E., Ernst KC. 2017. Socioeconomic and human behavioral factors associated with *Aedes aegypti* (Diptera: Culicidae) immature habitat in Tucson, AZ. J Med Entomol. 55(4): 955-963.

Appendix F1. Department of Entomology staff

Title	Name	FTE
Administration		
Business Manager, Senior	Doty, Rachel	1
Office Specialst, Senior	Green, Nirka	0.75
IT Staff		
Systems Administrator III	Picazzo Jr., Martin	0.2
Research & Extension Staff		
Assistant In Extension, Agronomic Crops IPM	Dayoob, Naomi	1
Assistant In Extension, Cotton IPM	Carlos Bordini, Isadora	1
Assistant In Extension, Entomology	Unnithan, Gopalan	0.49
Assistant In Extension, IPM Assessment/Pesticide Education	Dixon II, Wayne	1
Associate In Extension, Community IPM	Nair, Shakunthala	1
Associate In Extension, Public Health IPM	Li, Shujuan	1
Curatorial Assistant I	Simon, Jacob	0.49
Farm Attendant, Senior	Lizarraga, Gregoria	1
Horticultural Technician	Garcia, Joshua	0.48
Laboratory Coordinator I	Bland, Tanner	0.49
Laboratory Manager	Allan, Carson	1
Manager, Research Laboratory	Degain, Benjamin	1
Manager, Research Laboratory	Kelly, Suzanne	1
Manager, Research Laboratory	Yelich, Alexander	1
Manager, UAIC Collection	Hall, Wesley	1
Outreach Instructional Assistant II	Hardy, Jasmine	0.49
Photographer I	Martinez, Carlos	0.49
Research Specialist	Chavez, Leonard	1
Research Specialist, Senior	Buck, Norman	0.03
Research Technician	Bojorquez, Francisco	1
Research Technician	Partida, Jose	1
Research Technician	Soto-Shoumaker, Jenet	1
Research Technician I	Alvarez, Aida	0.3
Research Technician I	Arthur, Cauy	1
Research Technician I	Bojorquez, Franscisco	0.49
Research Technician I	Cahill, Madeleine	1
Research Technician I	Carrière-Walker, Jeremy	0.5
Research Technician I	Gay, Micah	1
Research Technician I	Husok, Oona	0.49
Research Technician I	Partida, Sebastian	1
Research Technician II	Castrezana, Sergio	0.9
Research/Laboratory Aide	Brown, Alexa	1
Research/Laboratory Aide	Ruiz, Javier	1
Research/Laboratory Aide	Tabashnik, Gabriel	0.35
Research/Laboratory Aide	Thacker, Emily	0.49
Research/Laboratory Aide	Thacker, Makayla	0.49
Research/Laboratory Glassware Att.	Garcia, Joshua	0.48
Researcher/Scientist IV	Isoe, Jun	1
Technical Expert	Hedgcock, Charles	0.15

Appendix F2. EIS GIDP Bylaws

BYLAWS

THE UNIVERSITY OF ARIZONA

Graduate Interdisciplinary Program in ENTOMOLOGY and INSECT SCIENCE
Approved October 19, 2009

PREAMBLE

Graduate Interdisciplinary Programs (GIDPs) report to the Vice President for Research, Graduate Studies and Economic Development through the Director of GIDPs.

The Graduate Interdisciplinary Program (GIDP) in Entomology and Insect Science offers the M.S. and Ph.D. degrees. In the following Articles and Bylaws, operating procedures, and policies of the Program are outlined. This organization and structure must conform to the guidelines for GIDPs.

Article 1. Membership in the Graduate Program.

Membership in the Graduate Interdisciplinary Program in Entomology and Insect Science is open to faculty at the University of Arizona who are willing to make a commitment to the GIDP. This commitment should be expressed through participation in developing and maintaining the GIDP, teaching courses, serving as host faculty for first year laboratory rotations, and serving as Major Professor. Tenured or tenure-eligible faculty will hold regular memberships, and untenured or non-tenure-eligible faculty will hold associate memberships.

Criteria for membership are a commitment to interdisciplinary approaches as well as activity and excellence in research or extension as demonstrated by research funding, publication record and service as advisors to students. Members of the Graduate Interdisciplinary Program will be reviewed periodically by the Executive Committee to ensure that they continue to meet these standards.

Membership can be proposed by candidates themselves or through nomination by a current member of the Program. Consideration of candidacy is initiated by submission of curriculum vitae and a letter of commitment to the Executive Committee. If the Executive Committee votes to recommend membership, a request is then submitted to the Director of Graduate Interdisciplinary Programs for approval and appointment. New members will present an introductory seminar to the insect science community at large.

The members of the Entomology and Insect Science GIDP will meet at least once a year to review the state of the program.

Article 2. Executive Committee (EC) and Chair of the Graduate Interdisciplinary Program in Entomology and Insect Science.

The GIDP in Entomology and Insect Science is administered by a Chair and an Executive Committee (EC), consisting of five to seven members. The Executive Committee will be made up of three faculty members with primary appointments in entomology and three faculty members with primary appointments elsewhere. The Chair is appointed for a renewable three-year term and EC members are appointed for renewable three-year terms. Both the Chair and the EC members will be chosen by vote by participating faculty that hold regular memberships. Nominations from participating faculty for both positions will be received by the EC. A faculty member may run for one or both positions. Fifty-one percent of the members will constitute a quorum. Majority vote of those present at a meeting or 51% return of ballots will rule. The roster of elected members will be forwarded to the Director of Interdisciplinary Graduate Programs for approval and appointment. The EC will also have 1 student member elected by the students to a renewable 1 year term.

A) The responsibilities of the **Executive Committee** are to:

1. Devise and implement procedures to be followed in selecting and reviewing members of the Entomology and Insect Science GIDP;
2. Devise and implement appropriate policies and procedures for the operation of the graduate program, such as admissions, curriculum, student supervision, completion of degree program requirements, and decisions regarding program resources;
3. Appoint GIDP faculty members to serve on the GIDP's two standing committees: the Graduate Student Admissions and Recruitment Committee (GS-ARC) and the Graduate Student Advisory and Progress Committee (GS-PAC**)** (see Article 3);
4. Appoint other ad hoc committees as needed for effective operation;
5. Act on recommendations of the GSAPC regarding academic counsel to new students and evaluations of students at various stages of progress through the Program;
6. Prepare and submit annual reports of the Entomology and Insect Science program's activities and accomplishments to the Director of Graduate Interdisciplinary Program;
7. Ensure that regular academic program reviews, consistent with the Board of Regents and USDA requirements, are carried out;
8. Facilitate interaction and communication within the Program in Entomology and Insect Science and with supporting academic units heads and deans;
9. Seek funding from appropriate University, State, Federal and private sources;
10. Solicit nominations to vacated slot(s) on the Executive Committee to ensure continuity over time.

B) The responsibilities of the **Chair of the Executive Committee (and of the GIDP).**

1. Administers the Program and activities of the EC with the assistance of the program coordinator of the GIDP;

2. Convenes and chairs meetings of the EC;
3. Acts on behalf of the EC and the GIDP to implement policies of the Program;
4. Serves as representative of the Program to the University Administration, granting agencies, prospective students, etc.;
5. Prepares and submits an annual report of activities and accomplishments of the Program according to University regulations.

The GIDP's Program Coordinator works closely with the Chair of the EC as well as the students, faculty, EC and standing committees to ensure timely fulfillment of the policies of the UA and the Program in Entomology and Insect Science, as well as the flow of information among all concerned.

Article 3. Standing Committees of the Graduate Program.

In addition to the EC, two standing committees carry important responsibilities for the operation and welfare of the Program.

1. Graduate Student Admissions and Recruitment Committee (GS-ARC).

The GS-ARC is responsible for evaluating applications from prospective graduate students for admission to the Program, organizing the campus visits of finalists, recommending students to the EC for admission to the Program, and coordinating efforts to recruit admitted students. GS-ARC also advises the EC with respect to publicizing the Program.

2. Graduate Student Progress and Advisory Committee (GS-PAC). The committee will--

-advise all first-year students who have not identified an advisor, and solicit and evaluate progress reports from all students.

- include at least 3 members of the Program's faculty, one of whom serves as Chair. The Committee members and Chair are appointed for renewable 3-year terms by the EC.

- solicit and evaluate progress reports from all students monitoring the progress of all students through annual review of student progress reports and reports of individual advisory committees, making recommendations about student advancement, probation, or termination to the EC.

- advise the EC regarding Program policies and procedures as well as revisions of the Program Handbook. Student input will be encouraged.

Article 4. Amendments.

The bylaws shall be amended or revised by movement of the EC and a two-thirds positive vote by the regular membership of the Program.

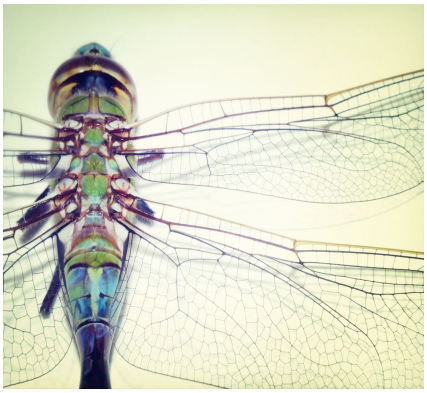
APPENDIX I.1

Graduate Interdisciplinary Program in Entomology and Insect Science

Student Handbook

2023 - 2024

Note: This handbook contains new guidelines for EIS graduation requirements in accordance with motions passed by faculty in May 2019. ***Students who matriculated prior to Fall 2022 should follow the guidelines for degree requirements as outlined from their first year of the program.***



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Welcome

Welcome to the Graduate Interdisciplinary Program in Entomology and Insect Science (GIDP-EIS). During your time in the program, whether as a master's or Doctoral candidate, you are encouraged to bridge scientific disciplines in ways that bring fresh perspectives to questions in insect biology. The program faculty is here to assist you in developing your individualized degree program and in designing and accomplishing your research. So, welcome, and best of luck in your graduate training.

Using this Handbook

This handbook describes the Program's current regulations and procedures, as well as the various requirements that must be met for the PhD and MS degrees. Please use the links provided in this handbook to review up-to-date information on Graduate College and EIS GIDP policies. ***It is GIDP policy that the student holds final responsibility for being aware of and responding to all GIDP and Graduate College policies, requirements, formats, and deadlines as they pertain to progression towards and completion of their degree.***

If you have any questions about the program, please contact the GIDP-EIS Graduate Program Coordinator, Paula Nielsen **pnielsen322@arizona.edu**

Contacts & Physical Resources and Facilities

Molly (Martha) Hunter, Chair GIDP in Entomology & Insect Science Marley Building, 641 (520) 621-9350 **mhunter@arizona.edu**	**Paula Nielsen, Graduate Program Coordinator** GIDP in Entomology & Insect Science Marley Building, 641C (520) 621-0847 **pnielsen322@arizona.edu**
Hayley Krall, Graduate Degree Counselor Graduate College, University of Arizona **hayleykral@arizona.edu** (520) 621-0119	**Graduate Student Representative** Please check EIS website for current student representative
EIS Breakroom – Marley 6th Floor	**EIS Mailroom (Forbes 410)** Entomology and Insect Science c/o Department of Entomology 1145 E. 4th St., PO Box 210036 Tucson, AZ 85721-0036

About the EIS Program

The Graduate Interdisciplinary Program (GIDP) in Entomology and Insect Science (EIS) offers Master of Science and Doctor of Philosophy degrees. The faculty of the EIS GIDP currently includes members representing seven departments: Entomology, Ecology and Evolutionary Biology, Epidemiology, School of Natural Resources and the Environment, Neuroscience, Molecular and Cellular Biology Geography. For an updated list of faculty and their research interests, please refer to the **EIS Program website.**

In addition to coursework and research opportunities, EIS Graduate students also have access to a variety of seminars, workshops, and conferences sponsored by the EIS GIDP, the Dept. of Entomology, the Graduate College and other programs and organizations on campus.

What is a GIDP?

Graduate Interdisciplinary Programs or GIDPs are PhD, Masters, and minor programs with collaborative relationships between all colleges across campus creating unique opportunities in interdisciplinary research. GIDPs transcend departmental boundaries by facilitating cutting edge teaching and research at the nexus of traditional disciplines. The high value placed on interdisciplinary research and education is indicative of The University of Arizona's enthusiasm and commitment to fostering innovation and creativity among its faculty and students.

To learn more about other GIDPS at the University of Arizona visit the **GIDP website**

Affiliation

EIS students' affiliation (for publications or presentations) is "Graduate Interdisciplinary Program in Entomology and Insect Science, 1145 E. 4th St., PO Box 210036, Tucson, AZ 85721." This is true even though your advisor (who may be a co-author on your work) has a separate, departmental affiliation (e.g., Dept. of Entomology or Dept. of Ecology and Evolutionary Biology). The EIS program and the two programs that preceded it also have close relationships with the Department of Entomology, and the College of Agriculture & Life Sciences (the college in which Entomology is housed), and these institutions should be gratefully acknowledged for any funding granted. You may also claim dual affiliation in manuscripts with the department of your advisor.

The GIDP in Entomology and Insect Science is administered by an Executive Committee. The Executive Committee is chaired by the Program Chair and includes six faculty members and a student representative. The Executive Committee of the GIDP in Entomology and Insect Science formulates policies and procedures for the operation of the graduate program in such areas as admissions, curricula, student supervision, and completion of degree program requirements.

Program Committees

In addition to the Executive Committee, there are two other standing committees for the program. The Admissions Committee coordinates all recruiting and admissions procedures. The Advisory Committee is relevant for current students. The Advisory (Progress) Committee solicits and evaluates annual progress reports from all students (more information on progress reports is available in Section 3, Advising and Progress).

Student Participation in Program Administration

At the end of each school year, the students in the EIS Graduate Program elect a Graduate Student Representative from among their peers to serve a one-year term, beginning the following fall.

The EIS Graduate Student Representative for the 2022-2023 Academic Year is Meagan Ash.

The primary duties of the Graduate Representative are:

- To bring the questions and concerns of the students in the Program to the attention of the Program Chair, and vice versa.
- Help the Program management develop Program policy as needed.
- Assist with the organization of the annual recruitment workshop in the Spring semester and other Program activities when appropriate.
- Appoint student committee members for EIS Awards in Education and Leadership (see Program Awards below).

EIS GIDP students are encouraged to work with the Executive Committee to improve any aspect of the Program, including, but not limited to, examinations, application processes, course requirements and electives, and research and funding opportunities. *To ensure that messages are not lost, students should direct comments through the Graduate Representative*. If there is a conflict of interest or some other complication that prohibits this path of action, please contact the EIS Program Coordinator to discuss.

Program Retreat

The EIS GIDP has historically hosted a program retreat, in the spring of every other year, and hope to start this again post-pandemic. Potential changes to program policy and activities are discussed by attending students and faculty. Student input is valued. Faculty then break off and settle on proposed motions for program changes. Motions are put forth to all EIS faculty for a vote. All changes to EIS GIDP policy will be promptly shared with students via the student email listserv.

Student Rights and Responsibilities

Responsibility for meeting EIS GIDP and University requirements ultimately rests with the student – students should not expect reminders of deadlines from the program.

Students are entitled to the following rights as members of the EIS GIDP:

- Right to representation through an elected Graduate Student Representative
- Right to appeal as outlined in Appendix 2: Student Appeals
- Right to understandable information on all degree requirements
- Right to understandable information on program progress through:
  - consistent assessments,
  - meetings with faculty advisors at least once per semester, and
  - timely feedback (maximum 6 week turn-around) on degree requirements,
- Right to prompt notification of changes in Program policy via the student listserv

Students are responsible for making Satisfactory Academic Progress (Appendix 1) and meeting the other expectations of the Graduate College and the EIS GIDP as outlined in this Handbook.
EIS students are also expected to abide by all relevant ethical and academic standards of the University as outlined below.

- **Academic Integrity**

- **Responsible Conduct of Research**
- **Graduate College Academic Policies**

Advising and Progress

Student advisors, Graduate Committees, and the Advisory Committee work together to ensure that students stay on track to degree completion. *Students are expected to meet with their committees and to complete progress reports annually.*

Expectations for Satisfactory Academic Progress

A student making satisfactory academic progress maintains a 3.0 GPA in program courses and is making timely progress on the steps to their degree as outlined in this handbook.

Failure to Achieve Satisfactory Progress

In the rare circumstances that a student fails to meet program guidelines for satisfactory progress, the student will receive written notification with a clear statement of what the student must do and a date by which such actions must be completed. The Graduate College will receive a copy of letters of unsatisfactory progress. Students will be given an opportunity to appeal or rebut, as described in Appendix 2: Student Appeals. Students who fail to improve by the deadlines specified may be dismissed from the program.

Advisors

You will meet with your advisor frequently during your program. Students generally come in with an advisor, but in the unusual circumstance that they are considering more than one faculty member as an advisor, they should select an advisor before the start of the second semester of study. This selection will be influenced by discussion with the potential advisor, research rotations, and individual meetings with the Program faculty.

If you are an undecided first year student, communicate with the faculty whose laboratories you are considering joining to make sure they are also willing to advise you. Please check the degree requirements and tracking in GradPath to make sure you stay moving ahead in your degree progress.

Annual Progress Report

Annual progress reports are required from all current students. Progress reports are generally due at the end of May, after the second semester has concluded – students will receive a notification in the Spring semester on the deadline for progress reports. The Advisory committee then meets to discuss all the student reports. Each student and their advisor receive a letter with the summary of the Committee's thoughts and concerns. When there's concern about the progress of a student, the report and letter from the Committee will be forwarded to the EIS Chair for further discussion with the student and advisor. Copies of all letters from the Advisory Committee will be filed with the Executive Committee and in the students' files. If students fail to make progress in successive years, the student may be consulted and then notified of milestones that must be reached by certain dates (see failure to achieve satisfactory progress, above). In rare circumstances, the Advisory Committee may recommend probation or dismissal.

The format for annual progress reports is available in Appendix 3.

Graduate Committees

Who can serve and what do they do?

The Graduate Committee, with your major advisor, will: (1) advise you on preparation of a Plan of Study, (2) supervise your research (3) conduct the comprehensive examination, and (4) evaluate and edit the dissertation and conduct the final examination and dissertation defense.

Students should select a Graduate Committee in the first year, **before the start of the third semester of study**. This selection will be influenced by discussions with your advisor and individual meetings with the Program faculty. If you are considering inviting a particular faculty member for your committee, you should establish a time to meet, and then plan to discuss your research plans, and ask whether they would be willing to serve on your Graduate Committee.

Note: Graduate Committees may change over the course of a student's program. Changes may occur because of a change of the student's research focus, the departure of a faculty member to another institution, or, rarely, because of a conflict with a committee member.

Who can serve on your committee? Committee member requirements are available on the **Graduate College website**

In addition to the yearly required committee meetings, it is highly advisable to schedule a committee meeting when the thesis or dissertation has taken shape and the end is in sight (e.g., the semester before you defend). Present the research that will be in the final thesis/dissertation to your committee at this time and make sure that all members approve of the scope, rigor, and organization of the final product. At this time, your committee can decide when it requires a final draft of the paper to review. At minimum, committees generally require the complete and formatted thesis/dissertation two weeks before the defense.

Advisory Committee Progress Reports

Annual progress reports are required from all current students. They are generally due at the end of May, after the second semester has concluded. The Advisory committee then meets sometime during the summer to discuss all the student reports. Each student and their advisor will receive a letter with the summary of the Committee's thoughts and concerns. When there's concern about the progress of a student, the report and letter from the Committee will be forwarded to the EIS Chair for further discussion with the student and advisor. Copies of all letters from the Advisory Committee will be filed in the students' files. If students fail to make progress in successive years, the Advisory Committee may recommend probation or termination.

The Graduate Coordinator will send out requests for progress reports in the spring semester. A sample format for the progress reports is available in Appendix 3.

EIS Program Requirements

Enrollment Policy

- With the exception of students in their last year who may take fewer credits, students ordinarily take between six (minimum) and 12 (maximum) units of graduate course work in each fall and spring semester to remain in good standing in the Program. Work with your Major Advisor and the EIS Program Coordinator to make sure you are enrolled for the right number of units. International students may need to take a certain number of units to fulfil their visa requirements.

- MS students may register for 1-8 units of EIS 900 Research and/or EIS 910 Thesis per semester. PhD students may register for 1-9 units of EIS 900 Research and/or EIS 920 Dissertation per semester. By the end of your program, MS students need 8 units of EIS 910 Thesis credits and PhD students need 18 units of EIS 920 Dissertation credits. When you are taking less than a full load of graded courses, your enrollment will consist of mainly these two types of units.

- These policies are subject to change. Please refer to **University Enrollment Policies** for current information.

- See more specific details in the paragraphs below.

Courses and Registration

All EIS students will start their program with some required courses taken in the first or second year. There are few of these, but because they are generally offered only once in a two-year cycle, you will need to take them when they are offered. After that time, you will select your courses in consultation with your Advisor and Graduate Committee. PhD students will also select a minor and complete minor requirements. You will also need to meet the Graduate College requirements for your program. However, you will find that you have a great deal of flexibility to choose the courses most relevant to your interests and research direction. A complete list of Entomology and EIS courses are available on the **Registrar's website,** but any graduate level course approved by your committee can be considered, and our students take courses in programs across campus, including in Ecology & Evolutionary Biology, Molecular and Cell Biology, Epidemiology, School of Natural Resources and the Environment, Plant Sciences, GIDP in Neuroscience, Geography, and others**.**

	• **View the Schedule of classes by semester.** • **Put in EIS (or other prefix) under Subject Area and click Search.** • **If you wish to see the course description, click on the link under Section.** • **See more information about the courses below and pay careful attention to the checklist that follows.**

Letter Grade vs Non-Letter Grade and Schedule Changes

- Courses for a letter grade can be added online through **UAccess.**
- Non-letter grade enrollment can consist of Independent Study, Laboratory Rotation, or Research units (including dissertation and thesis).
- Non-letter grade units can be added by submitting an email request to the EIS Graduate Coordinator. Please include the desired course number, number of units, and supervising instructor in your email. Please confirm your plans with the supervising instructor prior to making the request.
- Deadlines exist for all schedule changes. Please be aware of these important deadlines by checking the **Registrar's website.**

Required Courses

EIS 596A, Current topics in Entomology & Insect Science (Seminar)

The program seminar has a different format in fall and spring. In the fall students read on the topic of their planned thesis or dissertation topic and write weekly summaries of their reading. During class period, students present papers they've read, with all students presenting at least twice during the semester. Students also discuss the joint Entomology/EIS seminar series talk of the previous week. The spring seminar is for proposal writing. Students work throughout the semester in writing a draft of their MS or PhD proposal, with class periods being devoted to discussion of scientific writing, peer reviews and sharing progress. PhD students are required to take fall & spring semester offerings in both their 1st and 2nd year in the program. MS students are required to take the fall and spring seminar in their 1st year in the program.

EIS 792, Research Rotation

During the first year in the EIS program, each PhD student must complete at least two laboratory rotations, one of which must be conducted in a laboratory other than that of the student's advisor. Laboratory rotations count for course credit. Lab rotations encourage you to have hands-on experience in areas of interest, to learn research methods in the field and to become acquainted with the laboratory work and research group of prospective dissertation advisors.

You will earn 3 units per semester for a maximum of 9 possible units earned for rotation. The length of rotations is 8 weeks, with about 10 hours of work per week expected in the lab. However, the rotation project can be continued beyond 8 weeks with the agreement of the student, rotation mentor, major advisor, and program coordinator. The number of units you earn is dependent on the number of rotations you do and the time it takes to complete each one. It is common to complete 1 & ½ rotations in a semester with the 2nd rotation beginning mid-semester, with completion taking place in the following semester (with or without a second semester of course enrollment). Students are encouraged to complete a third rotation if they like. Please note, you cannot register for rotation mid-semester, you must register prior to the semester start.

There is no set format for a given rotation project. Both the student and rotation host should design rotation projects to achieve specific goals for student development and expected outcomes for the project. Before the project begins, submit a rotation form to the EIS Program Coordinator. The rotation form is available on the **EIS website.** **Do fill these out – they provide a clear plan and prevent misunderstandings or revisions of the scope of the rotation as it progresses.**

At least two of three of the following core courses:

EIS 517, Insect Systematics (offered alternative years in the fall)
EIS 520, Insect Molecular Physiology (offered alternative years in the spring) *
EIS 544, Insect Ecology (offered alternative years in the fall)

*This course has not had sufficient enrollment to be offered in recent years.

Seminars and Group Meetings

Students are expected to participate actively in group meetings, seminars, and activities of the Program.

GradPath

Students are required to complete **GradPath** forms via UAccess as they progress through their degrees. Please review the GradPath requirements under your degree and complete forms by the stated deadlines. For additional information see **GradPath User Guides**

Learning Outcomes Assessment

Program assessment forms are used to evaluate and monitor strengths and weaknesses in learning of all students in the program; assessment forms are not used to grade or judge individual students. Learning outcome surveys will be linked to emails to students at the time of comprehensive exams (for PhD students) and final defenses (both MS and PhD students).

An explanation of the assessment process and the EIS program learning outcomes for both MS and PhD students can be found here: **Graduate student learning outcomes assessment**.

EIS program assessment self-reflection forms **must be completed** by students **and** graduate committee members for each of the following degree milestones:

- Oral Comprehensive Exams
- Final Thesis Exams/Dissertation Defenses

Entomology & Insect Science PhD Student Requirements

*Please familiarize yourself with the **Graduate College policies** for doctoral students.*

Minimum Credit Units: 63

Required Core Coursework:

Minimum credits for Major: 36
Minimum credits for Minor: 9
Minimum credits for dissertation: 18

These courses are all offered alternate years, so students will take them in their first or second year.

Units will include EIS courses, courses in the minor, other courses chosen from the schedule of classes and approved by the Graduate Committee, and research and independent study units. Eligible transfer courses may also be included in this tally.

1. **At least two of three of the following core courses:**
   - EIS 520 Insect Molecular Physiology (3 units) *
   - EIS 544 Insect Ecology (3 units)
   - EIS 517 Insect Systematics (4 units)

2. **EIS 596A Current topics in Entomology & Insect Science Seminar (1 -3 units)**
   Course is taken four (4) times, fall & spring semester in the first and second year of the program.

3. **At least two research rotations EIS 792 (3-6 units).**
   One rotation needs to be completed in a laboratory other than the advisor of record.

4. **EIS 920 Dissertation (18 units).**

5. **PhD minor in a program other than EIS, consisting of at least 9 units.**

* This course has not had sufficient enrollment to be offered in recent years.

EIS courses available to PhD majors

EIS 501	Ecological Physiology (3 units)
EIS 505	Aquatic Entomology (4 units)
EIS 513	Applied Biostatistics (3 units)
EIS 515R	Insect Biology (3 units)
EIS 532	Comparative Immunology (3 units)
EIS 536	Agro-ecology (3 units)
EIS 553	Functional and Evolutionary Genomics (4 units)
EIS 557	Medical-Veterinary Entomology (3 units)
EIS 588	Principles of Cellular and Molecular Neurobiology (3 units)
EIS 597C	Controlled Environment Agriculture IPM (3 units)
EIS 599	Independent Study (1 – 5 units)
EIS 660	Infectious Disease Epidemiology (3 units)
EIS 699	Independent Study (1 – 3 units)
EIS 900	Research (1 – 8 units)
EIS 920	Dissertation (1 – 8 units

In this interdisciplinary program, we encourage students to take courses in other programs that suit their developing interests, in consultation with their graduate committees.

Popular courses available to EIS PhD majors

BE 534	Biosystems analytics (Python for data analysis)
BE 587	Metagenomics
BIOS 576A	Biostatistics in public health
BIOS 576B	Biostatistics for research
ECOL 596W	Special topics in Ecology and Evolution: Practical and reproducible data science
ECOL 530	Conservation genetics
ECOL 528R	Microbial genetics
ECOL 506R	Conservation biology
ECOL 519	Introduction to modeling in biology
ECOL 526	Population genetics
ECOL 587R	Animal behavior
ECOL 600B	Fundamentals of ecology
ENVS 567	Introductory statistics and multivariate statistics with R
EPID 573A	Basic principles of epidemiology
PLP 550	Principles of plant microbiology
NRSC 572	Neurodevelopment in action

Elective Coursework

In the fall students taking the required EIS 596A seminar course will attend Entomology/EIS research seminars and, separately, read the literature in their own area of research, write summaries and twice per semester, present a paper relevant to their own research in the class meeting time. The spring semester EIS 596A seminar course will be a structured proposal writing workshop, with frequent peer, advisor, and course instructor review of drafts.

Minor Requirements

Minors must be in a program or department other than EIS. Nine (9) units are generally required for a minor. A member of the minor department or program must serve on the student's graduate committee and approve the units taken for fulfillment of the minor.

Speaking Requirement

PhD students who have completed their comprehensive exams must present two talks on their research progress, one of which may be on campus. Attending and presenting at conferences are excellent opportunities to share research results and develop scientific communication skills.

Teaching Requirement

University level teaching is considered essential training for an academic career. Therefore, PhD students must serve as a Teaching Assistant, or have an equivalent type of teaching experience for at least one semester sometime during their graduate program.

Time Limitation

PhD students must pass their Final Defense within 5 years of passing the Comprehensive Exam.

Steps to your Entomology & Insect Science PhD Degree

Choosing a Graduate Committee

The Graduate Committee must be chosen by the end of the second semester. The composition of your graduate committee must be submitted on GradPath. The Graduate College requires a minimum of three committee members to approve the dissertation, all of whom must be University of Arizona tenured, tenure-track, or equivalent. The fourth and fifth members, if any, may be UA faculty or approved special members. Things to keep in mind:

- It's best to have a minimum of 4. This is helpful if a committee member can't attend meetings or the dissertation defense. However, 5 or more members may provide logistical difficulty in scheduling.

- Three members must be regular faculty at the University of Arizona; however, it is possible to include a 4th person as a "Special Member" if that person has special skills and knowledge. A request must be submitted to the Graduate College for a "Special member". The request requires basic information and a CV for the proposed committee member.

- In GradPath there is a distinction between the Comprehensive Exam Committee and Doctoral Dissertation Committee. This means that a change in committee is possible. All changes must be entered into GradPath.

- Please see more details about **PhD Graduate Committees.**

GradPath Forms

GradPath Forms:

- Responsible Conduct of Research Statement *must be completed in the first semester*
- Plan of Study *by third semester in residence*
- Comprehensive Committee Appointment Form *before beginning of the Written Comprehensive Exam*
- Announcement of Doctoral Comprehensive Exam *at least 10 days before Oral Exam*
- Prospectus/Proposal Confirmation *no later than six months before Final Defense*
- Announcement of Final Oral Defense *at least 10 days before Final Defense*

Plan of Study

The plan of study lists:
(1) graduate courses the student intends to transfer from other institutions (if any).
(2) courses already completed at The University of Arizona which the student intends to apply toward the graduate degree; and
(3) planned additional coursework to be completed to fulfill degree requirements.

The Plan of Study must be entered into GradPath. The Graduate College requires electronic approval signatures for the Doctoral Plan of Study from the Chair of the EIS and the student's major advisor so students should be sure to have the program chair and major advisor "ok" coursework prior to submitting the form for signatures. The Plan of Study must be completed by the third semester in residence. Students often delay submitting a Plan of Study because their planned course are not definite. In fact, revisions to a Plan of Study occur frequently and are the norm. Do submit your Plan of Study on time – it can be amended multiple times.

Comprehensive Examination

The comprehensive examination is designed to ensure that PhD students are broadly trained, can synthesize new knowledge and think independently. Preparation for the comprehensive examination provides a rare opportunity to intensively read, think and write about one's discipline.

The comprehensive examination must be taken according to the **Graduate College regulations**. Under normal circumstances, the comprehensive examination should be taken in your second or third year.

The examination, which has written and oral parts, tests knowledge in both the major and minor areas of concentration.

The written exam consists of two parts:

The first part is a dissertation proposal, which should outline independent research, and is generally written according to the guidelines of a relevant funding agency (e.g., NIH, USDA, NSF).

The dissertation proposal can be developed in consultation with your committee.

In the second part, you will write an essay on a topic chosen by the Committee. This second assignment will give you an opportunity to develop a synthetic, critical essay in an area allied but separate from your dissertation problem and will be written without any consultation with other students or faculty.

The second essay will be turned in a week after being presented.

The oral exam is given by your Graduate Committee.

The oral examination involves broad questions across your general field of study as well as more specific questions within your area of specialization. You should demonstrate strong fundamental knowledge in areas pertaining to Entomology & Insect Science as well as in the discipline represented by your minor.

It may be advisable to speak to each member of your committee several weeks before your oral exam to ask them whether there is a particular body of work that they recommend you study (e.g., texts, papers, or topics). When the committee feels that the student is insufficiently prepared for the oral exam, they may postpone the exam, to allow more time for preparation. If the student is unprepared in the exam, the Committee will fail the student.

The Graduate College allows only one re-take of the oral exam. Comprehensive Exam Instructions can be found on the Graduate College **website**.

The Comprehensive Exam Committee Appointment Form and Announcement of Doctoral Comprehensive Exam should both be filed with the Graduate College via GradPath forms found in **UAccess**

Advancement to Candidacy

When the student has an approved doctoral Plan of Study on file, has satisfied all course work, residence requirements, and passed the written and oral portions of the Comprehensive Examination, the student has "advanced to candidacy" and is eligible to apply for certain fellowships that are exclusively for students at this advanced stage of their program (e.g., USDA Predoctoral Fellowship). The Graduate College will notify you by e-mail when you have advanced to doctoral candidacy. Students will be charged graduate candidacy fees. Students at this point must file a Doctoral Dissertation Committee Appointment (EISPHD) form with the Graduate College via GradPath forms found in **UAccess**

Deadlines for the submission of forms pertaining to doctoral programs can be found here **Important Degree Dates and Deadlines | The University of Arizona Graduate College**

Dissertation and Final Examination

In the months before your defense, you and your Graduate Committee will agree upon a schedule for completion of chapters, and submission of the dissertation to the Committee members. You are expected to provide the members of your committee with the final, polished version of the dissertation at least two weeks prior to the scheduled Final Examination, or defense.

The Announcement of Final Oral Defense (EISPHD) form must be on GradPath at least 10 days prior to the defense.

The defense consists of a scheduled, advertised public seminar by the candidate followed by an oral examination by your Graduate Committee that cannot exceed two hours. While the oral portion of the Comprehensive Examination is often broad ranging, the final oral examination is generally focused on the dissertation. The Graduate College requires a minimum of three members to approve the dissertation, all of whom must be University of Arizona tenured, tenure-track, or equivalent. The fourth and fifth members, if any, may be UA faculty or approved special members. If a committee has only three members, all must approve the dissertation.

If the committee requires revisions, those must be done in a timely manner, not to exceed one year. If the revisions are not completed by the dissertation submission deadline for the term when the student defends, the student will be required to register for the next semester and will graduate in the semester when the revisions are complete and approved. If revisions are not done by the end of the time to degree period, the student will have to re-take the comprehensive examinations to demonstrate currency of knowledge.

Exit Interview

Upon completion of the dissertation defense, students should schedule a meeting with the Program Chair. The purpose of this meeting is congratulatory as well as information-seeking. The department is committed to the quality of its graduate program, and the advice and experiences of successful students are valued.

Suggested Entomology & Insect Science PhD Timeline

Year One

fall

- **(Upon arriving in Tucson:) Initial meeting with Program Coordinator**
  Responsible Conduct of Research; submit GradPath form
  Visit with EIS faculty to select and plan lab rotations.
  Complete first laboratory rotation(s); turn in rotation(s) report

spring

Complete final rotation(s), turn in final rotation(s) report
Select Major Advisor (if did not arrive with one)
Develop Plan of Study with Major Advisor
Choose Graduate Committee; submit GradPath form
Annual Graduate Committee meeting for review of progress

Year Two

fall

- Submit final Plan of Study; **submit GradPath form**
  Appoint Comprehensive Examination Committee; **submit GradPath form**

spring

- Complete coursework
  In year 2 or 3 schedule and complete Written and Oral Comprehensive Exam; **submit GradPath form, submit self-reflection assessment form**
  Annual Graduate Committee meeting for review of progress

Year Three

fall

- Appoint Doctoral Dissertation Committee; **submit GradPath form**

spring

- Annual Graduate Committee meeting for review of progress

Year Four

fall

- Focus on dissertation research, completion of chapters, preparation of manuscripts for publication

spring

- Annual Graduate Committee meeting for review of progress

Year Five

fall

- Prepare for dissertation defense
  Meet with the Graduate Committee

spring

- Schedule Defense; **submit GradPath form**
  Final Defense; **submit self-reflection assessment form**
- Schedule exit interview with program chair

Entomology & Insect Science MS Student Requirements

*Please familiarize yourself with the **Graduate College policies** for master's degree students.*

Minimum Credit Units: 32

Required Core Coursework:

At least 15 units must be completed toward the MS requirements in letter-graded courses (vs. research or independent study units). **At least 24 credits** must be in non-thesis credits.

1. At least two of three of the following core courses:

- EIS 520 Insect Molecular Physiology (3 units) *
- EIS 544 Insect Ecology (3 units)
- EIS 517 Insect Systematics (4 units)

2. EIS 596A Current topics in Entomology & Insect Science Seminar (1 -3 units)
Course is taken two (2) times, fall & spring semester in the first year of the program.

3. EIS 910 Thesis (8 units).

*This course has not had sufficient enrollment to be offered in recent years.

EIS courses available to EIS MS majors

EIS 501	Ecological Physiology (3 units)
EIS 505	Aquatic Entomology (4 units)
EIS 513	Applied Biostatistics (3 units)
EIS 515R	Insect Biology (3 units)
EIS 532	Comparative Immunology (3 units)
EIS 536	Agro-ecology (3 units)
EIS 553	Functional and Evolutionary Genomics (4 units)
EIS 557	Medical-Veterinary Entomology (3 units)
EIS 588	Principles of Cellular and Molecular Neurobiology (3 units)
EIS 597C	Controlled Environment Agriculture IPM (3 units)
EIS 599	Independent Study (1 – 5 units)
EIS 660	Infectious Disease Epidemiology (3 units)
EIS 699	Independent Study (1 – 3 units)
EIS 900	Research (1 – 8 units)

In this interdisciplinary program, we encourage students to take courses in other programs that suit their developing interests, in consultation with their graduate committees.

Popular courses available to EIS MS majors

BE 534	Biosystems analytics (Python for data analysis)
BE 587	Metagenomics
BIOS 576A	Biostatistics in public health
BIOS 576B	Biostatistics for research
ECOL 596W	Special topics in Ecology and Evolution: Practical and reproducible data science
ECOL 530	Conservation genetics
ECOL 528R	Microbial genetics
ECOL 506R	Conservation biology
ECOL 519	Introduction to modeling in biology
ECOL 526	Population genetics
ECOL 587R	Animal behavior
ECOL 600B	Fundamentals of ecology
ENVS 567	Introductory statistics and multivariate statistics with R
EPID 573A	Basic principles of epidemiology
PLP 550	Principles of plant microbiology
NRSC 572	Neurodevelopment in action

Elective Coursework

n/a

Additional Requirements

No other requirements, although training in teaching with a teaching assistantship is encouraged.

Time Limitation

MS students must complete all degree requirements within 5 years. The expected timeline for MS students is 2-3 years.

Steps to your Entomology & Insect Science MS Degree

Choosing a Graduate Committee

The Graduate Committee must be chosen by the end of the second semester. Committee members must be submitted on GradPath. The Graduate College requires a minimum of three members to approve the thesis, all of whom must be University of Arizona tenured, tenure-track, or equivalent. Typically, MS graduate committees have three members, two faculty other than the advisor. A fourth faculty member can be included, or an approved special member. Things to keep in mind:

- Thesis **committees** must consist of three members; at least two must be members of the Graduate Faculty. If the third member is not a member of the Graduate Faculty, he or she must be approved by the Graduate College as a Special Member. Special Member requests are submitted by the Program Coordinator. The request requires basic information and a CV for the proposed committee member.

- Please see more details about **MS Graduate Committees**

GradPath Forms:

GradPath Forms:

- Responsible Conduct of Research Statement *should be completed before the end of the first semester*
- Plan of Study *by third semester in residence*
- Master's Committee Appointment Form *as soon as Plan of Study is approved*

Plan of Study

A Plan of Study lists:

(1) the graduate courses the student intends to transfer from other institutions (if any).

(2) the courses already completed at The University of Arizona which the student intends to apply toward the graduate degree; and

(3) additional coursework to be completed to fulfill degree requirements.

The Plan of Study must be entered into GradPath. The Graduate College requires electronic approval signatures for the Doctoral Plan of Study from the Chair of the EIS and the student's major advisor.

The Plan of Study must be completed by the third semester in residence. Students often delay submitting a Plan of Study because their planned course are not definite. In fact, revisions to a Plan of Study occur frequently and are the norm. Do submit your Plan of Study on time – it can be amended multiple times.

Final Examination

A typical thesis MS degree defense is similar to a PhD defense. The defense consists of a scheduled, advertised public seminar by the candidate followed by an oral examination by the Graduate Committee. The final examination is designed to ensure that MS students have a thorough understanding of their thesis project. The structure of the MS final examination is flexible and will be decided by the student's Graduate Committee. Students should consult their advisors on effective exam preparation. Following the defense, the thesis is submitted to the Graduate College.

A candidate who fails a final examination may, upon the recommendation of the program, be granted a second examination. The results of the second examination are final.

MS students may also decide to complete a non-thesis MS degree. This is generally a terminal degree (i.e. not a stepping stone to a PhD program), is awarded on the basis of completed coursework (with or without an additional project) and may be elected because of a student focus on outreach rather than research, or because the student's goals have changed. Students electing a non-thesis MS ordinarily have a final committee meeting to discuss the student's learning outcomes from the program and future plans.

Exit Interview

Upon completion of the Final Defense, students should schedule a meeting with the Program Chair. The purpose of this meeting is congratulatory as well as information-seeking. The department is committed to the quality of its graduate program, and the advice and experiences of graduating students are valued.

Suggested Entomology & Insect Science MS Timeline

fall — ***Year One***

- (Upon arriving in Tucson:) Initial meeting with Program Coordinator
  Select Major Advisor
  Responsible Conduct of Research; **submit GradPath form**

spring

Develop Plan of Study with Major Advisor; **submit GradPath form**
Choose Graduate Committee; **submit GradPath form**
Annual Graduate Committee meeting for review of progress

fall — ***Year Two***

- Finish coursework
  Thesis research

spring

- Graduate Committee meeting to discuss thesis results and presentation
  Schedule and complete Final Exam; **submit GradPath form, submit MS thesis to the Graduate College**
  Exit Interview; **submit self-reflection assessment form**

Steps for EIS MS student to transfer to the EIS PhD Program

- The student's advisor and/or committee members must approve.

- The student must complete a significant piece of writing and submit it to their advisor and the Program Chair. This could be the first chapter of the MS thesis, or a draft. The writing sample and request to change programs must be endorsed by the advisor and subsequently approved by the Admissions Committee.

- Once the EIS Admissions committee has approved the transition, the student must still "apply" through GradApp (and pay application fee) to the doctoral program. Students can make this transition at any time of year; the regular deadline for application to the program (Dec. 1 each year) does not apply.

Required for application:

- **The Statement of Purpose/Personal Statement**
  The student can upload a previous statement. No additional evaluation occurs at this stage, so no additional work is required.

- **CV**
  Any version (including your admissions application CV) will work. Or you can upload the 2-page CV submitted for the student progress report.

New letters of recommendation are not required.

- The student must send an email to degree counselor that he/she does not want to complete the MS. This will help establish the new PhD record in GradPath.

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hayleykral@arizona.edu

- The student will let the Program Coordinator know that the application is submitted. The PC will close the application and will take action to recommend admission.

- The student must accept their admission. A PhD record will be established in GradPath for student.

Entomology & Insect Science Minor Student Requirements

(for students from other University of Arizona PhD programs)

Minimum Credit Units: 9

Required Core Coursework

9 units are required for the minor. Completion of these courses with a "B" average for the required units is necessary for granting of the minor.

A member of the GIDP EIS faculty must serve on the student's committee to represent the EIS minor and will approve the units selected. EIS does not require representation at the written Comprehensive Examination but does require an EIS GIDP faculty member to be present at the oral examination, and EIS-related material must be covered. The student's dissertation (Doctoral final oral examination) committee must contain one faculty GIDP EIS member. This committee member must be present at the dissertation defense, either in person or by teleconference.

EIS courses available

EIS 501	Ecological Physiology (3 units)
EIS 505	Aquatic Entomology (4 units)
EIS 513	Applied Biostatistics (3 units)
EIS 515R	Insect Biology (3 units)
EIS 517	Insect Systematics (4 units)
EIS 520	Insect Molecular Physiology (3 units) *
EIS 532	Comparative Immunology (3 units)
EIS 536	Agro-ecology (3 units)
EIS 544	Insect Ecology (3 units)
EIS 553	Functional and Evolutionary Genomics (4 units)
EIS 557	Medical-Veterinary Entomology (3 units)
EIS 588	Principles of Cellular and Molecular Neurobiology (3 units)
EIS 596A	Current topics in Entomology & Insect Science Seminar (1 -3 units)
EIS 597C	Controlled Environment Agriculture IPM (3 units)
EIS 599	Independent Study (1 – 5 units)
EIS 660	Infectious Disease Epidemiology (3 units)
EIS 699	Independent Study (1 – 3 units)
EIS 900	Research (1 – 8 units)

**This course has not had sufficient enrollment to be offered in recent years*

Financial Information

Entomology and Insect Science Program funding

Student funding is extremely varied. Students may be funded from fellowships, may be self-funded, or may be supported by Program funds or faculty grants in their first year while they take courses and do laboratory rotations.

Students in their second and subsequent years are funded by research assistantships from their advisors, teaching assistantships, training grant funds, or individual fellowships. All students are strongly encouraged to apply for individual fellowships as they are excellent training in summarizing research. If granted, fellowships and grants are prestigious and increase the probability of further funding and of securing positions after graduation. Fellowships also increase student independence. Students who are not legal residents of Arizona, but are on an RA or TA, receive a waiver of the out-of-state tuition charged by the University of Arizona.

Students who are self-funding, have less than a 'full time' (0.5) RA or TA, or who are on certain types of fellowships, may be responsible for some portion or all tuition charges. However, before you pay these, check with the EIS Program Coordinator to see whether we have GRS/GTS funds to distribute that can reduce or eliminate your financial liability. These are generally distributed once a year, so you may have to anticipate more than a semester in advance. Enrollment in the University's student health plan for the student is covered when a student holds an assistantship position.

Many EIS students have taken advantage of the TA opportunity in the Introductory Biology labs (MCB 181 or EEB 182). If you anticipate looking for a TA for the following year or semester, let the Program Chair know, and they will let you know when either program is accepting applications. Other Departments or programs may also have TAships that you can apply for – work with the Program Chair to make sure they know when you're looking for a position, and also when you've found one.

Scholarship Universe is a scholarship matching service exclusively for University of Arizona Students. When a student logs in, they are asked a series of questions and matched to scholarships based on their answers. Scholarship Universe matches Wildcats to thousands of UA and non-UA opportunities and can help you to apply for and receive scholarship awards quickly and easily. Very commonly, students who take the time to apply to SU get awarded small scholarships that a) are helpful financially and b) can and should be listed on one's CV. We urge everyone to do this.

Mandatory start of semester fees

All students are responsible for paying the mandatory UA fees charged on their Bursar's account. Log in to UAccess Student, click on the "Finances" tab and scroll down to "Account Summary." There, if you owe anything, you will see a breakdown of each charge. Fee amounts vary and depend on the number of units taken. Please be sure to pay these fees by the first day of class each semester. If you do not pay them by that date, you will be charged a late fee.

Multiple Means of Support

The University has strict regulations governing academic year employment limits. Details are available in the **GA Manual,** If you have specific questions, contact the **Graduate College** (520) 621-3471.

Additional Funding Opportunities

General Funding, Internal

The Graduate College
Financial resources page on their website where you will find a list of various funding opportunities for graduate students.

Graduate Center Office of Fellowship
The Office of Fellowships is a branch of the Graduate Center that assists graduate students in searching and applying for funding outside of the University of Arizona. They also offer grant writing workshops and presentation.

CALS Scholarships via Scholarship Universe
One application puts you into consideration for all CALS scholarships. Applications accepted January – March.

Research, Innovation & Impact
Provides access for faculty, students, and researchers to multiple funding databases.

Research Funding

- **Graduate & Professional Student Council Research Grants**
- **Willock Research Award**

UA Conference/Research Travel Funding

- **Carter Travel Award**
- **Raphael and Jolene Gruener Research Travel Award**
- **Graduate & Professional Student Council travel grant**

General Funding, External

- **USDA-National Institute for Food & Agriculture**
  There are two categories of awards. One is the predoc fellowship for for grad students advanced to candidacy, and the other is a postdoc fellowship.
- **NSF Graduate Research Fellowship**
  Students can apply as undergraduate seniors, and as doctoral students within the first year and before completing the fall term of the 2nd year. Those who are US citizens, nationals, or permanent resident aliens can apply. Graduate students may only apply one time.
- **Department of Energy Scholars Program**
  The DOE Scholars Program is a department-wide program designed to create a pipeline of highly qualified talent in disciplinary fields that support mission critical areas of the U.S. Department of Energy (DOE).
- **Howard Hughes Medical Institute**
  Applications announced by the university. Students apply at the university level and if selected to advance to the next level are then invited to apply to the HHMI application system.
- **Sigma Xi**
  To become a member of Sigma Xi, the Scientific Research Honor Society you must be recommended by a current member.

Hear about a new funding opportunity?

Please email the EIS Program Coordinator.

Program Awards

EIS Student Leadership Award	EIS Student Education Award	Carruth Award
Recognizes excellence in EIS graduate students who play a leadership role within the EIS program.	Recognizes an EIS graduate student who has excelled in education. Educational excellence can be achieved in any mix of TAships, laboratory mentoring, and outreach.	Recognizes an EIS graduate student who has completed exceptional work, as demonstrated by their annual Progress Report.

Award Allocation

One award per year which includes a cash award

Award Committee

The EIS student leadership award committee will consist of 2-3 EIS graduate students and one EIS faculty member. The Program Chair and the Student Executive Committee Member will jointly nominate the members of the committee. The EIS student education award committee will consist of 1 EIS graduate student and 2 program faculty. The Program Chair and the Student Executive Committee Member will jointly nominate the members of the committees.

The award is allocated by the EIS Advisory Committee, a standing committee of four EIS faculty members that reviews the annual Progress Reports.

Award Nominees

Students can self-nominate or be nominated by others for either Leadership or Education awards. The student then writes the application. The EIS Program Coordinator will send out a request for nominations, usually in the spring semester.

All students completing Progress Reports are automatically nominated for the Carruth Award.

Award Application

Applications should not exceed one page and should describe the achievements that make the student eligible for the award.

The award application is the Progress Report submitted by each student.

Important Links

Academic Resources

Graduate College

Provides information on Graduate College policies, contacts, information about resources, deadlines, and other useful information).

Graduate Student Academic Services (GSAS)

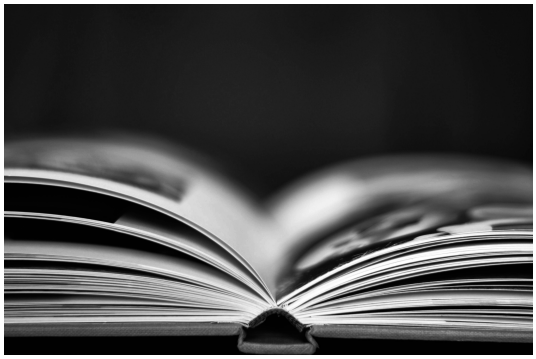
The Graduate Student Academic Services (GSAS) Office within the Graduate College is here to help students, faculty, and staff keep track of academic progress and the steps needed to complete a graduate or professional degree. Information on dates and deadlines can be found here.

Graduate Center

Serves as a hub for resources important to graduate students and postdoctoral fellows.

International Student Services

International graduate students in need of guidance, particularly in regard to travel and immigration.



UArizona Libraries

For library information, resources, and help.

Borrow Technology

Students in need of technology or equipment can check out items through the library.

University Information Technology Services (UITS)

UITS is available online to help with technology needs and support. Visit for their full range of services.

Office of Student Computing Resource (OSCR)

The Office of Student Computing Resource is now providing software assistance online. OSCR consultants can assist and guide you on how to use software to finish your projects.

Student IT Center

The Student IT Center features online learning and teaching technologies, including tools for collaboration and testing.

Writing Efficiency Sessions (WES)

WES are group writing sessions focused on productivity and output.

Summer Fellowship Application Development Program

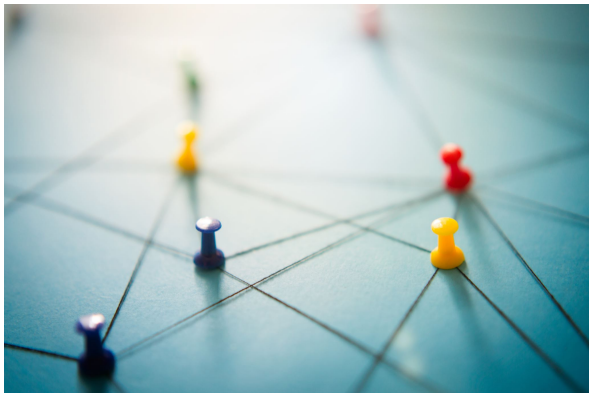
The Summer Fellowship Application Development Program offers deadlines and writing support to assist UArizona students in completing fellowship applications over the summer.

Personal Resources

Quick Link for New and Current Students

Here you will find information for:

- Academic Services, Policies and Procedures
- Costs and Funding
- Professional Development
- Child Care Subsidies and Family Friendly Information
- Health, Wellness and Safety
- Other UArizona Resources & Information
- Third-party Information & Resources



Campus Safety & Wellness

Resources to enhance students' safety and well-being. Including information on how to sign up for UA Alert to be notified of campus emergencies.

Campus Recreation

Included in your fees, it has three locations and open seven days a week.

Campus Pantry

The Campus Pantry aids students facing food insecurity. It has a new location and new hours during the current campus closure.

Campus Health

Campus Health is a one-stop-shop for health and wellness. From medical, mental health, and wellness services, to events, workshops, and student groups, they're here to support all students.

Counseling and Psych Services (CAPS)

Whether you're ready to start counseling or medication, have a question, seeking community, want to learn new skills, or just need to vent, there's a path for you. CAPS services are available to all enrolled University of Arizona students.

At Counseling and Psychiatric Services (CAPS) students can speak with licensed mental health professionals about things like:

- anxiety and depression
- eating and body image
- alcohol and drug concerns
- family, friend, roommate, and relationship problems
- sexual assault and relationship violence
- crises and trauma
- psychiatric medication
- And anything else you need to talk about.

Please call CAPS prior to going into the office. CAPS Main phone: 520-621-3334

Entomology & Insect Science Resources

Keys

Talk to your advisor about the keys you will need. If you are based in Marley, you will need to register a 4-digit pin to get into the building. To do this, send an email to Mike Riehle and he will send your email address to the Security company. You should then get a link that will enable you to set up your pin. Physical keys will be necessary for your laboratory and potentially office space.

Your advisor can tell the Entomology Dept. administration (currently Nirka Green) that you need a key to a particular room, and with the authorization you will receive, you can make the trek to the Key Desk north of Speedway to get keys.

Lab/Office Space

Your supervisor will assign you bench space in their laboratory. Students conducting research rotations may not be assigned individual bench space and instead may be assigned shared lab space for the duration of the rotation.

Your supervisor may also assign office space if there is some available. If your supervisor does not have adequate office space available, contact the **EIS Program Coordinator** for assistance.

University of Arizona Insect Collection (UAIC)

Over one million pinned and identified insects are curated in the University of Arizona Insect Collection (UAIC) located in Forbes building Room 410, next to the front offices of the Department of Entomology. The UAIC is a valuable resource for insect-related research projects and it is a great place to deposit voucher specimens resulting from your research.

Contact **Dr. Gene Hall** (Collection Manager) for more information about the UAIC.

Meeting rooms

The 7th Floor Meeting Room (Marley 741H), Entomology Classroom (Forbes 412) and Entomology Library (Forbes 403E) can be reserved by phoning the Entomology office staff (621-1151), or by emailing **Nirka Green.**

Seminars

Entomology & EIS: Fridays at 11:00 am in the Marley 230 Lecture Hall. Fall semester only.

Ecology & Evolutionary Biology: Mondays at 3:00 pm and Tuesdays 12:30 pm

Listservs

As an EIS graduate student, you are automatically subscribed to the EIS student listserv: **eis-students@list.arizona.edu**. You can email the address to send messages to all program students.

eis-faculty@list.arizona.edu is the listserv for all EIS faculty members.

ent@list.cals.arizona.edu is the listserv for all Entomology faculty and staff. Email **Nirka Green** to be added.

eeb@list.arizona.edu is the Department of Ecology and Evolutionary Biology. How to join: **instructions**

Graduate Student Learning Outcomes Assessment

As part of the accreditation process, and to measure whether students are achieving the learning outcomes desired, every academic program must have a "learning outcomes assessment." It is important to stress that this assessment is *not* used to grade or judge the student; instead, the responses are used by the Chair and Executive Committee to analyze patterns of strengths and challenge areas for students *across the program.* Based on the abstracted, anonymous data, the faculty may then make changes to the program to address any issues that need to be addressed through the curriculum. In 2023, upon consultation with the Office of Instruction and Assessment, the Executive Committee of the EIS Program revised the Assessment Rubric consistent with the goals of the program. Specifically, a quantitative 5-point scale for proficiency for learning outcomes was replaced by qualitative responses (by faculty) and self-reflection prompts (for students), more appropriate for a program with ~25-30 MS and PhD students.

MS Assessment

MS students will complete a self-reflection survey after:

Final thesis defense

PhD Assessment Activities

PhD students will complete a self-reflection survey after each of the following:

- Oral comprehensive exam
- Final dissertation defense

The EIS program has three learning outcomes. The first asks about the student understanding of insect biology (content learning outcome), the second asks about whether the student can think critically and creatively to perform and analyze research (the research learning outcome) and the third asks whether the student can communicate the research findings and the context for the research (the communication outcome). At a MS final defense, the student will be asked to reflect on their strengths and weaknesses with respect to all three learning outcomes. At a PhD oral comprehensive exam, the student will be asked to reflect on their mastery of discipline content (learning outcome 1). At the PhD final dissertation defense, the student will be asked to reflect on their research and communication skills (learning outcome 2 and 3).

Expected Student Learning Outcomes

1. **Discipline content:** The student demonstrates understanding of key concepts in insect biology as well as those underlying their general subject area (e.g. physiology, molecular biology, genomics, ecology, systematics, evolution or behavior).

2. **Research:** The student exhibits a) critical thinking skills to evaluate the scientific literature and articulates how their research fits into and advances the discipline. The student b) develops creative and innovative research ideas and approaches. The student c) uses multiple research approaches to collect scientific data related to their research area, and can interpret, analyze and critique their data.

3. **Communication:** The student communicates their research (importance, approaches taken, summary and interpretation of results) effectively through oral presentation and can express the potential impact of their work on society in lay terms.

Appendix 1: Student Appeals

All students of the EIS GIDP have the right to appeal decisions which impact their academic standing.

Graduation Requirements

Appeals for changes in the graduation requirements can be made to the Program Chair and will be considered at the next Executive Committee meeting.

Course Grades

University policy for grade appeals can be found under Grade Appeal in the **University's General Catalog**.

Unsatisfactory Academic Progress

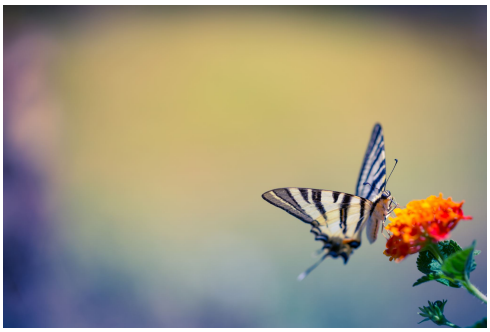
Students who receive notification of unsatisfactory progress from the Advisory committee will be given an opportunity to appeal the actions and/or deadlines required to prevent program termination as dictated by the committee. Appeals can be made to the Program Chair and will be considered at the next Executive Committee meeting.

In any case, should a student feel that there is a conflict of interest that may interfere with the objective review of their appeal, this issue should be raised with either the Program Chair or the Program Coordinator.

Grievance Policy

Should a graduate student feel he or she has been treated unfairly, there are a number of resources available. With few exceptions, students should first attempt to resolve difficulties informally by bringing those concerns directly to the person responsible for the action, or with the student's graduate advisor, the department head, or the immediate supervisor of the person responsible for the action. If the problem cannot be resolved informally, the student may be able to file a formal grievance.

For additional information: https://grad.arizona.edu/policies/academic-policies/grievance-policy#grievance-responsibility



Appendix 2: Progress Report Format

Note: Progress Report Format is subject to change – when completing your report, use the format provided by the Program Coordinator in the spring semester.

THE UNIVERSITY OF ARIZONA
Entomology & Insect Science
Graduate Interdisciplinary Program

MS Annual Progress Report 2022-2023

Graduate Student Name: Click or tap here to enter text. **Major Advisor Name:** Click or tap here to enter text.

Arrival term: Click or tap here to enter text. **Expected graduation term:** Click or tap here to enter text.

Your current grade point average: Click or tap here to enter text.

The names of the members of your graduate committee (if you have one)
Click or tap here to enter text.
Click or tap here to enter text.
Click or tap here to enter text.
Click or tap here to enter text.
Click or tap here to enter text.

The last time your graduate committee met (if they have met)
Click or tap here to enter text.

Do you have a committee meeting planned or scheduled?) ☐ Yes | ☐ No
If yes, when?
Click or tap here to enter text.

GradPath form progress
MS students have 4 required GradPath forms.

MS - Entomology & Insect Science (Active in Program)
Responsible Conduct of Research Statement (EISMS)
Plan of Study (EISMS)
Master's/Specialist Committee Appointment Form (EISMS)
Master's/Specialist Completion Confirmation (EISMS)

Have you completed your Plan of Study
☐ Yes | ☐ No

If yes, is it up to date?
☐ Yes | ☐ No

What is your next GradPath form to complete?
Click or tap here to enter text.

1. A paragraph summary of the thesis research project (even if preliminary). **Please write this for educated non-specialists (i.e. not just for your advisor).**

This section has been variable in quality - use this as an opportunity to really think about your research and how you'd describe it to a non-specialist.

Click or tap here to enter text.

MS Annual Progress Report (page 2)

2. Goals of the past calendar year (from last year's report), and a discussion of how those goals were met, or not met, and if the latter, why not.

If you are a first-year student, or haven't submitted one of these before, you may have to think back on what your goals were and do what you can to recreate them.

Click or tap here to enter text.

3. Goals for the next twelve months. These should be two to five concrete statements and should include research objectives as well as other aspects of progress in your program.

(Some hypothetical goals for different students could be: Form a committee and have a committee meeting, Collect a second season of field data on the influence of pollinators on nectar microbiome, Finish coursework requirements, or Submit draft of master's thesis to committee). Try to make them realistic, because these goals will be measured against your progress at the end of next year.

Click or tap here to enter text.

4. Other things that you think pertinent.

Click or tap here to enter text.

5. A current 2-page CV. Should include contact information, education, experience (academic work/research/teaching), awards and honors, service/activities, outreach, presentations, and publications.

There is no prescribed format - you can use the format you prefer. You may want to go over your CV with your advisor to make sure it's clear, concise and lists everything important.

When you're done, please highlight (with the Microsoft Word highlight function, with an asterisk or in bold) the awards, presentations, TAs, or publications *of the past year*.

THE UNIVERSITY OF ARIZONA
Entomology & Insect Science
Graduate Interdisciplinary Program

PhD Annual Progress Report 2022-2023

Graduate Student Name: Click or tap here to enter text. **Major Advisor Name:** Click or tap here to enter text.

Arrival term: Click or tap here to enter text. **Expected graduation term:** Click or tap here to enter text.

Your current grade point average: Click or tap here to enter text.

The names of the members of your graduate committee (if you have one)
Click or tap here to enter text.
Click or tap here to enter text.
Click or tap here to enter text.
Click or tap here to enter text.
Click or tap here to enter text.

The last time your graduate committee met (if they have met) Click or tap here to enter text.

Do you have a committee meeting planned or scheduled?) ☐ Yes | ☐ No
If yes, when? Click or tap here to enter text.

Number of Dissertation (EIS 920) units completed.
Click or tap here to enter text.

Have you met your speaking requirement?

☐ Yes | ☐ No Click or tap here to enter text.

PhD students are expected to give two research talks following completion of their comprehensive examination, at least one on campus.

Have you met your 1 semester teaching requirement, or equivalent?

☐ Yes | ☐ No Click or tap here to enter text.

PhD students must complete at least one semester of a Teaching Assistantship.

Note: Close to finishing students whose committee has not insisted on a teaching experience and/or speaking experiences may be exempt but let us know anyway.

GradPath form progress
PhD students have 9 required GradPath forms.

PHD - Entomology & Insect Science (Active in Program)
Responsible Conduct of Research Statement (EISPHD)
Plan of Study (EISPHD)
Comp Exam Committee Appointment Form (EISPHD)
Announcement of Doctoral Comprehensive Exam (EISPHD)
Results of Comprehensive Exam (EISPHD)
Doctoral Dissertation Committee Appointment (EISPHD)
Prospectus/Proposal Confirmation (EISPHD)
Announcement of Final Oral Defense (EISPHD)
Results of Final Oral Defense (EISPHD)

Have you completed your Plan of Study?
☐ Yes | ☐ No

If yes, is it up to date?
☐ Yes | ☐ No

Have you passed your comprehensive examinations?
☐ Yes | ☐ No

What is your next GradPath form to complete?

Click or tap here to enter text.

PhD Annual Progress Report (page 2)

1. A paragraph summary of the dissertation research project (even if preliminary). **Please write this for educated non-specialists (i.e. not just for your advisor).**

This section has been variable in quality - use this as an opportunity to really think about your research and how you'd describe it to a non-specialist.

Click or tap here to enter text.

2. Goals of the past calendar year (from last year's report), and a discussion of how those goals were met, or not met, and if the latter, why not.

If you are a first-year student, or haven't submitted one of these before, you may have to think back on what your goals were and do what you can to recreate them.

Click or tap here to enter text.

3. Goals for the next twelve months. These should be two to five concrete statements and should include research objectives as well as other aspects of progress in your program.

(Some hypothetical goals for different students could be: Form a committee and have a committee meeting, Collect a second season of field data on the influence of pollinators on nectar microbiome, Finish coursework requirements, or Submit draft of master's thesis to committee). Try to make them realistic, because these goals will be measured against your progress at the end of next year.

Click or tap here to enter text.

4. Other things that you think pertinent.

Click or tap here to enter text.

5. A current 2-page CV. Should include contact information, education, experience (academic work/research/teaching), awards and honors, service/activities, outreach, presentations, and publications.

There is no prescribed format - you can use the format you prefer. You may want to go over your CV with your advisor to make sure it's clear, concise and lists everything important.

When you're done, please highlight (with the Microsoft Word highlight function, with an asterisk or in bold) the awards, presentations, TAs, or publications *of the past year*.

Appendix J1. University of Arizona Insect Collection (UAIC)

The University of Arizona Insect Collection (UAIC) is one of the largest, oldest and most diverse arthropod museums for the Sonoran Desert Region. It houses over two million research specimens, 83% of which are identified to the species-level, representing an estimated 35,000 species, The UAIC has a rich history, is highly active, and has a bright future as an important provider of biodiversity data, well-curated specimens, and in-depth expertise for students, researchers, educators, and the public, as evidenced by our strong record and growing achievements in research, service, and education.

The UAIC is administered by the Department of Entomology in the College of Agriculture and Life Sciences and is viewed as an integral part of this Land Grant University. It is secured by a long-term commitment of the University of Arizona and its many dedicated associated systematists. Today, the UAIC is fortunate to have an excellent team of dedicated personnel. We have nine "staff" members: the Curator (PI, W. Moore), Collection Manager (G. Hall), an IT specialist (R. Zimmerman), a photographer (C. Martinez), four graduate student curatorial assistants (D. Bergamaschi, C. Bradley, R. Ikagawa, J. Montoya), and three undergraduate research assistants (T. Bland, O. Husok, and J. Simon). The Curator is a tenured associate professor with a 50% research, 20% curation, 15% teaching, 15% service split. The Collection Manager is full-time staff with a 50% collection management, 50% extension split, The IT specialist is a volunteer, and the photographer is 0.49 FTE temporary position. Graduate students are not paid specifically to work in the UAIC but have volunteered large amounts of time for curation of particular groups, outreach programs, and assisting visiting researchers. Undergraduates serve crucial roles in maintaining the UAIC, including freezing drawers, preparing specimens, photographing specimens with their labels, and assisting with other maintenance duties. Further, we are extremely fortunate to have an endowment to offset expenses for visiting systematists to work in the UAIC on their specialty group during their sabbatical leave. This unique endowment helps to ensure the vitality and growth of the UAIC in perpetuity.

In addition to the regular "staff" noted above, several systematists are officially associated with the museum and the Department of Entomology and regularly help with the curation of particular groups. These include Drs. Kim Franklin (Formicidae), Michael Irwin (Therevidae), Tristan McKnight (Asilidae) and Ed Pfeiler (Lepidoptera), Over the past 15 years, over 40 other experts have volunteered their time and knowledge to help curate their specialty groups. These researchers continue a rich tradition of systematics that inspires students and all users of UAIC– extension agents, museum staff, researchers, and members of the public. Because our active community spans many generations, we provide an exceptionally rich environment for nurturing an understanding of the scale and importance of biological diversity.

The quality of the curation in terms of the percentage of specimens identified to the species level is high. The Smithsonian Institution's curation assessment method, known as the McGinley system (McGinley, 1993), works by assigning a numerical curation code (1-8) to the basic units used in insect collections. These are: Level 1- conservation problem; Level 2- unidentified unsorted material, sorted only to major groups (usually family); Level 3- unidentified material, sorted to "loan-able units" (usually genus); Level 4- material identified to species level but not incorporated into main collection; Level 5- identified and integrated material which is inadequately curated; Level 6-identified, integrated, and adequately curated; Level 7- physical curation complete, species-level inventory complete; and Level 8: physical curation complete, individual specimen label data captured, Overall, in 2011 at the time we submitted our last NSF CSBR proposal, 83% of the collection was curated at McGinley level 7. Post-renovation, **collection use has more than doubled** (*Table 1*) and the increase in the number of systematists living in southern Arizona who wish to deposit their collections in the UAIC has been overwhelming (*Table 2*) We have recently been offered several substantial, new donations which we anticipate will arrive within the next three years, largely of insect pollinators.

Table 1. Activity of the UAIC before and after 2012-14 renovations, A = number of visitors, B = number of specimens donated.

	A	B
Covid years		
2019	300	15K
2018	465	13K
2017	355	27K
2016	370	10K
2015	400	15K
2012-14 UAIC Renovations		
2011	176	5K
2010	215	17K
2009	175	3K
2008	180	3K
2007	154	3K

Table 2. Sizable donations already incorporated after 2012-14 renovations. A= name of donor and taxa donated, B= number of drawers, C= percent at McGinley Level 7 or greater. SASI=Sonoran Arthropod Studies Institute.

A	B	C
SASI, all	50	75%
Pape, all cave fauna	60	100%
McCleve, beetles	50	100%
Smith, beetles	24	100%
O'Brien, weevils (syn)	5	100%
Lingafelter, longhorn beetles	5	100%
Woodley, jewel beetles	5	100%
Botz, true bugs (syn)	5	100%
O'Brien, true bugs (syn)	1	100%
King, bees	5	100%
Menke, wasps (syn)	1	100%
ASDM, bees	10	100%
Watkinson, leps	40	100%
Melton, leps/bees	30	100%

The UAIC user community is diverse, ranging from outstanding undergraduate students to highly active emeritus insect systematists. Annually, we host thousands of visitors, ranging from resident researchers to individual walk-ins, campus tour groups, and vast numbers of people seeking information on the biology of the region. These visits illustrate the high profile and vibrant nature of UAIC, which complement our unique biological collections. The University of Arizona has one of the highest concentrations of insect scientists in the country and most of them use the UAIC in conjunction with research and outreach programs, Approximately 200 researchers, including faculty, staff, research associates, postdoctoral fellows and students distributed across 14 UA departments work on various aspects of insect science.

The UAIC Facilitates Collections-Based Research

The UAIC is a very active research collection. During the past ten years, it has averaged 10 loans to researchers annually, Prior to the 2012-14 renovations the UAIC received between 150 and 200 research & public visitors per year; since then, these numbers have doubled (see Table 1), This high rate of visitation is due in part to improved visitor resources following our last CSBR award and in part to our location in the megadiverse Sonoran Desert Region, which attracts researchers from around the world, Many researchers also visit the UAIC as they pass through Tucson to collect in the Madrean Sky Islands of the southwestern US and northern Mexico, and/or to participate in one of the intensive summer courses on insect systematics offered at the American Museum of Natural History's Southwest Research Station (SWRS) in Portal, Arizona each year, such as the Ant Course, the Bee Course, Beetle Course, and the Lepidoptera Course.

The deserts of the southwestern US and northwestern Mexico are fast becoming the research focus of many ecologists and conservation biologists because they are among the areas most impacted by climate change, population growth, and expanding human land (and water) use in North America (Sala et al. 2000; Smith et al. 2000), The University of Arizona is home to the USA National Phenology Network. Working under the motto that "changes in phenology are the "fingerprint" of climate change," the USA

National Phenology Network research team is particularly interested in tracking changes in the phenology of flowering plants and their insect pollinators (especially in agricultural settings). Pollination by native insects contributes more than $3 billion in agricultural crops each year. Metadata on specimens of insect pollinators provide a valuable window into the past to determine if and how much pollinator phenology has changed over the years.

Since 2013 we have digitized 130,733 UAIC specimens, Specimen-level data are captured in a two-step process. First, we photograph the specimen and all associated labels, including the unique UAIC specimen number, in a single shot using USB camera and 3D printed led dome light (designed and 3D printed by Charles Bradley, current Moore Lab PhD student), Each photograph is named with the unique UAIC specimen number. An associated Excel file tracks the unique specimen number, image, and taxonomic data associated with the specimen. Although our specimen-level data will be managed by Ecdysis, we will continue to share our data with SCAN, iDigBio, and GBIF. Fortunately, the Extended Specimen Network functions implemented in the new version of Symbiota that powers Ecdysis will allow us to easily link our pollinator specimen records to the Barcode of Life Database (BOLD) and to their host plant species (and host plant specimen when available) in SEINet thus making formal associations between these two large Symbiota database networks which will promote future digitalization and pollinator-plant research,

As part of our current NSF-funded project we are digitizing 44,200 additional specimens from UAIC holdings of insect pollinators, including 30,000 specimens of native bees (Hymenoptera: Apoidea: Anthophila), 1,100 hawk moths (Lepidoptera: Sphingidae), 3,100 brush-footed butterflies (Lepidoptera: Nymphalidae), 4,600 bee flies (Diptera: Bombylidae), 4,700 hover flies (Diptera: Syrphidae), and 700 thick-headed flies (Diptera: Conopidae).

The UAIC is the Cornerstone of Insect Diagnostics

The UAIC is an invaluable resource for Cooperative Extension, especially in support of our integrated pest management (IPM) programs. Accurate and timely arthropod identifications are critical to IPM decision-making in urban, agricultural, and natural settings. Statewide stakeholders who benefit from timely and accurate diagnostics include growers, pest control advisors, county extension agents, master gardeners, landscape professionals, park managers, turf managers, poison control, and homeowners, Collection manager Gene Hall is responsible for arthropod diagnostics in support of IPM at UA, Each year he responds to over 500 arthropod samples or electronic queries submitted by stakeholders to the UAIC.

Reliable, rapid, species-level identification of insect specimens is critical to making science-informed decisions aiding conservation efforts for our native pollinators, and much more. UAIC is obtaining and publishing sequence data that will allow for rapid DNA-based identification of all pollinators from the Sonoran Desert and Madrean Sky Island Regions and will house the associated voucher specimens in perpetuity. We are making sequences from our expertly-identified museum specimens publicly and freely available in the Barcode of Life Database (BOLD) to enable success of future biotic surveys and monitoring projects in the region. These data will also increase the resolving capacity and power of future research efforts using environmental DNA (eDNA), Unlike traditional biodiversity assessment methods, where captured or recorded individuals are used to determine presence or abundance, eDNA-based biodiversity assessment relies on our ability to capture the genetic signature left behind by organisms (shedding, excreting, decaying, feeding etc.). Several studies have already successfully shown that eDNA can be a highly accurate biomonitoring tool. However, this potential is dependent on our ability to accurately match the left-behind genetic signatures to the correct species, which is achieved by comparing the short sequences found in an environment with DNA from expertly-identified voucher specimens.

Once a barcode reference library for pollinators in the region is complete, researchers will be able to track pollinator health without the need for time-intensive manual inventories and even to molecularly identify which insects pollinate rare and endangered plants simply by sampling eDNA left on flowers themselves.

The UAIC Contributes to Formal Classroom Teaching

The UAIC is a key resource for several of our core courses, Students make their own insect collections in Insect Biology (ENTO 415), which is a required course for the minor in Entomology and the Undergraduate Certificate in Entomology, and in our upper division Insect Systematics course EIS 517. These courses as well as the Insect Discovery course make use of our extensive teaching collection of insects maintained by the UAIC.

TUCSON BEE COLLABORATIVE. In 2019 Curator Moore (UAIC), Dr. Kimberly Franklin (Conservation Scientist at the Arizona-Sonora Desert Museum, ASDM) and Jennifer Katcher (General Biology Instructor at Pima Community College) co-founded the Tucson Bee Collaborative (TBC). In 2021 the TBC was recognized by UA as a Vertically Integrated Project (VIP). VIP's are transformative approaches to enhancing higher education by engaging undergraduate and graduate students in ambitious, long-term, large-scale, multidisciplinary project teams led by faculty, Course-based undergraduate research experiences (CURE) are being developed and being offered through the Tucson Bee Collaborative. CURES allow students to conduct real research within the context of a formal course, through which they produce data that have broad scientific and societal relevance. They have a proven, positive impact on student learning and retention, problem-solving skills, solidification of their identities as scientists, and increase their likelihood of obtaining a college degree in a STEM discipline. The Tucson Bee Collaborative VIP and related CUREs can help to address several of the greatest challenges to human health and food security. All TBC CUREs center on specimen-based research on pollinators and the importance of natural history collections for studying biodiversity. Founded on the principle that well-curated natural history collections have always been, and will always be, the foundation of modern biology, the UAIC plays a central role in the Collaborative. Our students will learn cutting-edge skills in DNA analysis and digital imaging that will enable them to lead the 4th industrial revolution. Each student adopts a UAIC insect specimen, extracts DNA, sets up and runs a PCR, runs a gel, and learns to view, edit, and align DNA sequence data. This provides an experience-based understanding of the utility of DNA sequence data for identifying species and inferring evolutionary relationships as well as the opportunity to be a published scientist on the Barcode of Life Database (BOLD) and present their research to their peers and broader community in poster symposiums. The skills students learn in the process of DNA barcoding offer a unique foundation for a wide variety of jobs in biotechnology. A key Arizona Advantage of this project is that Arizona has the highest diversity of bees of any state in the US, which helps position UA as a global leader in documenting, understanding, and protecting pollinators. Building on our excellent track record of recruiting and retaining female and Hispanic-American students, we will continue to actively recruit students from groups that have been underrepresented in STEM. To date we have served over 340 PCC students and 25 UA students. All CURE students visit the UA campus to tour the UAIC and Dr. Moore's molecular laboratory (located in building next door to Forbes). Students are not only taught the importance of natural history museums in documenting the flora and fauna of the biodiversity hotspot in which they live, they are also provided an opportunity to engage in hands-on collections-based research themselves.

By involving college students in the process of obtaining and publishing the DNA barcode data, we are helping to train the future environmental workforce. Through our network of CUREs, undergraduate and graduate students build community connections, obtain biotechnology skills, and come to understand the importance of specimen-based research and natural history museums. We are thus documenting the morphological and genetic diversity of our native pollinators, while simultaneously building resources for rapid, reliable species-level identification and creating a standardized baseline for future monitoring of

changes in native bee diversity in the region, The project is also establishing a systematic and genetic foundation necessary for a myriad of hypothesis-driven research questions related to pollinators, food security, and effects of climate change in the Southwestern United States being addressed by students in the TBC-VIP,

Insect displays conceived and produced by Fall 2022 Insect Systematics students.

Insect specimens were collected, curated, and identified by students as part of the course's insect collection assignment. Students then arranged their specimens around original drawings (made by one of the students) that covered the bottom of a glass-covered insect display case. One display features pollinators of specific plants, and the other features habitats where various insects are found around the Las Milpitas farm. At the end of the semester, these displays were given to Las Milpitas de Cottonwood, a farm run by the community Food Bank of Southern Arizona.

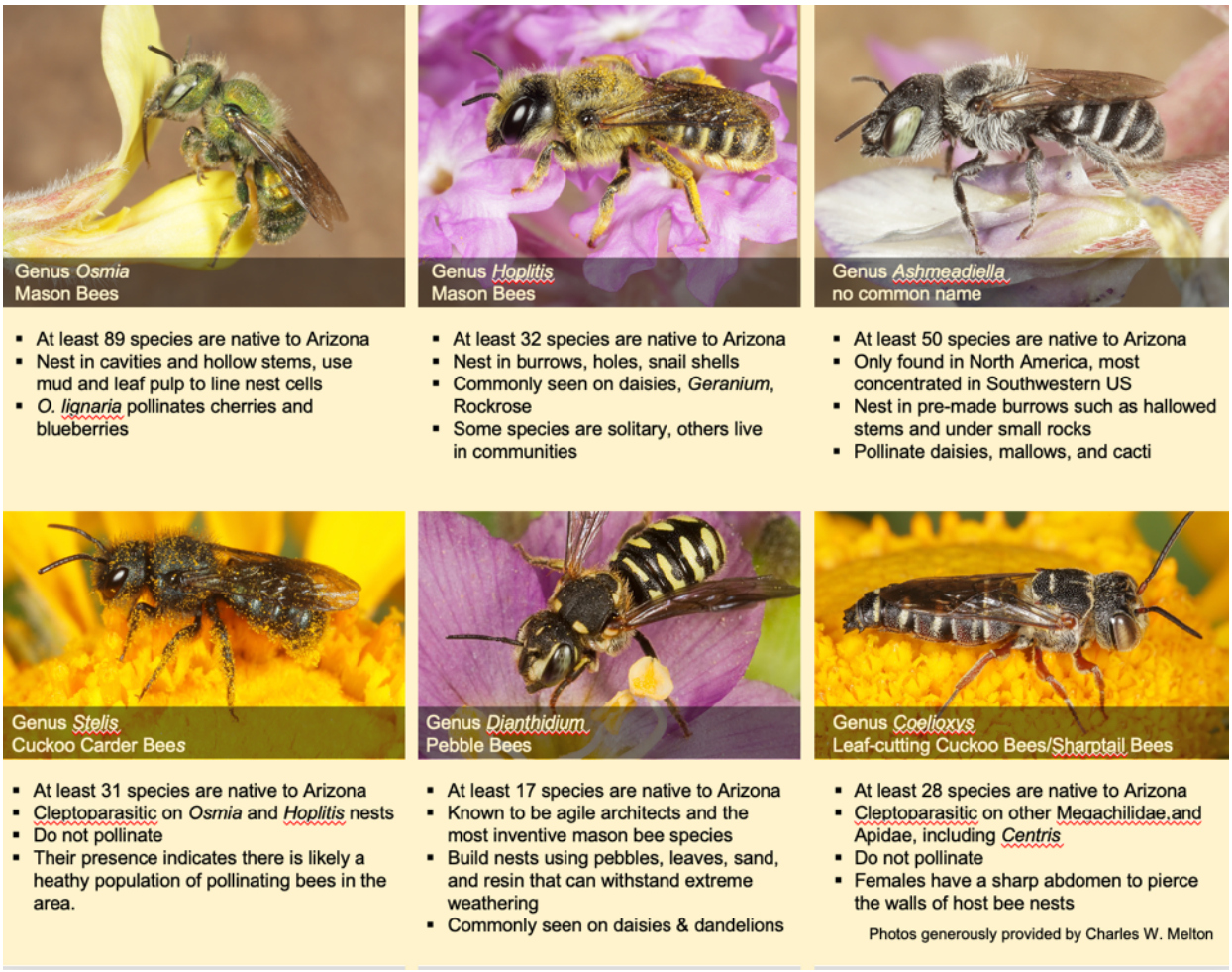

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Entomology
Insect Collection


Las Milpitas


Las Milpitas de Cottonwood
A COMMUNITY FARM
WELCOME!
Las Milpitas is a community farm that provides educational opportunities, capacity building, and a place for area residents and students to grow their own food. It also serves as a working demonstration ...te in desert food production, composting, ecological restoration, and permaculture for the greater Tucson community.
¡BIENVENIDOS!
Las Milpitas es un espacio comunitario el cual provee oportunidades educativas, incrementa la capacidad comunitaria de autogestión, y es un lugar en donde los residentes locales y estudiantes pueden cultivar sus propios alimentos. También sirve como espacio de demostración sobre la producción de alimentos, compost, restauración ecológica, y permacultura en beneficio de la comunidad de Tucson.
Community Food Bank of Southern Arizona
CITY
APOYAMOS
¡JUSTICIA PARA TODOS!

Outreach flyer conceived and produced by Spring 2023 Discovering Biodiversity (CURE) students.

Our students' course-based research projects focused on several genera of leaf cutter bees (family Megachilidae). In the process of researching them, the students discovered the importance of native pollinators such as wild bees. They produced this trifold flyer as a product of the course. We passed these out to the public at various outreach events, including at the Arizona-Sonora Desert Museum's "Insect Mania" night July 8, 2023.



The UAIC Contributes to other Outreach Initiatives of the Entomology Department

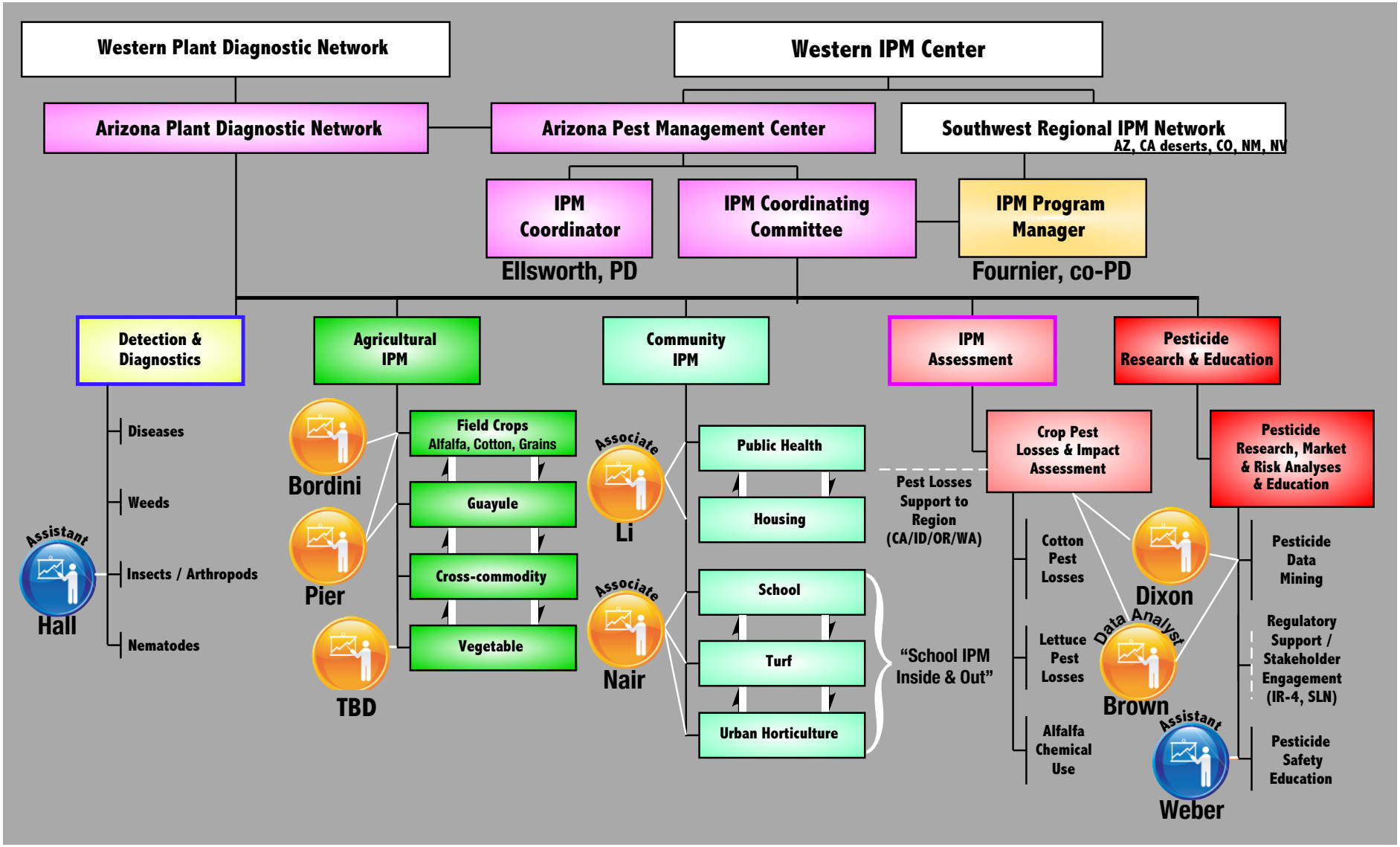
The UAIC serves as an important resource for interactions between the Department of Entomology, EIS students and the public, Students and staff create artful, educational displays of specimens shown at the annual Arizona Insect Festival, in the Insect Discovery Program and in other classroom visits to both Tucson area schools and UA classrooms. EIS students are involved in the frequent tours of the UAIC, for example during the Festival of Books, for the Undergraduate Biology Research Program (UBRP) students, and for community groups. EIS students are also involved with UAIC staff in helping to provide the public and agencies with identifications of arthropods associated with homes, gardens, crops, livestock, forensics, and venomous attacks,

THE INSECT DISCOVERY PROGRAM. In Arizona, state science teaching standards recommend that insects be a component of the elementary school science curriculum. In the Tucson Unified School District insects are the central focus of the second-grade life sciences curriculum. The UA Insect Discovery Program provides classroom visits and UA campus workshops to help teachers make the most of their students' fascination with insects. Last year Insect Discovery completed its 16th year of activities, during which it served over 3000 K-12 students from 30 local schools, well over half of which are Title 1 schools, many of which have over 50% minority enrollment. UAIC graduate and undergraduate students participate in classroom visits and workshops and in return they receive course credit as well as training

and experience in communicating science. Each visit and workshop use pinned insect collections for activities that explore insect diversity and classification. Since young children handle these fragile, dried insect collections, the UAIC supplies Insect Discovery with fresh, pinned specimens each year.

THE ARIZONA INSECT FESTIVAL, In 2011 the UAIC organized and helped sponsor the first Arizona Insect Festival, which took place in the center of the University of Arizona campus. Now in its 11th year, the festival delights over 5000 visitors from the Tucson community who attend the festival annually. In addition to contributing its own booth, the UAIC provides many outreach displays for many of the other booths at the Arizona Insect Festival each year.

Appendix J2. University of Arizona IPM Program Organization



Appendix J2. University of Arizona IPM Program Organization

*Blue text denotes current Entomology faculty

1. Western IPM Center (WIPMC)
Funded (1 of 4) by USDA-NIFA
Administered by UC-Davis, Baur, Director
Ellsworth, one of four Co-Directors

2. Southwest Regional IPM Network
Information network funded through WIPMC Signature Program (2012 – 2026)
Competitive grant subaward – Ellsworth & Fournier (co-PIs)
Fournier, Network Coordinator
Scope: AZ, CO, NM, NV and arid desert region of CA

3. Arizona Pest Management Center (APMC)
Founded in 2003 by UA-IPM (3-d) as proposed by Ellsworth, Palumbo, Baker & seeded by UA-Cooperative Extension Statewide Initiative. Since 2009, has thrived on a series of competitive institutional USDA-NIFA grants (Ellsworth & Fournier, CoPIs). The APMC synergizes the full set of University of Arizona research and Extension resources involved in IPM in Arizona. Base funding is highly leveraged and provides foundational capacity for stakeholder engagement, IPM program delivery and measurement of outcomes.

4. IPM Coordinator
Nominated by IPM Coordinating Committee, appointed by UA Extension Director, currently Ellsworth
IPM Coordinating Committee Chair
Representative to WERA-069, the regional coordinating committee for IPM in the West
Reporting requirement to USDA-NIFA

5. IPM Coordinating Committee
20-member committee with broad representation of IPM interests in Arizona
Oversight of IPM Programs
Approve APMC budgets
Baur (ex-officio), Birkemeyer (stakeholder), Dias, Ellsworth (Committee Chair, team leader), Evans, J. (stakeholder), Evans L. (stakeholder), Farrar (stakeholder), Frisvold, Gouge (team leader), Hu, Johnson (ex-officio), Montoya (stakeholder), Mostafa, Norton, Orr (ex-officio), Palumbo (team leader), Peterson (stakeholder), Poudel-Ward, Richardson (stakeholder), Schuch, IPM Program Manager & Associate Director, APMC (Fournier)

6. IPM Program Manager
Al Fournier
Associate Specialist, non-continuing (80% Extension, 10% Research, 10% Service)
Stationed at Maricopa Ag Center; supported by EIP, state funds, and grants
Supports IPM programs & faculty (evaluation, needs assessment, grant support, coordination)

7. Program Focus: Agricultural IPM (Ellsworth & Palumbo, focus leaders)

Consists of programmatic teams of County, Departmental and Ag. Center faculty

a. Cotton & Guayule – Ellsworth (team leader), Bordini & Pier (staff)
b. Cross-commodity Research & Outreach Program – Ellsworth / Palumbo (team leaders)
c. Vegetables – Palumbo (team leader), staff position vacant

8. Program Focus: Community IPM (Gouge, focus leader)

Supporting needs of diverse and underserved communities, including issues of public health, food safety and resilience

a. Public Health & Housing
- Food Safety – Rock (team leader), Li (staff)
- Vector Management – Gouge & Walker (team leaders), Li (staff)
- Housing – Gouge (team leader), Li (staff)

b. School IPM Inside & Out (includes buildings, turf & landscape) – Gouge (team leader), Nair (staff)

9. Program Focus: IPM Assessment (Fournier, focus leader)

Continuing need of all IPM programs & priorities identified by Federal IPM Roadmap

a. Crop Pest Losses & Impact Assessment

Funded by WIPMC Signature Program to Ellsworth & Fournier + leveraged resources
- Cotton Pest Losses – Ellsworth (leader), Pier & Bordini (staff)
- Lettuce Pest Losses – Palumbo (leader)
- Regional outreach on diverse crops – Ellsworth (leader) Fournier (support)

10. Program Focus: Pesticide Research & Education (Fournier, focus leader)

Consists of pesticide-related programs of research and outreach, including work impacting public policy

a. Pesticide Research, Marketing & Risk Analyses, & Education
- Pesticide Data Mining – Fournier (team leader), Dixon & Brown (staff)
- Regulatory Support / Stakeholder Engagement
  - IR-4 (registration support for specialty crops) – Palumbo (state liaison)
  - Pesticide Registration Review – Fournier (leader), Dixon (staff)
- Pesticide Safety Education – Weber (leader)

11. Western Plant Diagnostic Network (WPDN)

Funded (1 of 5) by USDA-NIFA to facilitate coordination of diagnostics activities between USDA, land grant institutions, and state departments of agriculture
Administered by UC-Davis, McRoberts & Brenes-Arguedas, Co-Directors

12. Arizona Plant Diagnostic Network (AzPDN)

Facilitates coordination of in-state diagnostic activities related to regulation and early detection and links local diagnostic labs to regional and national networks (Hu, leader)

13. Program Focus: Diagnostics and Detection

Consists of diagnostics labs and Specialists throughout the state that provide pest diagnostic services to facilitate IPM decision making in urban, agriculture and natural environments

a. Plant disease diagnostics – Hu (Plant Sciences) & Poudel-Ward (Yuma CE)

b. Weed diagnostics – Dias (Plant Sciences)

c. Insect diagnostics – Hall (Entomology), Coordinator, UA Insect Collection (Moore & Gouge, co-leaders)

d. Nematode diagnostics – un-filled

(rev. 8/2023)

Appendix J3

IPM Coordinating Committee Membership
September 2023

Name	Dept. / Affiliation	Location
Peter Ellsworth, Chair & IPM Coordinator, Specialist & Professor	Entomology	Maricopa Agricultural Center Maricopa, AZ
Matt Baur, Director (ex-officio, WIPMC)	Western IPM Center	University of California Davis, CA
Keith Birkemeyer (stakeholder)	ProBest, LLC	Gilbert, AZ
José Dias (weed scientist) Assistant Specialist & Assistant Professor	Plant Sciences	Maricopa Agricultural Center Maricopa, AZ
Junior Evans (stakeholder)	Corteva	Yuma, AZ
Lin Evans (stakeholder)	Lin Evans Enterprises	Phoenix, AZ
Jim Farrar (stakeholder)	UC Statewide IPM	University of California, Davis, CA
George Frisvold Specialist & Professor	Ag & Resource Economics	UA Main Campus Tucson, AZ
Dawn Gouge, Specialist & Professor	Entomology	Maricopa Agricultural Center Maricopa, AZ
Alex Hu, Assoc. Specialist & Associate Professor	Plant Sciences	UA Main Campus Tucson, AZ
Ken Johnson, Director (ex-officio, MAC)		Maricopa Agricultural Center Maricopa, AZ
Tom Montoya (stakeholder)	Independent PCA	Gilbert, AZ
Ayman Mostafa, Area Extension Agent & Interim Director	Maricopa Co Cooperative Extension	Phoenix, AZ
Randy Norton, Area Extension Agent & Director	Safford Ag Center, Graham, Greenlee, Cochise Co Cooperative Extension	Safford, AZ
Ethan Orr, Assoc. Director, ANR Programs (ex-officio, UACE)	School of Government & Public Policy, Cooperative Extension Administration	UA Main Campus Tucson, AZ
John Palumbo, Specialist, Professor & Endowed Chair	Entomology	Yuma Agricultural Center Yuma, AZ
Jack Peterson (stakeholder)	Arizona Dept. of Agriculture	Phoenix, AZ
Bindu Poudel-Ward (plant pathologist, diagnostician)	Yuma Co. Cooperative Extension	Yuma, AZ
Jesse Richardson (stakeholder)	Corteva	Mesa, AZ
Ursula Schuch, Associate Specialist	Plant Sciences	UA Campus Tucson, AZ

Appendix J4. IPM Program Leverage of EIP Dollars (2017–2020)

The USDA-NIFA Extension Implementation Program (EIP) grant administered by the Arizona Pest Management Center of the University of Arizona was invested in two primary program areas and two secondary program areas over the last grant cycle. Over a 4-year period, those investments were leveraged 5-fold by funding secured or enabled by our IPM staff in more than 70 grants, gifts and contracts. That leveraged activity in research and Extension expenditures greatly increases the value of EIP investments made in Arizona and the scope and number of outcomes and impacts achieved by our IPM programs.

Team	Leverage	Investment	N-fold
Veg IPM	$ 1,633,536	$ 390,173	4.19
Ag IPM	$ 2,022,930	$ 339,335	5.96
School IPM, Public Health IPM, PSEP	$ 1,768,302	$ 354,452	4.99
	$ 5,424,768	$ 1,083,961	5.00

rev. 3/5/21

1. Bordini, I. & Ellsworth, P. Being Selective in IPM: Investigating Insecticide Safety to Natural Enemies and Biological Control in Cotton. 2019 Western SARE Professional Development State Program – AZ. $7,000. 5/2020 – 12/2020.
2. Bordini, I., Ellsworth, P., Fournier, A., Naranjo., S. Empowering producers to effectively integrate chemical and biological controls through research and outreach on selective chemistries and impacts on natural enemies. Western SARE graduate student grant program. $25,000. 5/2018 – 4/2019.
3. Bordini, I., Ellsworth, P., Fournier, A., Naranjo., S. Enhancing IPM by integration of chemical and biological controls through assessment of selectivity of chemistries and function of biocontrol. Western IPM Center grants program (USDA-NIFA). $30,000. 3/2018 – 3/2019.
4. Bordini, I., Ellsworth, P., Fournier, A., Naranjo., S., Richardson, J., Grettenberger, I. Being Selective in IPM: Novel Research to Reduce Risk and Advance Integration of Chemical and Biological Control. Western IPM Center grants program (USDA-NIFA). $30,000. 3/2021 – 2/2022.
5. Bordini, I., N. Dayoob. 2020. Making the Right Decisions with Predator Thresholds for Whitefly Management in Cotton (production of 2 videos). United States Department of Agriculture, Western Sustainable Agriculture Research & Extension (SARE), AZ State SARE support. $7,500. 2020.
6. Dayoob, N., P.C. Ellsworth, A. Fournier. 2020. Guayule Insect Pest Management During Stand Establishment. USDA-AMS, Specialty Crop Block Grant (AZ). $57,333. 2020-2021.
7. Dixon, W.A. & A.J. Fournier. 2019. Arizona Crop Information Site Migration Supports Arizona Agriculture. University of Arizona Cooperative Extension, Extension Strategic Initiative Program. $42,332. 3/2019 – 1/2020.
8. Ellsworth, P.C. 2014. A Western IPM Center Led by California, Arizona and Oregon. USDA-NIFA, Crop Protection and Pest Management, Regional Centers Program, subaward: Crop Pest Losses and Impact Assessment. $324,375. 1/2015 – 12/2018.
9. Ellsworth, P.C. 2014. Building Capacity for Sustainable Pesticide Safety Education in

Arizona. Crop Life America, Pesticide Safety Education Program Improvement & Modernization Initiative. $75,000. 7/2014 – 6/2017.

10. Ellsworth, P.C. 2014. Conduct Field Evaluation of Transgenic Cotton for Pest Resistance and Alfatoxin Contamination. USDA-ARS, Specific Cooperative Agreement. $50,000. 2014-2019.
11. Ellsworth, P.C. I. Bordini, N. Dayoob. Insecticide Impacts on non-target organisms in cotton. 2017 Gifts. $7,500. 2017-2018.
12. Ellsworth, P.C., A. Fournier. 2018. A Western IPM Center Led by California, Arizona, and Oregon (FY18); Signature Program Area: Crop Pest Losses & Impact Assessment; Regional IPM Information Network. USDA-NIFA CPPM Regional Coordination Program (Subaward from UC-ANR, 4 million). $335,174. 09/2018-08/2022.
13. Ellsworth, P.C., I. Bordini, N. Dayoob. 2017. Managing Insect Threats to Stand Establishing Guayule. Bridgestone. $46,000. 2017-2021.
14. Ellsworth, P.C., I. Bordini, N. Dayoob. 2018. Non-target effects of 'Lygus Bt' cotton - Functional effects of 'Lygus Bt' cotton on biocontrol services. Monsanto Company. $51,622. 2018-2019
15. Ellsworth, P.C., I. Bordini, N. Dayoob. Chemical Controls of Lygus Bugs and Whiteflies in Cotton. 2017 – 2020 Gifts. $256,600. 01/2017 – 12/2020.
16. Ellsworth, P.C., I. Bordini, N. Dayoob. Chemical Controls of sugarcane aphid in forage sorghum. 2017 Gifts. $8,000. 2017 – 2018.
17. Ellsworth, P.C., J. Palumbo, Y. Carriere, A. Fournier, W. Dixon, L. Brown, S. Castle, N. Prabhaker. “Prospective” Resistance Management: Empowering Growers to Understand and Exploit Refugia. Monsanto Insect Knowledge Management Program (competitive). $424,325. 07/2015 – 6/2018.
18. Ellsworth, P.C., S. Naranjo. 2018. Non-target and functional effects of 'Lygus Bt' cotton biocontrol services. United States Department of Agriculture, RSA contract. $104,169. 2018-2020.
19. Ellsworth, P.C., S. Naranjo. 2019. Longitudinal study of non-target and target effects of cotton insecticides in AZ & CA. United States Department of Agriculture, RSA contract. $60,000. 2019.
20. Ellsworth, P.C., S. Naranjo. 2021. Improving Insect Management Strategies in Arizona Cotton. Arizona Cotton Research & Protection Council. $20,000. 01/2021-12/2021.
21. Ellsworth, P.C., S.E. Naranjo, A.J. Fournier. 2017. Designing & Evaluating Sustainable Cotton Systems with Reduced Pest & Pesticide Risks. Cotton Incorporated. $135,000. 1/2017 – 12/2019.
22. Ellsworth, P.C., S.E. Naranjo, A.J. Fournier. 2020. Selectivity of Cotton Insecticides Drive Ecotoxicological Gains and Improve Arizona Cotton IPM. $45,000. 1/2020 – 12/2020.
23. Ellsworth, P.C., S.E. Naranjo, I. Bordini, & N. Pier. 2017. Improving Insect Management Strategies in Arizona Cotton. Arizona Cotton Growers Association. $71,717. 1/01/2017 – 12/31/2020.
24. Fournier, A., P. Ellsworth, W. Dixon, J. Peterson. 2019. Influencing Pesticide Registration Decisions for Specialty Crops. USDA-AMS, Specialty Crops Block Grant Program (AZ). $54,483. 10/01/2019-12/31/2020.
25. Fournier, A., P. Ellsworth, W. Dixon, J. Peterson. 2020. Improving Transparency of Pesticide Registration Review for Specialty Crops. USDA-AMS, Specialty Crops Block Grant Program (AZ). $55,138. 10/2020-09/2021.

26. Fournier, A., P.C. Ellsworth, J. Palumbo. 2017. Pesticide Use Data Benefits Specialty Crops. USDA-AMS, Specialty Crops Block Grant Program (AZ). $97,402. 10/2017-09/2019
27. Gouge, D. H., S. Li, S. Nair. 2020. Tribal Emergency Preparedness for Pest Outbreak Workshop. Inter-Tribal Council of Arizona, Inc. (ITCA) - Bureau of Indian Affairs Tribal Resilience Program Grant. $15,000. 2020.
28. Gouge, D. H., S. Li, S. Nair. 2019. Reducing Pests and Pest Management Related Hazards in Low-income Multiunit Public Housing – A Family and Consumer Science Application. Cooperative Extension, University of Arizona. $18,658. 03/2019 – 2/2020
29. Gouge, D. H., S. Li, S. Nair. 2021. Tribal Emergency Preparedness for Pest Outbreak Workshop. Inter-Tribal Council of Arizona, Inc. (ITCA) - Bureau of Indian Affairs Tribal Resilience Program Grant. $15,000. 2021.
30. Gouge, D. H., S. Li, S. Nair.2020. Fendona CS efficacy assessment on bark scorpions from direct contact and residual control under controlled (lab) conditions. BASF Corporation. $6,000. 07/2020 – 10/2020
31. Hall, W., P.C. Ellsworth, N. Pier, L. Abrell. 2017. Blister Beetle Impact on Specialty Crops. USDA-AMS, Specialty Crop Block Grant (AZ). $19,870. 10/2017-9/2022.
32. Hall, W., L. Abrell, D. Diaz, P.C. Ellsworth, N. Pier. 2018. Blister Beetle Risks to Specialty Crops. USDA-AMS, Specialty Crop Block Grant (AZ). $36,239. 10/2018-9/2022.
33. Huseth, A.S., G.G. Kennedy, S.E. Naranjo, & P.C. Ellsworth. 2018. Understanding the potential for resistance and biological control impacts of thrips and plant bug active Bt deployment. USDA-NIFA, BRAG. $498,993. 2018 – 2021.
34. Jeffery, B. 2019. Backcountry Preservation Plan, Casa Grande Ruins National Monument. US Department of the Interior, National Park Service. $80,000. 07/2019 – 07/2020.
35. Jeffery, B. 2017. Backcountry Preservation Plan, Casa Grande Ruins National Monument. US Department of the Interior, National Park Service. $80,000. 07/2017 – 07/2018.
36. Li, S. 2019. Development of three IPM guides for property manager: bed bugs, cockroaches, and house mice. Housing and Urban Development. Stop Pests in Housing. Northeastern IPM Center / Cornell University. $6,000. 01/2019 – 06/2019.
37. Li, S. and S. Nair. 2019. Navajo Nation Integrated Pest Management Workshop, Inter Tribal Council of Arizona, Inc. $5,400. 2019.
38. Li, S. and S. Nair. National IPM Training for Tribal Communities. Inter Tribal Council of Arizona, Inc. $8,660. 2019.
39. Li, S., D. H. Gouge, K. Walker, A. J. Fournier, S. Nair, M. Brophy, J. Weber, N. Dayoob. 2020. Emergency Preparedness through Integrated Pest Management Education and Tribal Partnerships in Arizona. U.S. Environmental Protection Agency, Border 2020 Program. $99,974. 02/2020 – 08/2021.
40. Li, S., D.H. Gouge, K.R. Walker, K.C. Ernst, P. Rivadeneira, P.C. Ellsworth. 2019. Public Health IPM Education in American Indian Communities. Cooperative Extension, University of Arizona. $31,895. 03/2019 – 2/2020.
41. MacLean, M.F., A.J. Fournier, P. Beamer, A.F. Arellano, E.J. Bedrick. 2020. Prenatal Exposure to Pesticide Mixtures and Childhood ADHD. National Institute of Environmental Health Sciences. $746,964. 9/2020 – 8/2023.

42. Murray, K., P. Jepson & A.J. Fournier. (Oregon State University lead) 2016. IPMSPs: Bringing "Integration" to Pest Management Strategic Plans. USDA-NIFA, Crop Protection and Pest Management, Applied Research and Development Program. $215,460. 9/2016 – 8/2021.
43. Palumbo, J. C. 2017. Enhancing Vegetable IPM Education in Arizona. USDA-AMS, Specialty Crops Block Grant Program (AZ). $82,638. 10/2015- 9/2017.
44. Palumbo, J. C. 2018. Insect Management in Organic Vegetables Crops. USDA-AMS, Specialty Crops Block Grant Program (AZ). $68,194. 10/2016-9/2018.
45. Palumbo, J. C. 2019. Diamondback Moth Management in Arizona Vegetables. USDA-AMS, Specialty Crops Block Grant Program (AZ). $67,990. 10/2017- 9/2019.
46. Palumbo, J. C. 2019. Enhancing IPM for Arizona Vegetables. USDA-AMS. Specialty Crops Block Grant Program (AZ). $92,722. 10/2017- 9/2019.
47. Palumbo, J. C. 2020. Enhancing IPM Education for Arizona Vegetable Industry. USDA-AMS, Specialty Crops Block Grant Program (AZ). $92,588. 10/2019- 9/2021.
48. Palumbo, J. C. 2020. Monitoring Diamondback Moth Activity and Insecticide Resistance in Arizona Vegetables. USDA-AMS. Specialty Crops Block Grant Program (AZ). $57,045. 10/2019- 9/2021
49. Palumbo, J.C. 2017. Evaluation of Insecticide Alternatives for Whiteflies and CYSDV in Melons. California Melon Research Board. $20,396. 3/2017-2/2018.
50. Palumbo, J.C. 2017. Evaluation of New Insecticides for Insect Management in Desert Head Lettuce. Arizona Iceberg Lettuce Research Council. $23,050. 9/2017- 8/2018.
51. Palumbo, J.C. 2017. Monitoring for Lettuce Insects in Yuma County. Arizona Iceberg Lettuce Research Council. $4,755. 9/2017- 8/2018.
52. Palumbo, J.C. 2018. Evaluation of Insecticide Alternatives for Whiteflies and CYSDV in Melons. California Melon Research Board. $21,616. 3/2018-2/2019.
53. Palumbo J.C. 2018. Evaluation of New Insecticides for Insect Management in Desert Head Lettuce. Arizona Iceberg Lettuce Research Council. $19,994. 9/2018- 8/2019.
54. Palumbo, J.C. 2018. Monitoring for Lettuce Insects in Yuma County. Arizona Iceberg Lettuce Research Council. $3,720. 9/2018- 8/2019.
55. Palumbo, J.C. 2019. Evaluation of Insecticide Alternatives for Whiteflies and CYSDV in Melons, California Melon Research Board. $16,698. 3/2019-2/2020.
56. Palumbo, J.C. 2019. Evaluation of New Insecticides for Insect Management in Desert Head Lettuce. Arizona Iceberg Lettuce Research Council. $19,518. 9/2019- 8/2020.
57. Palumbo, J.C. 2019. Monitoring for Lettuce Insects in Yuma County. Arizona Iceberg Lettuce Research Council. $4,905. 9/2019-8/2020.
58. Palumbo, J.C. 2019. Profiling Western flower Thrips Activity in Leafy Vegetables, Syngenta Crop Protection. $47,880. 7/2018-6/2019.
59. Palumbo, J.C. 2020. Evaluation of Insecticide Alternatives for Whiteflies and CYSDV in Melons, California Melon Research Board. $14,931. 3/2020-2/2021.
60. Palumbo, J.C. 2020. Insect Management in Desert Head Lettuce. Arizona Iceberg Lettuce

Research Council. $19,774. 9/2020- 8/2021.

61. Palumbo, J.C. 2020. Monitoring for Lettuce Insects in Yuma County. Arizona Iceberg Lettuce Research Council. $6,389. 9/2020- 8/2021.
62. Palumbo, J.C. 2020. Experimental Insecticides on Leafy Vegetables. BASF Corporation $20,700. 5/2020 -4/2021.
63. Palumbo, J.C. 2020. Profiling Lepidopterous Larvae Activity in Leafy Vegetables. Syngenta Crop Protection. $24,000. 7/2019-6/2020.
64. Palumbo, J.C. 2020. Profiling Western flower Thrips Activity in Leafy Vegetables. Syngenta Crop Protection. $17,000. 7/2019-6/2020.
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67. Schuch, U.K., D.H. Gouge, K. Umeda. IPM and Strategic Plant Use for Human Health in Health Care Facilities. 2019. Cooperative Extension, University of Arizona. $18,172. 03/2019 – 2/2020.
68. Sutherland, A., D-H. Chow, C. Foss, D. H. Gouge, S. Li, S. Nair, A. Romero, H. Spafford. 2017. Work Group: Developing effective bed bug outreach programs for diverse clientele in the West. Western Region IPM Center, USDA-NIFA. $30,000. 03/2017-02/2018.
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70. Walker, K., M. Riehle, K. Ernst, D.H. Gouge. 2017. Impacts of targeted larviciding and ULV adulticiding on the abundance and age structure of Aedes aegypti in south-central Arizona. Centers for Disease Control and Prevention. $1,250,000. 07/2017 – 06/2021.

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COOPERATIVE EXTENSION

Cotton Insecticide Use Guide

Knowing and Balancing Risks

Isadora Bordini[1], Alfred Fournier[1], Steven Naranjo[2], Naomi Pier[1], Peter C. Ellsworth[1]; [1]University of Arizona, [2]USDA-ARS

Many factors must be considered when choosing an insecticide, such as cost, efficacy, risk of resistance, and safety to non-target organisms. This ***Cotton Insecticide Use Guide*** summarizes the diverse risks of insecticides used to control three pests, helping you make well informed pest management decisions.

Product Risks to Arthropod Natural Enemies

Beneficial predators like *Orius* pirate bugs, *Geocoris* big-eyed bugs, crab spiders, *Collops* beetles, lacewing larvae, and *Drapetis* flies provide free biological control. Check product selectivity or compatibility with these natural enemies by looking at the background colors.

Fully Selective	**GREEN: LOW risk to natural enemies**
Partially Selective	**YELLOW: MODERATE risk to natural enemies**
Not selective	**RED: HIGH risk to natural enemies**

Product Efficacy

Consider efficacy of products against the target pest, based on the number of stars. Check whether insecticides provide control of specific life stages by checking letters next to stars.

Product Name	Common Name	IRAC No.[1]	Chemical Group	Silverleaf Whitefly
Courier	buprofezin	16	Chitin inhibitor	★★★★ (N)

★★★★ excellent ★★★ good ★★ fair ★ suppression E,N = efficacy against eggs & nymphs only, respectively

Resistance Management

Resistance can erode the efficacy of any product, but levels vary geographically and seasonally. Comments indicate resistance levels of whiteflies to products. Where resistance has not yet been detected in Arizona's populations, the cell is left blank.

SWF, Risk of Resistance
under investigation
mild–moderate

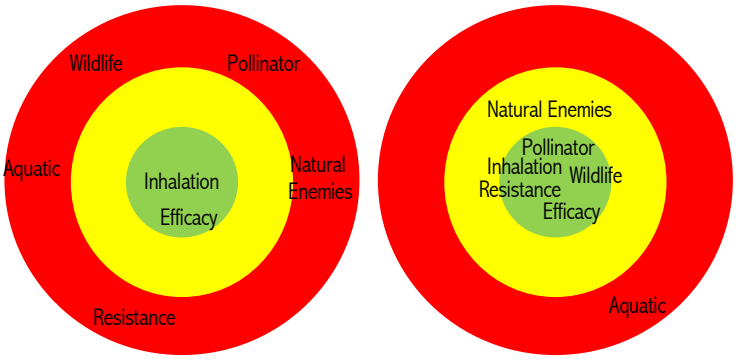
Risk to Human Health & the Environment

Identification of risk is based on scientific assessment. Check level of risk to bystanders, pollinators, and aquatic and terrestrial wildlife. "Yes" indicates a **significant risk of concern** has been identified. A blank cell does not indicate lack of any risk. Some risk is associated with the use of any product, especially to pesticide applicators, who should follow all personal protective equipment and other requirements for applying pesticides safely.

Risk to Aquatic Life (fish, algae)	Risk to Wildlife (mammals, birds)	Risk to Pollinators (bees)	Inhalation Risk (human bystanders)
Yes		Yes	
Yes	Yes	Yes	

Choosing Products Wisely = Minimizing Risks

Perhaps the worst product a grower could choose is the one that doesn't work. Risks are minimized by choosing insecticides that are effective against pests, while providing safety to natural enemies and other non-target organisms, and to human health.



Insecticide A **Insecticide B**

Each insecticide decision carries with it a variable combination of risks. The ***Cotton Insecticide Use Guide*** identifies 7 different risk factors (selectivity towards natural enemies, target pest efficacy, aquatic life, terrestrial wildlife, pollinators, bystander inhalation, and insecticide resistance in whitefly populations). Where possible, a grower should target products that minimize these risks. While "Insecticide A" has excellent target pest efficacy and very low risks to bystander health, it poses high risks to natural enemies, pollinators, aquatic and terrestrial wildlife, and higher risks for resistance development in whiteflies. "Insecticide B" poses a low risk to all factors, except for natural enemies (moderate risk) and aquatic life (high risk). The ultimate goal is to aim for excellent efficacy while minimizing risks as much as possible. In this example, "Insecticide B" fulfills this criteria better than "Insecticide A".

Each decision and every product has risk. Even when risk is not shown on the table, some level of risk will be present. Minimizing these risks conserves biocontrol and avoids catastrophic ecological effects that can increase the need for future sprays to control primary pests that resurge (e.g., whiteflies) or secondary pests that break out (e.g., mites).

Economic risks are important, too! Consider product cost and value alongside factors shown in the table. A lower-priced insecticide that slightly increases other risks may sometimes be the best choice. However, growers should consider the broad set of risks associated with insecticide use and avoid the false economy of always choosing the "cheapest" insecticide. The IPM goal should be to identify, balance and prioritize all insecticide risks, considering them on a case-by-case basis, for each grower and system.

8/4/22

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***Cotton Insecticide Use Guide*.** Insecticides have been screened for efficacy against target pests, *Lygus hesperus*, *Bemisia argentifolii* (MEAM1; silverleaf whitefly, SWF), and *Euschistus servus* (brown stink bug); as well as for their impact on non-target beneficial arthropods including >20 predators common in Arizona cotton. Those insecticides with full selectivity or safety towards these beneficial predators are in green; those that are partially selective or safe are in yellow; broad spectrum insecticides are in red. Some insecticides pose environmental and human health risks that require mitigations such as buffer zones and additional personal protective equipment (PPE). IRAC group numbers are provided to facilitate rotation of chemistry and SWF resistance risks are presented.

Product Name	Common Name	IRAC No.[1]	Chemical Group	Lygus Bug	Silverleaf Whitefly	Brown Stink Bug	Risk to Aquatic Life	Risk to Wildlife	Risk to Pollinators	Inhalation Risk	SWF, Risk of Resistance
Carbine	flonicamid	29	Feeding inhibitor	★★★★							
Courier	buprofezin	16	Chitin inhibitor		★★★★ (N)						under investigation
Exirel / Benevia	cyantraniliprole	28	Diamide		★★★★						
Knack / Farewell	pyriproxyfen	7C	Juvenoid		★★★★ (E,N)						mild–moderate
Oberon[2]	spiromesifen	23	Lipid synthesis inhibitor		★★★★ (N)						under investigation
PQZ	pyrifluquinazon	9B	Pyridine azomethine		★★★★						
Sefina Inscalis	*afidopyropen*	*9D*	*Pyropene*		★★★						
Sivanto prime	flupyradifurone	4D	Butenolide		★★★★						
Transform	sulfoxaflor	4C	Sulfoxamine	★★★★	★						
Assail / Intruder[3]	acetamiprid	4A	Neonicotinoid		★★★★		Yes				moderate–severe
Belay	clothianidin[4]	4A	Neonicotinoid	★★	★★		Yes		Yes		
Centric	thiamethoxam[4]	4A	Neonicotinoid		★★		Yes		Yes		
Venom	dinotefuran	4A	Neonicotinoid		★★★		Yes		Yes		
Acephate	acephate	1B	Organophosphate	★★★		★		Yes	Yes		
Bidrin	dicrotophos[5]	1B	Organophosphate	★		★	Yes	Yes	Yes	Yes	
Cormoran	novaluron + acetamiprid	15 + 4A	Chitin inhibitor	★★ (N)	★★	★ (N)	Yes				
Diamond / Mayhem	novaluron	15	Chitin inhibitor	★ (N)	★	★ (N)	Yes				
Synergized pyrethroids	various[6]	3A + 1B	Pyrethroid + organophosphate		★★		Yes	Yes	Yes		moderate–severe
Vydate C-LV	oxamyl[5]	1A	Carbamate	★★★★			Yes	Yes	Yes	Yes	

Background color: **Green** = Fully selective and safe to beneficials; **Yellow** = Partially selective or safe to beneficials; **Red** = broad spectrum, not safe to beneficials; ***Italics*** = based on preliminary testing. Risks as calculated from ipmPRiME (Jepson et al. 2014); 'Yes' indicates moderate to high risk for the given category.

★★★★, Excellent control; ★★★, Good control; ★★, Fair control; ★, Suppression only; **E, N** = Efficacy against eggs or nymphs only, respectively.

[1] The Insecticide Resistance Action Committee (IRAC) assigns numbers for each unique mode of action or class of chemistry. Many appear on U.S. insecticide labels and are helpful for resistance management.

[2] At 0.125–0.156 lbs ai / A only; higher rates are more destructive of natural enemies.

[3] The State of Arizona has approved a Special Local Needs (SLN) increase in acetamiprid use rates by up to +50% against difficult-to-control whiteflies. Impact to beneficials is more severe at these higher rates.

[4] This active ingredient can significantly affect bee populations, other pollinators and birds, can persist for years in soils, and can leach into waterways and groundwater.

[5] This active ingredient is considered highly hazardous by the Word Health Organization (WHO Ib), a restricted use pesticide with signal words DANGER and POISON, requiring posting, additional PPE, and closed systems. Avoid if possible.

[6] Beta-cyfluthrin[ab], bifenthrin[b] and lambda-cyhalothrin[b] are considered highly hazardous by the [a]WHO (Ib) or in the [b]Globally Harmonized System of Classification and Labelling of Chemicals (GHS Category 2). Avoid if possible.

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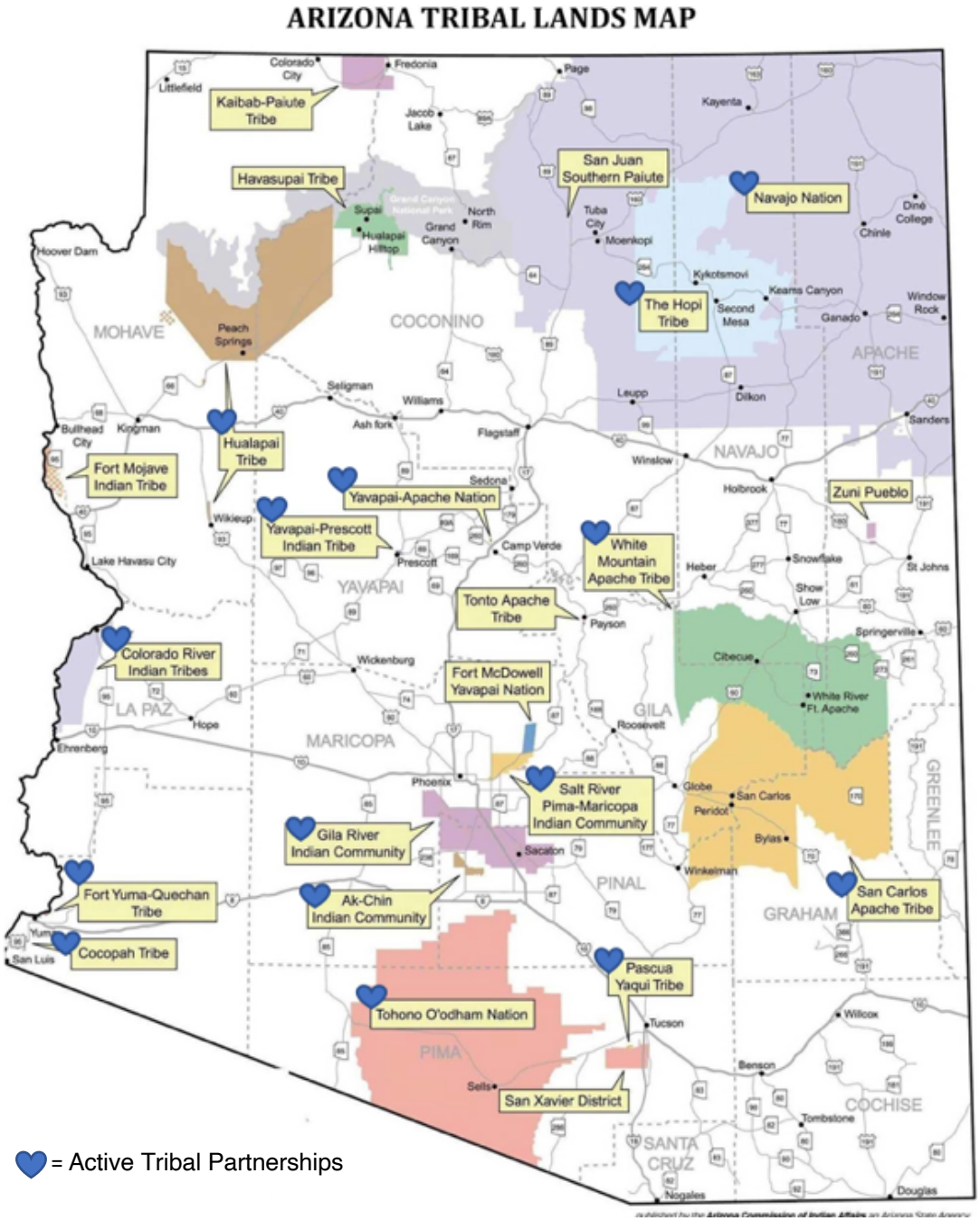

Appendix J6. Tribal Partnerships. The UA Public Health IPM Team has cultivated trusting relationships with tribal leaders, experts and professionals with 15 Arizona tribes (blue hearts) to address critical health issues through IPM research and outreach. Tribal collaborators include environmental health and vector control professionals, health care/services, tribal housing authorities, council members, animal control officers, pest management professionals, school personnel, veterinary technicians, first responders, and more. Our Agricultural IPM program engages four of these tribes as well, each managing individual and large tribal farms (Colorado River Indian Tribes, Gila River Indian Community, Ak-Chin Indian Community, Salt River Pima-Maricopa Indian Community).

Appendix J7
529 Selected Extension Publications & Other Outputs, 2016 - 2022

Extension Publications (72)

1. Arizona Pest Management Center (APMC). 2018. National Institute of Food and Agriculture's Crop Protection and Pest Management Program Saves Lives, Dollars & the Environment in Arizona. University of Arizona, Arizona Pest Management Center. Link
2. Bordini I., A. Fournier, S. Naranjo, N. Pier, P.C. Ellsworth. 2020. Cotton Insecticide Use Guide – Knowing and Balancing Risks. IPM Short. University of Arizona, Arizona Pest Management Center. Link
3. Ellsworth P.C., N. Pier, A.J. Fournier, S.E. Naranjo. 2019. Making Use of Predators in Cotton. IPM Short. University of Arizona, Arizona Pest Management Center. Link
4. Ellsworth P.C., N. Pier, A.J. Fournier, S.E. Naranjo. 2019. Utilizando los Predatores en Algodon. IPM Short. University of Arizona, Arizona Pest Management Center. Link
5. Ellsworth, P.C., I. Bordini, N. Pier. 2021. ThryvOn™ Cotton, Frequently Asked Questions. IPM Short. University of Arizona, Arizona Pest Management Center. Link
6. Ellsworth, P.C., I. Bordini, N. Pier. 2021. Tips on How to Manage Lygus Efficiently in ThryvOnTM Cotton. Presentation Handout. University of Arizona, Arizona Pest Management Center. Link
7. Ellsworth, P.C., N. Pier, W.E. Hall. 2021. Potential Pest of Arizona Pecans: Rapid Communication. IPM Short. University of Arizona, Arizona Pest Management Center. Link
8. Ellsworth, P.C., N. Pier. 2022. First Foliar Insecticide Special Local Needs Registrations for Palestriped Flea Beetle Control During Guayule Stand Establishment. IPM Short. University of Arizona, Arizona Pest Management Center. Link
9. Ellsworth, P.C., N.M. Pier, A.J. Fournier, S.E. Naranjo, 2020. Utilización de Depredadores en Algodón. IPM Short. University of Arizona, Arizona Pest Management Center. Link
10. Ellsworth, P.C., Pier N., A.J. Fournier, S.E. Naranjo, T. Vandervoet. 2019.Whitefly Predator "Thresholds" in Cotton IPM Short. University of Arizona, Arizona Pest Management Center. Link
11. Evancho, B., W. McCloskey, N. Pier, K. Caffrey. 2021. Resistant Palmer Amaranth Control – Best Management Practices. IPM Short. University of Arizona, Arizona Pest Management Center. Link
12. Fournier, A.J., N. Pier, P.C. Ellsworth. 2020. Your Voice Matters: Influencing Pesticide Registration Review. University of Arizona Cooperative Extension. Publication no. AZ1811. Link
13. Fournier, A.J., P.C. Ellsworth, N. Pier, W. Dixon II. 2016. Pesticide Use Data – Why Getting it Right Matters. IPM Short. University of Arizona, Arizona Pest Management Center. Link
14. Gouge D.H., P. Rivadeneira, S. Li. 2018. Roof Rats: Pathogens and Parasites. University of Arizona Cooperative Extension. Publication no. AZ1784-2018. Link
15. Gouge D.H., S. Li, C. Bibbs, S. Nair. 2018. Scorpions of the Desert Southwest United States. Extension Publication. University of Arizona Cooperative Extension. Publication no. AZ1768 Link
16. Gouge D.H., S. Li, K.R. Walker, C. Sumner, S. Nair, C. Olson, F.B. Ramberg. 2019 (revised). Mosquitoes: Biology and Integrated Mosquito Management. University of Arizona Cooperative Extension. Publication no. AZ1706. Link

17. Gouge D.H., S. Li, S. Nair, K.R. Walker, C. Bibbs. 2018. Mosquito and Tick Repellents. Extension Publication. University of Arizona Cooperative Extension. Publication no. AZ1761 Link
18. Gouge, D. H., T. Stock. 2021. Integrated Pest Management for Bed Bugs in Schools. Oregon State University PNW 757. Link
19. Gouge, D.H., H. Venkat. 2021. Rabies Risk Reduction. University of Arizona Cooperative Extension. Publication no. AZ1874. Link
20. Gouge, D.H., S. Li, S. Nair, M. Brophy, K. Walker, C Sumner, F. Ramberg. 2021. Mosquitoes and Disease Concerns. University of Arizona Cooperative Extension. Publication no. AZ1912. Link
21. Gouge, D.H., S. Li, S. Nair, M. Brophy, K. Walker, P.A. Andrade-Sanchez. 2021. Mosquitos. Quick Read Brochure in Spanish. University of Arizona Cooperative Extension. Publication no. AZ1873S. Link
22. Gouge, D.H., T. Stock. 2021. Bed Bugs in the Classroom. Pacific Northwest Extension Publishing. PNW 756 Link
23. Hall, W.E., J.D. Sherman, W. Moore, P.C. Ellsworth, N. Pier. 2021. First Detection of Pecan Bud Moth in Arizona. IPM Short. University of Arizona, Arizona Pest Management Center. Link
24. Hall, W.E., N. Pier, P.C. Ellsworth. 2019. Blister Beetle Basics. IPM Short. University of Arizona, Arizona Pest Management Center. Link
25. Hall, W.E., N. Pier, P.C. Ellsworth. 2019. Blister Beetles in Food? IPM Short. University of Arizona, Arizona Pest Management Center. Link
26. Li S., D.H. Gouge, A.J. Fournier. 2019. Practical Methods of Controlling Bed Bugs at Home (revision). University of Arizona Cooperative Extension. Publication no. AZ1642. Link
27. Li S., D.H. Gouge, K.R. Walker, A.J. Fournier, S. Nair, M.R. Wierda, J. Hurley. 2016. The Zika Virus. IPM Short. University of Arizona, Arizona Pest Management Center.
28. Link
29. Li S., D.H. Gouge, K.R. Walker, A.J. Fournier. 2019. Longhorned Tick a New Invasive Tick in the United States. University of Arizona Cooperative Extension. Publication no. AZ1792. Link
30. Li S., D.H. Gouge, S. Nair, A.J. Fournier, W.E. Hall. 2019. Arizona Kissing Bugs. University of Arizona Cooperative Extension. Publication no. AZ1787. Link
31. Li S., D.H. Gouge, S. Nair, K.R. Walker, A.J. Fournier. 2018. What you should know about mosquito and tick repellents. IPM Short. University of Arizona, Arizona Pest Management Center. Link
32. Li, S., D.H. Gouge, I. Ruberto, S. Nair, A.J. Fournier, W.E. Hall. 2022. What You Should Know About Kissing Bugs. University of Arizona Cooperative Extension. Publication no. AZ1992. Link
33. Li, S., D.H. Gouge, M. Brophy, S. Nair, K. Walker, P. Andrade-Sanchez. 2021. Garrapatas Marrones del Perro y Fiebre Maculosa de las Montañas Rocosas (Brown dog ticks and Rocky Mountain spotted fever in Spanish). Publication no. AZ1935S. Link
34. Li, S., D.H. Gouge, M. Brophy, S. Nair, K. Walker, P. Andrade-Sanchez. 2021. Brown Dog Ticks and Rocky Mountain Spotted Fever. IPM Brochure. University of Arizona Cooperative Extension. Publication no. AZ1935. Link
35. Li, S., D.H. Gouge, S. Nair, A.J. Fournier. 2021 (revised from 2015). Head Lice: Identification, Biology, and Integrated Pest Management. University of Arizona Cooperative Extension. Publication no. AZ1687. Link

36. Li, S., D.H. Gouge, S. Nair, K. Walker, M. Brophy. October 2021. Brown Dog Ticks. Brochure. University of Arizona Cooperative Extension. Publication no. AZ1871. Link
37. Li, S., D.H. Gouge, S. Nair, L. Graham, A.J. Fournier, K. Umeda. 2021. Beware of Fire Ant Stings. University of Arizona Cooperative Extension. Publication no. AZ1954. Link
38. Li, S., J. Weber. 2020. Protecting Your Flocks from External Parasites – Mites and Lice. University of Arizona Cooperative Extension. Publication no. AZ1858. Link
39. McCloskey W., P.C. Ellsworth, K. Umeda. 2017. Auxin Herbicides in Arizona Cotton: Avoiding Off-target Movement. IPM Short. University of Arizona, Arizona Pest Management Center. Link
40. McCloskey, W., B. Evancho, N. Pier. 2021. Guayule Weed Management During Establishment in Arizona – December 2021. IPM Short. University of Arizona, Arizona Pest Management Center. Link
41. McCloskey, W., N. Pier. 2019. Avoiding 2,4-D and Dicamba Off-Target Movement from Cotton. IPM Short. University of Arizona, Arizona Pest Management Center. Link
42. McCloskey, W., N. Pier. 2019. Spray Legally: Summary of EnlistTM, Engenia® and Xtendimax® Application Use Requirements on Cotton. IPM Short. University of Arizona, Arizona Pest Management Center. Link
43. Murray, K., I. Sandlin, P. Ellsworth, P. Jepson, A. Fournier, H. Luh, D. Walenta. 2021. Measuring the Economic Impact of Pests and Pest Management on Oregon Peppermint. Oregon State University Extension Service. Publication number EM-9303. Link
44. Murray, K., I. Sandlin, P.C. Ellsworth, P. Jepson, A.J. Fournier, H. Luh and S. Reitz. 2022. The Economic Impact of Onion Pests in the Treasure Valley: A Look at Pests and Associated Pest Management Practices, 2018 – 2019. Oregon State University Extension Service, Oregon State University. Publication EM 9347. Link
45. Nair S., D.H. Gouge, S. Li, P.C. Ellsworth, M.R. Wierda, A.J. Fournier. 2016. Why Pesticide Application Notifications in Schools are Important. IPM Short. University of Arizona, Arizona Pest Management Center. Link
46. Nair S., D.H. Gouge, S. Li, P.L. Warren, A.J. Fournier, M.R. Wierda, K. Umeda, D.M. Kopec. 2016. Honey Bees in Community Environments – Identification and Biology. IPM Short. University of Arizona, Arizona Pest Management Center. Link
47. Nair S., D.H. Gouge, S. Li. 2018. Something's Biting Me But I Can't See it. IPM Short. University of Arizona, Arizona Pest Management Center. Link
48. Nair S., D.H. Gouge, S. Li. 2019. Bed Bugs: What Home Care Providers and Welfare Workers Need to Know. University of Arizona Cooperative Extension. Publication no. AZ1804. Link
49. Nair S., K. Umeda, W.B. McCloskey, D.H. Gouge, P.C. Ellsworth. 2018. Weed Control Choices for Turf and Landscapes. IPM Short. University of Arizona, Arizona Pest Management Center. Link
50. Nair S., S. Li, D.H. Gouge. 2018. Head Lice in Schools. IPM Short. University of Arizona, Arizona Pest Management Center. Link
51. Nair, S., D.H. Gouge, A. Mostafa, S. Li, K. Umeda, H. Li-Byarlay. 2020. Wild Honey Bees in Community Environments – Identification, Biology, and Reducing Risks. University of Arizona Cooperative Extension. Publication no. AZ1846. Link
52. Nair, S., D.H. Gouge, and A.C. Murillo. 2021. Backyard Chickens and Ectoparasites: Introduction and Management. University of Arizona Cooperative Extension. Publication no. AZ1878-2021. Link

53. Nair, S., D.H. Gouge, S. Li. 2021. Chinches: lo que los proveedores de cuidados en el hogar y los trabajadores sociales deben saber. (Trifold brochure-Spanish). University of Arizona Cooperative Extension. publication AZ 1804S. Link
54. Nair, S., D.H. Gouge, S. Li., K. Walker. 2021. Personal Repellents. IPM Brochure Trifold – (Quick read-English). University of Arizona Cooperative Extension. Publication no. AZ1955. Link
55. Nair, S., D.H. Gouge, S. Li., K. Walker. 2021. Repelentes de Mosquitos y Garrapatas. IPM Brochure Trifold – (Quick read-Spanish). University of Arizona Cooperative Extension. Publication no. AZ 1955S. Link
56. Nair, S., D.H. Gouge, S. Li., K. Walker. 2021. Use of Personal Repellents for Protection Against Mosquitoes and Ticks. IPM Brochure. University of Arizona Cooperative Extension. Publication no. AZ1913. Link
57. Pier N., A.J. Fournier, P.C. Ellsworth. 2018. Risky Business: What is Risk? IPM Short. University of Arizona, Arizona Pest Management Center. Link
58. Pier N., P.C. Ellsworth. 2020. Cotton Fleahoppers in Cotton. IPM Short. University of Arizona, Arizona Pest Management Center. Link
59. Pier N., W.E. Hall, P.C. Ellsworth. 2020. False Chinch Bugs in Cotton. IPM Short. University of Arizona, Arizona Pest Management Center. Link
60. Pier, N., L. Brown, P.C. Ellsworth, J.C. Palumbo, Y Carriere, A.J. Fournier, S. Castle N. Prabhaker. 2016. Maps Provide Directions for Resistance! IPM Short. University of Arizona, Arizona Pest Management Center. Link
61. Reese, S, S. Li, D.H. Gouge. 2020. Integrated Pest Management for Bed Bugs – A Guide for Property Managers. Stop Pests in Housing. University of Arizona Cooperative Extension and the Northeastern IPM Center. Link
62. Reese, S, S. Li, D.H. Gouge. 2020. Integrated Pest Management for German Cockroaches – A Guide for Property Managers. Stop Pests in Housing. University of Arizona Cooperative Extension and the Northeastern IPM Center. Link
63. Reese, S., D.H. Gouge, T. Stock, R. Corrigan, S. Li, and S. Nair. 2021. House Mice: A Guide for Property Managers. Stop Pests in Housing. University of Arizona Cooperative Extension and the Northeastern IPM Center. Link
64. Stock, T., D.H. Gouge. 2021. Ants in the Classroom. Pacific Northwest Extension Publishing. PNW762. 2pp. Link
65. Stock, T., D.H. Gouge. 2021. Integrated Pest Management for Ants in Schools. Oregon State University PNW761. Link
66. Umeda, K., D. Kopec, and S. Nair. 2021. Annual Bluegrass (Poa Annua) Control in Non-overseeded Bermudagrass and Winter Overseeded Turfgrasses in Low Desert Arizona. University of Arizona Cooperative Extension. Publication no. AZ1885-2021. Link
67. Umeda, K., S. Nair, and M. Chamberland. 2021. Clear Up the Confusion: Know How to Select the Appropriate Herbicide to Control Weeds. University of Arizona Cooperative Extension. Publication no. AZ1914-2021. Link
68. Vandervoet T., P.C. Ellsworth, L.M. Brown, A.J. Fournier, S.E. Naranjo. 2019. Making Whitefly and Predator Counts. IPM Short. University of Arizona Cooperative Extension. Publication no. AZ1813. Link
69. Walker, K.R., H. Yaglom, D.H. Gouge, M. Brophy, M. Casal, O. Encinas. 2018. The Brown Dog Tick and Epidemic Rocky Mountain spotted fever in Arizona and northwestern Mexico. University of Arizona Cooperative Extension. Publication no. AZ1769 Link

70. Weber, J. S. Li. 2020. Protecting Your Flocks from External Parasites – Mites and Lice (Control de Parasitos Externos en Aves de Corral). (In Spanish) University of Arizona Cooperative Extension. Publication no. AZ1858S Link
71. Wierda M.R., A.J. Fournier, W.B. McCloskey, K. Umeda. 2017. Water Soluble Packaging WSP: Mixer/Loader Exposures Best Practices and Labeling Changes. IPM Short. University of Arizona, Arizona Pest Management Center. Link
72. Wierda M.R., D.H. Gouge. 2017. Tick & Flea Collars Integrated Pest Management and Your Safety. IPM Short. University of Arizona, Arizona Pest Management Center. Link

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Presentations & Videos (YouTube) (24)

1. Bordini, I. It's All About Size: Are we Doing Research at the Right Scale? UArizona Cooperative Extension Field Crops Clinics. 01/20/22. 20 views. Link
2. Ellsworth, P.C. 2020 Cotton Insecticide Screening Trials for Lygus and Whiteflies. Play list of 10 short videos recorded in the field. 11/4/2020. 43 views. Link
3. Ellsworth, P.C. 2021 Cotton Pest Control in Review. Arizona Cotton Symposium. University of Arizona Cooperative Extension. 02/10/22. 30 views. Link
4. Ellsworth, P.C. Predator Thresholds for Whitefly Control: Even more helpful than you think! UArizona Cooperative Extension Field Crops Clinics. 01/20/22. 39 views. Link
5. Ellsworth, P.C., I. Bordini, N. Pier. 2021. Frequently Asked Questions about ThryvOn Cotton in Arizona. 8th Annual New technologies Workshop for Field Crops. 06/21/2021. 35 views. Link
6. Ellsworth, P.C., I. Bordini, N. Pier. 2021. Tips on How to Manage Lygus Efficiently in ThryvOn Cotton. UArizona Cooperative Extension Cotton "Tent Talks". 07/11/2021. 62 views. Link
7. Ellsworth, P.C., N. Pier, I. Bordini 2021 Trends in Cotton Insect Management & What's Next? UArizona Cooperative Extension Field Crops Clinics. 01/27/21. 45 views. Link
8. Ellsworth, P.C., N. Pier, I. Bordini. 2020. Virtual Tour & Discussion of Cotton Insect Management Research Plots. 10th Annual Central Arizona Farmer Field Day. 10/28/2020. 61 views. Link
9. Fournier, A.J. Pesticide Registration Review Update. UArizona Cooperative Extension Field Crops Clinics. 02/04/2021. 93 views. Link
10. Gouge, D.H. 2020 Mosquito Surveillance. University of Arizona Cooperative Extension. 8/10/20. 73 views. Link
11. Harrington, K. 2021 Preparing for 2022: Alfalfa Weevil Pest Management. UArizona Cooperative Extension Alfalfa and Forage "Tent Talks" 07/17/2021 21 views. Link
12. Harrington, K. First Year with Weevil Threshold APP: Let's Use it and Use it Wisely. UArizona Cooperative Extension Field Crops Clinics. 01/20/22. 12 views. Link
13. Li, S., 2021. Creepy Crawly Backyard Bugs. University of Arizona Cooperative Extension 10/19/21. 83 views. Link
14. Li, S., 2021. Engaging Tribal Stakeholders to Address Public Health Pests. University of Arizona Cooperative Extension. 10/5/21. 144 views. Link
15. Li, S.J, K.A. Smith. 2020 Integrated Mosquito Management. University of Arizona Cooperative Extension. 8/13/20. 62 views. Link

16. Li, S.J, K.A. Smith. 2020 Mosquito Surveillance. University of Arizona Cooperative Extension. 8/7/20. 192 views. Link
17. Li, S.J. 2021 Cockroaches: More than a Nuisance. University of Arizona Cooperative Extension. 4/15/21. 71 views. Link
18. Li, S.J. 2021 Itchy Bugs and Updates on New Products. University of Arizona Cooperative Extension. 4/13/21. 235 views. Link
19. Mostafa, A. Management Approaches for Alfalfa Pests. UArizona Cooperative Extension Field Crops Clinics. 02/02/2021. 47 views. Link
20. Mostafa, A. Management of Aphids and Balanced Nutrients in Alfalfa. UArizona Cooperative Extension Field Crops Clinics. 01/20/2022. 33 views. Link
21. Mostafa, A. Pest Management Practices for Arizona Forage Crops. Annual UA Alfalfa & Forage Workshop. 04/21/22. 15 views. Link
22. Mostafa, A., K. Harrington, W. Burayu. 2020. 2019 & 2020 Sugarcane Aphid Management on Forage Sorghum Research Trials at MAC. 10/28/20. 29 views. Link
23. Mostafa, A., K. Harrington, W. Burayu. 2021 Chemistries for Pest Management of Forage Crops. 8th Annual New technologies Workshop for Field Crops. 06/20/2021. 54 views. Link
24. Mostafa, A., K. Harrington, W. Burayu. 2021 Pest Management for Forage Crops07/16/2021. 18 views. Link

Presentations (PDF) (10)

1. Bordini, I., N. Pier, P.C. Ellsworth. 2020. Biocontrol Informed Thresholds, Insecticide Selectivity, and Risk Reduction in Whitefly Management. UA Cooperative Extension January Field Crops Clinics. 1/10/20. (Virtual Presentation) Link
2. Ellsworth, P.C. 2016. Fulfilling Our Mission. Campus Administrative Team In-Service, Maricopa Ag Center Campus Administrative Team In-Service, Maricopa Ag Center. 11/1/16. (Presentation). Link
3. Ellsworth, P.C., N. Pier, I. Bordini, S.E. Naranjo. 2020. Making the Right Decisions with Predator Thresholds for Whitefly Management in Cotton. UA Cooperative Extension Virtual Tent Talk. (Presentation) Link
4. Ellsworth, P.C., N. Pier, I. Bordini. 2020. Push-Pull-Control: Securing Guayule's Future. UA Cooperative Extension Tent Talk. (Virtual Presentation) 6/3/20. Link
5. Ellsworth, P.C., S.E. Naranjo, I. Bordini, N. Pier. 2020. Latest Arizona Research on ThryvOn Cotton Trait Technology. Desert Agriculture Conference. 4/28/20. (Virtual Presentation) Link
6. Fournier, A.J., W.A. Dixon II, P.C. Ellsworth. 2017. Helena Desert Agronomy Meeting. 2/15/17. (Presentation) Link
7. Hall, E.W., P.C. Ellsworth, L. Abrell, N. Pier, D. Diaz. 2019. Blister Beetles: A Challenge for Arizona's Growers. UA Cooperative Extension Conference, Tucson, AZ August 2019. (Poster) Link
8. Hong, Z., A.J. Fournier. 2022. Comments from Western Stakeholders influence EPA Pesticide Registration Decisions. UA Cooperative Extension Annual Conference. 8/11/22. (Poster) Link
9. Li, S., D.H. Gouge, A.J., Fournier, S. Nair, A. Dorame-Avalos, S.K. Reese, M Brophy, K. Walker, K.C. Ernst, T. Teegerstrom, P.C. Ellsworth. 2020. Honoring and Empowering Tribal Nations and Indigenous Peoples Through IPM Education and Emergency Preparedness. 2020 UA Cooperative Extension Virtual Conference. 10/8/20. (Poster & Presentation). Link

10. Nair, S., D.H. Gouge, K. Umeda, Li, S., Fournier, A.J., Schuch, U. 2020. Implementing IPM in schools without IPM legislation: Experiences from Arizona. 2020 Arizona Cooperative Extension Virtual Conference. 1/6/20. (Poster) Link

Online Courses/Presentations for Continuing Education Credits (9)
These courses, recorded live, include presentations on a variety of IPM topics. Only courses with involvement of Entomology faculty members are shown.

1. Dinwiddie, D., R. Masson. 2022 Southwest Ag Summit online on-demand workshop. "Integrated Pest Management in Vegetables". CEUs offered: 2.0 AZDA, CA-DPR, and CCA. (Jun 2022). 100% effort. On-demand link
2. Dinwiddie, D., R. Masson. 2022 Southwest Ag Summit online on-demand workshop. "IPM Regulatory Update". CEUs offered: 1.0 AZDA, CA-DPR, and 2.0 CCA. (Jun 2022). 100% effort. On-demand link
3. Dinwiddie, D., R. Masson. 2022 Southwest Ag Summit online on-demand workshop. "Cotton Management: Insects, Nutrients and Weeds". CEUs offered: 1.0 AZDA, CA-DPR, and 2.0 CCA. (Jun 2022). On-demand link
4. Keith, M., Dinwiddie, D., Masson, R. 2022. Maximizing the Fundamentals of IPM, an Organic Approach to IPM. Online on-demand CEUs offered: 1.0 CCA. 60 min. (Sept 2022). On-demand link
5. Masson, R. 2019. End of Year Desert IPM Seminar. 6 Speakers. 30 attendees. live. CEUs offered: 3.0 AZDA and CA-DPR. Yuma, AZ. (Dec 2019). Course removed from on-demand circulation.
6. Masson, R. 2022. Yuma Fall IPM Seminar. 13 speakers, live in-person and zoom, converted to on-demand. CEUs offered: 5.0 AZDA, CA-DPR, and CCA. 46 in-person attendance, 48 zoom, and 11 on-demand. Yuma, AZ. (Aug 2022). On-demand link
7. Masson, R. End of Year Desert IPM Seminar. 8 Speakers. Zoom. 30 attendees. CEUs offered: 3 AZDA and CA-DPR. Yuma, AZ. (Dec 2020). Course removed from on-demand circulation.
8. Masson, R., D. Dinwiddie. 2022. A Day in the Life of a Pest Control Advisor, Interactive Iceberg Lettuce IPM Video. CEUs offered: 2.0 AZDA, CA-DPR, CCA. 108 min. (Jun 2022). 100% effort. Casual View (no-CEUs) CEU version
9. Masson, R., J. Leon. 2021 Southwest Ag Summit online on-demand workshop. "Vegetable IPM". CEUs offered: 2.0 AZDA, CA-DPR, and CCA. (Jun 2021). Course removed from on-demand circulation.

Newsletter Articles (192)

Community IPM Newsletters (38)
Community IPM Newsletters cover Integrated Pest Management in schools, homes and communities. Topics range from insect and rodent management to turf and landscapes and public health IPM. A selection is included below. All newsletters can be found online. Link.

1. Brandt, R., W.E. Hall, 2021. Bug Bonanza: 7 Big, Colorful Critters to Try to Spot This Monsoon Season. UA School and Home IPM Newsletter. Aug 2021.

2. Gouge, D. H., J. Weber, S. Li, S. Nair. 2020. People Unite Against the Threat of COVID-19. UA School and Home IPM Newsletter. Apr 2020.
3. Gouge, D. H., S. Li, S. Nair. 2019. Mosquitoes. UA School and Home IPM Newsletter. Sept 2019.
4. Gouge, D. H., S. Nair, S. Li. 2020. Bee Informed: Warming and Swarming. UA School and Home IPM Newsletter. Mar 2020.
5. Gouge, D. H., S. Nair, S. Li. 2020. Unfortunate Facts about Flu. UA School and Home IPM Newsletter. Jan 2020.
6. Gouge, D., C. Rock. 2018. IPM for Microorganisms with a Focus on Flu Part 2. School & Home IPM Newsletter. Feb 2018
7. Gouge, D., S. Li. 2018. Flea borne Typhus. 2018. UA School and Home IPM Newsletter. Oct 2018.
8. Gouge, D.H., S. Nair, L. Rose, M. Nelson, J.A. Hurley, T. Stock, S. Li, V. McGregor. 2021. What You Need to Know About Disinfectant Wipes. UA School and Home IPM Newsletter. Apr 2021.
9. Gouge, D.H., T. Stock, S. Reese, R. Corrigan, S. Li, S. Nair, S. 2022. House Mice: Signs of Uninvited Four-legged Visitors. UA School and Home IPM Newsletter. Jan 2022.
10. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Wild Honey Bees UA School and Home IPM Newsletter. May 2016.
11. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Kissing Bugs UA School and Home IPM Newsletter. Sept 2021. January 2016.
12. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Zika and IPM Weed Control UA School and Home IPM Newsletter. Apr 2016.
13. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Pesticide Application Notification in Schools and Zika Virus UA School and Home IPM Newsletter. Feb 2016.
14. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. School Preparation Guidance for Summer Management Teams. UA School and Home IPM Newsletter. May 2018.
15. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. Spring Preemergence Weed Control in Lawns. UA School and Home IPM Newsletter. Mar 2018.
16. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. IPM for Microorganisms – Focus on Flu Part 2. UA School and Home IPM Newsletter. Feb 2018.
17. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda. 2018. IPM for Microorganisms: Cleaning Disinfecting and Sanitizing. UA School and Home IPM Newsletter. Jan 2018.
18. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, M.R. Wierda, M.R. Wierda. 2017. Increase in Rabies Cases in Animals School and Home Integrated Pest Management. UA School and Home IPM Newsletter. Sept 2017
19. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2017. Stop School Pests. UA School and Home IPM Newsletter. Feb 2017.
20. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2017. CDC Online Classes UA School and Home IPM Newsletter. Jan 2017.

21. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Ants UA School and Home IPM Newsletter. Sept 2016.
22. Li S., D.H. Gouge, S. Nair, A.J. Fournier, U.K. Schuch, K. Umeda, D.M. Kopec, P.L. Warren, M.R. Wierda. 2016. Pesticide Safety and IPM Weed Control UA School and Home IPM Newsletter. Mar 2016.
23. Li, S., D.H. Gouge, I. Ruberto, S. Nair, A.J. Fournier, W.E. Hall. 2021. What You Should Know About Kissing Bugs. UA School and Home IPM Newsletter. June 2021.
24. Li, S., D.H. Gouge, J. Weber, S.A. Kells, J.A. Hurley, A.J. Fournier, S. Nair, K. Buhl. 2020. What You Should Know About N95 Respirators and Face Masks. UA School and Home IPM Newsletter. Apr 2020.
25. Li, S., D.H. Gouge, S. Nair, A.J. Fournier, K. Umeda. 2018. Beware of Fire Ant Stings. 2018. Ed. Li, S. School & Home IPM Newsletter. UA School and Home IPM Newsletter. Aug 2018.
26. Li, S., D.H. Gouge, S. Nair, L. Graham, A.J. Fournier, K. Umeda. 2021. Beware of Fire Ant Stings. UA School and Home IPM Newsletter. Mar 2021.
27. Li, S., M. Brophy, D.H. Gouge, S. Nair, K. Walker. September 2020. Brown Dog Ticks and Repellents. UA School and Home IPM Newsletter. Sept 2020.
28. Nair, S., D.H. Gouge, S. Li. 2019. Caregivers and Bed Bugs. UA School and Home IPM Newsletter. Nov 2019.
29. Nair, S., D.H. Gouge, S. Li. 2019. Fall Pests and Pest-proofing Tips. UA School and Home IPM Newsletter. Oct 2019.
30. Nair, S., D.H. Gouge, S. Li. 2020. Fall Pests and Pest Prevention Check List. UA School and Home IPM Newsletter. Oct 2020.
31. Nair, S., D.H. Gouge, S. Li. 2021. Fly Facts. UA School and Home IPM Newsletter. Sept 2021.
32. Nair, S., D.H. Gouge, S. Li. 2021. Keep Pests Away This Spring. UA School and Home IPM Newsletter. Jan 2021.
33. Nair, S., D.H. Gouge, S. Li. 2021. Not All Termites are Terrible! UA School and Home IPM Newsletter. Nov 2021.
34. Nair, S., D.H. Gouge, S. Li. 2021. Scary-Looking Gentle Giants. UA School and Home IPM Newsletter. May 2021.
35. Nair, S., D.H. Gouge, S. Li. Year-End Landscape and Turf Tips. 2020. UA School and Home IPM Newsletter. Dec 2020.
36. Nair, S., D.H. Gouge. S. Li. 2022. Leaf-footed Bugs Want Your Veggies, Not Your Blood. UA School and Home IPM Newsletter. May 2022.
37. Nair, S., D.H. Gouge. S. Li. 2022. Roof Rats in Sensitive Environments – Keep them away with landscape management and IPM. UA School and Home IPM Newsletter. Apr 2022.
38. Nair, S., S. Li. 2020. Spring Cleaning for Pest Management. UA School and Home IPM Newsletter. Feb 2020.

Vegetable IPM Updates (154)

Since 2010, The Vegetable IPM Team has produced bi-weekly updates on insect, weed and disease management, as well as other timely topics. Dr. John Palumbo produces Extension-quality publications on Vegetable Insect Management. These are linked to virtually every update and are available in the web archive. Link.

1. Palumbo, J.C. 2016. 2014-15 Insecticide Usage on Arizona Lettuce. UA Veg IPM Updates, Vol. 7, No.8.

2. Palumbo, J.C. 2016. 2016 Guidelines for Whitefly / CYSDV Management on Fall Melons. UA Veg IPM Updates, Vol. 7, No. 15.
3. Palumbo, J.C. 2016. Aphid Identification in Desert Lettuce (revised 2016). UA Veg IPM Updates, Vol. 7, No. 23.
4. Palumbo, J.C. 2016. Aphid Management in Desert Produce Crops – 2016. UA Veg IPM Updates, Vol. 7, No. 1.
5. Palumbo, J.C. 2016. Corn Earworm Management on Desert Produce. UA Veg IPM Updates, Vol. 7, No. 4.
6. Palumbo, J.C. 2016. Impact of Bagrada Bug Infestations on Desert Cole Crops, 2010-2015. UA Veg IPM Updates, Vol. 7, No. 11.
7. Palumbo, J.C. 2016. Insecticide Modes of Action on Desert Produce and Melon Crops (revised Feb 2016). UA Veg IPM Updates, Vol. 7, No. 6.
8. Palumbo, J.C. 2016. Insecticide Resistance Management Guidelines for Lepidopterous Larvae in Lettuce (Revision), UA Veg IPM Updates, Vol. 7, No. 22.
9. Palumbo, J.C. 2016. Insecticide Usage on Desert Lettuce, 2015-16. UA Veg IPM Updates, Vol. 7, No. 12.
10. Palumbo, J.C. 2016. Insect Losses and Management on Desert Lettuce: 2004-2016. UA Veg IPM Updates, Vol. 7, No. 14.
11. Palumbo, J.C. 2016. Insect Management on Desert Produce Crops: Western Flower Thrips (revision). UA Veg IPM Update, Vol. 7, No. 3.
12. Palumbo, J.C. 2016. Interactions Between Insects & Weeds in Desert Crops. UA Veg IPM Updates, Vol. 7, No. 10.
13. Palumbo, J.C. 2016. Leafminer Management on Desert Vegs. UA Veg IPM Updates, Vol. 7., No. 7.
14. Palumbo, J.C. 2016. Lepidopterous Larvae Control Chart 2016. UA Veg IPM Updates, Vol. 7, No. 4.
15. Palumbo, J.C. 2016. Pest Abundance on Desert Produce and Melon Cops in 2016. UA Veg IPM Updates, Vol. 7, No. 25.
16. Palumbo, J.C. 2016. Seed Corn Maggot on Spring Melons - 2016. UA Veg IPM Updates, Vol. 7, No. 2.
17. Palumbo, J.C. 2016. Western Flower Thrips Control Chart- 2016. UA Veg IPM Updates, Vol. 7, No. 5.
18. Palumbo, J.C. 2016. Whitefly Management in Fall Produce - 2016. UA Veg IPM Updates, Vol. 7, No. 19.
19. Palumbo, J.C. 2016. Whitefly Management in Spring Melons - 2016. UA Veg IPM Updates, Vol. 7, No.9.
20. Palumbo, J.C. 2017. Guidelines for Diamondback Moth Management in Cole Crops. UA Veg IPM Update, Vol. 8, No. 18.
21. Palumbo, J.C. 2017. Pest Abundance on Desert Produce and Melon Cops in 2017. Veg IPM Update, Vol. 8, No. 25.
22. Palumbo, J.C. 2017. Organic Insecticides for Diamondback Moth on Broccoli, 2017. Veg IPM Updates, Vo. 8, No. 23.
23. Palumbo, J.C. 2017. Efficacy of Foliar Insecticides Against Diamondback Moth Whitefly. Veg IPM Updates, Vo. 8, No. 23.
24. Palumbo, J.C. 2017. Efficacy of Foliar Insecticides Against Diamondback Moth - 2017. Veg IPM Updates, Vo. 8, No. 20.

25. Palumbo, J.C. 2017. Bagrada Bug Management Tips – 2017. Veg IPM Updates, Vol. 8, No. 19
26. Palumbo, J.C. 2017. Whitefly Management in Spring Melons - 2017. Veg IPM Updates, Vol. 7, No. 9.
27. Palumbo, J.C. 2017. Lepidopterous Larvae Management in Desert Produce Crops, 2017. UA Veg IPM Updates, Vol. 8, No. 4.
28. Palumbo, J.C. 2017. Thrips Management in Desert Leafy Vegs - 2017. Veg IPM Updates, Vol. 8, No. 5.
29. Palumbo, J.C. 2017. *Liriomyza* Leafminer Management on Desert Melons. Veg IPM Updates, Vol. 8, No. 6.
30. Palumbo, J.C. 2017. Aphid Management in Desert Produce Crops-2017. Veg IPM Updates, Vol. 8, No. 2.
31. Palumbo, J.C. 2017. Insecticide Modes of Action on Desert Veg Crops. UA Veg IPM Updates, Vol. 8, No. 9.
32. Palumbo, J.C. 2017. Impact of Bagrada Bug on Desert Cole Crops: Veg IPM Updates, Vol. 8, No. 10.
33. Palumbo, J.C. 2017. Insecticide Usage on Desert Lettuce, 2016-17. UA Veg IPM Updates, Vol. 8, No. 11.
34. Palumbo, J.C. 2017. Impact of Diamondback Moth Outbreaks on Arizona Cole Crops. Veg IPM Updates, Vol. 8, No. 13 .
35. Palumbo, J.C. 2017. Guidelines for Whitefly and CYSDV Management on Fall Melons. Veg IPM Updates, Vol. 8, No. 14.
36. Palumbo, J.C. 2017. Foxglove Aphids on Desert Produce. Veg IPM Updates, Vol. 8, No. 2
37. Palumbo, J.C. 2018. Pest Abundance on Desert Produce and Melon Crops in Fall 2018. Veg IPM Updates, Vol. 9, No. 25.
38. Palumbo, J.C. 2018. Weather Can Have Major Impacts on Insects. Veg IPM Updates, Vol. 9, No. 24.
39. Palumbo, J.C. 2018. Aphid Identification in Desert Produce Crops. Veg IPM Updates, Vol. 9, No. 23.
40. Palumbo, J.C. 2018. Insect Trapping Trends: Six Year Average. Veg IPM Updates, Vol. 9, No. 22.
41. Palumbo, J.C. 2018. Lepidopterous Larvae Management in Desert Produce Crops, 2018. Veg IPM Updates, Vol. 9, No. 20.
42. Palumbo, J.C. 2018. Bagrada Bug Management Tips for the Low Desert 2018. Veg IPM Updates, Vol. 9, No. 19.
43. Palumbo, J.C. 2018. 2018 Guidelines for Diamondback Moth Management in Cole Crops. Veg IPM Updates, Vol. 9, No. 18.
44. Palumbo, J.C. 2018. Diamondback Moth on Desert Cole Crops in 2017-18. Veg IPM Updates, Vol. 9, No. 17
45. Palumbo, J.C. 2018. Insect Management on Desert Produce and Melons: Pests at Stand Establishment (Revision). Veg IPM Updates, Vol. 9, No. 16.
46. Palumbo, J.C. 2018. Cultural practices for Whitefly Management in Desert Melons. Veg IPM Updates, Vol. 9, No. 13.
47. Palumbo, J.C. 2018. 2018 Guidelines for Whitefly and CYSDV Management on Melons. Veg IPM Updates, Vol. 9, No. 14.
48. Palumbo, J.C. 2018. Spider Mites on Melons. Veg IPM Updates, Vol. 9, No. 9.

49. Palumbo, J.C. 2018. Thrips Management in Desert Leafy Vegs - 2018. Veg IPM Updates, Vol. 9, No. 5.
50. Palumbo, J.C. 2018. Insecticide Usage in Desert Lettuce, 2017-18. Veg IPM Updates, Vol. 9, No. 12.
51. Palumbo, J.C. 2018. Impact of Bagrada Bug on Desert Cole Crops: Eight Year Summary. Veg IPM Updates, Vol. 9, No. 11.
52. Palumbo, J.C. 2018. Interactions between Insects and Weeds in Desert Crops. (Revision), Veg IPM Updates, Vol. 9, No. 10.
53. Palumbo, J.C. 2018. Spider Mites on Melons. Veg IPM Updates, Vol. 9, No. 9.
54. Palumbo, J.C. 2018. Insect Management on Desert Melons: Whiteflies (revised Apr 2018). Veg IPM Updates, Vol. 9, No. 8.
55. Palumbo, J.C. 2018. Insecticide Modes of Action on Desert Vegs. (Updated Mar 2018). Veg IPM Updates, Vol. 9, No. 6.
56. Palumbo, J.C. 2018. Corn Earworm Management on Desert Produce (Updated Mar 2018) Veg IPM Updates, Vol. 9, No. 5.
57. Palumbo, J.C. 2018. Aphid Identification in Produce (revised Feb 2018). Veg IPM Updates, Vol. 9, No. 4.
58. Palumbo, J.C. 2018. Insect Management on Desert Produce Crops: Thrips (Revision). Veg IPM Updates, Vol. 9, No. 3.
59. Palumbo, J.C. 2018. Seed Corn Maggot in Spring Melons 2018. Veg IPM Updates, Vol. 9, No. 2.
60. Palumbo, J.C. 2018. Aphid Management in Desert Produce Crops – 2018. Veg IPM Updates, Vol. 8, No. 1.
61. Palumbo, J.C. 2018. Foxglove Aphids on Desert Produce (revised Feb 2018). Veg IPM Updates, Vol. 9, No. 4.
62. Palumbo, J.C. 2019. Keys to Effective Aphid Management in Leafy Vegs Veg IPM Updates, Vol. 10, No. 1.
63. Palumbo, J.C. 2019. New Insecticides for Desert Produce and Melon Crops. Veg IPM Updates, Vol. 10, No. 2.
64. Palumbo, J.C. 2019. Seed Corn Maggot in Spring Melons 2019. Veg IPM Updates, Vol. 10, No. 3.
65. Palumbo, J.C. 2019. Biopesticide Efficacy in Desert Produce Crops. Veg IPM Updates, Vol. 10, No. 4.
66. Palumbo, J.C. 2019. Relative Efficacy Index *(REI)* for Biopesticides on Desert Produce. Veg IPM Updates, Vol. 10, No. 4.
67. Palumbo, J.C. 2019. Foxglove Aphids on Desert Produce (revised Mar 2019). Veg IPM Updates, Vol. 10, No. 5.
68. Palumbo, J.C. 2019. Aphid Management in Desert Produce Crops 2019. Veg IPM Updates, Vol. 10, No. 5.
69. Palumbo, J.C. 2019. Thrips Management in Desert Produce Crops – 2019. Veg IPM Updates, Vol. 10, No. 5.
70. Palumbo, J.C. 2019. Corn Earworm Management on Desert Produce (Updated 2019). Veg IPM Updates, Vol. 10, No. 5.
71. Palumbo, J.C. 2019. Diamondback Moth Management in Desert Cole Crops -2019. Veg IPM Updates, Vol. 10, No. 5.

72. Palumbo, J.C. 2019. Insecticide Modes of Action on Desert Veg Crops *(Revision).* Veg IPM Updates, Vol. 10, No. 6.
73. Palumbo, J.C. 2019. Lettuce Aphid on Late Season Produce. Veg IPM Updates, Vol. 10, No. 7.
74. Palumbo, J.C. 2019. Insect Management on Desert Melons: Whiteflies (Updated 2019). Veg IPM Updates, Vol. 10, No. 8.
75. Palumbo, J.C. 2019. Whitefly Management in Spring Melons – 2019. Veg IPM Updates, Vol. 10, No. 8.
76. Palumbo, J.C. 2019. Spider Mites in Melons. Veg IPM Updates, Vol. 10, No. 9.
77. Palumbo, J.C. 2019. Weed Interference with Insect Management in Desert Crops. Veg IPM Updates, Vol. 10, No. 10.
78. Palumbo, J.C. 2019. Nine Years of Bagrada Bug on Desert Cole Crops. Veg IPM Updates, Vol. 10, No. 11.
79. Palumbo, J.C. 2019. Insecticide Usage in Desert Lettuce, 2018-19. Veg IPM Updates, Vol. 10, No. 12.
80. Palumbo, J.C. 2019. Insect Losses on Desert Lettuce: A 15-yr Summary. Veg IPM Updates, Vol. 10, No. 13.
81. Palumbo, J.C. 2019. Cultural Practices for Whitefly Management in Melons. Veg IPM Updates, Vol. 10, No. 14.
82. Palumbo, J.C. 2019. 2019 Guidelines for Whitefly/CYSDV Management on Fall Melons. Veg IPM Updates, Vol. 10, No. 15.
83. Palumbo, J.C. 2019. Insect Management on Desert Produce and Melons: Pests at Stand Establishment (Updated Aug 2019). Veg IPM Updates, Vol. 10, No. 16.
84. Palumbo, J.C. 2019. Bagrada Bug Management Tips - 2019. Veg IPM Updates, Vol. 10, No. 17.
85. Palumbo, J.C. 2019. Diamondback Moth on Desert Crops: Survey Results 2016-2018. Veg IPM Updates, Vol. 10, No. 18.
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2. Bordini, I., P.C. Ellsworth, S.E Naranjo. Novel Insecticides Support Conservation Biological Control in Cotton. 2021 Beltwide Cotton Conferences, National Cotton Council of America. Virtual Live-Stream Event. 1/6/21
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4. Bordini, I., P.C. Ellsworth, S.E. Naranjo, A.J. Fournier. Conservation Biological Control of *Bemisia Tabaci* in Cotton Using Selective Insecticides. (MS Award presentation). Entomological Society of America & International Organization of Biological Control, St. Louis, MO. 11/19/19
5. Crump A., J. Farrar, A.J. Fournier, P.C. Ellsworth. 2017. Pesticide Use Data Informs Regulatory Policies. American Chemical Society 254th National Meeting and Exposition, Washington, DC. 8/21/17.
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9. Ellsworth P.C., A.J. Fournier, J.C. Palumbo, S.E. Naranjo, G.B. Frisvold. 2016. Chronicling Successful Integration of Technology and Knowledge Over 25 Years of IPM in Arizona Symposium on Economics of IPM in the 21st Century: Multiple Perspectives from Around the World, International Congress of Entomology, Orlando, FL. 9/26/16. Link
10. Ellsworth P.C., A.J. Fournier, T. Vandervoet, S.E. Naranjo. The Arizona Whitefly IPM Model: Cooperative Extension as Key to Translating and Transforming the Mexican Cotton System. 2nd International Whitefly Symposium. Arusha Tanzania Africa, 02/18/2016. Link
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15. Ellsworth, P.C. Where Do We Go After Bt? – Academic. Beltwide Cotton Conferences. San Antonio, TX. 1/4/22.
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29. Li, S. 2020. Arizona Pest Management Center - Effective Partnerships in IPM Education. 2020 Arizona Annual Vector Control Conference (Virtual), Arizona Department of Health Services. 4/15/20.
30. Li, S. 2022. Engaging Tribes in Integrated Pest Management. 2022 Arizona Vector Conference. Maricopa, AZ. 3/30/22.
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34. Li, S., A. Dorame-Avalos, T. Puetz, B. Bell, et al. 2021. Arizona Tribal Environmental Health Professionals Think Tank. 2021 Tribal EPA Region 9 Annual Virtual Conference. 10/19/21.
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47. Nair, S. 2021. A Deeper Dive into Commercial Rodents and Flies. Emergency Preparedness for Outbreaks of Insect and Arthropod Vectors and Communicable Pests Workshop. Inter Tribal Council of Arizona (ITCA) and Bureau of Indian Affairs (BIA). Phoenix, AZ. 5/25/21.
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58. Nair, S., T.A. Green, D.H. Gouge, K. Umeda, A.J. Fournier, S. Li, U.K. Schuch, D.M. Kopec. Encouraging Schools to Practice Integrated Pest Management. (Poster) ESA International Branch 1st Virtual Symposium, 4/16/18.
59. Naranjo S.E., J. Romeis, A.M. Shelton, P.C. Ellsworth. 2019. Bt Crops and Biological Control: Can They Work Together in IPM? PIE Section Symposium: Advocating for IPM in a Dynamic Agricultural World. Entomological Society of America, St Louis, MO. 11/19/19.
60. Naranjo S.E., P.C. Ellsworth, G. Frisvold. 2016. What is the Economic Value of Conservation Biological Control? Entomological Society of America Pacific Branch. ESA Pacific Branch Annual Meeting, Honolulu, HI. 4/2/16.
61. Naranjo S.E., T. Vandervoet, P.C. Ellsworth. 2020. Development of Biological Control Informed Thresholds for Management of Whitefly in Cotton. 2020 Beltwide Cotton Conferences, Austin, TX. 1/10/20.
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68. Reisig, D., P.C. Ellsworth, E.W. Hodgson. The Roles of Soft Technologies and Cooperative Extension in Solving Wicked IPM Problems. Entomological Society of America, Southeastern Branch and American Phytopathological Society Caribbean Division. San Juan, Puerto Rico. 3/29/22.
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