Western IPM Center
Fostering responsible pest management for a sustainable future.

The Western Front

NEWSLETTER OF THE WESTERN INTEGRATED PEST MANAGEMENT CENTER June 2012

Protecting Beneficials in Hawai'i and the American Pacific: A Workshop on the Conservation of Pollinators and Other Beneficial Species

In April, the WIPMC sponsored a well-attended meeting in Hawai'i for growers, educators, researchers, beekeepers, extension agents, resource specialists, master gardeners, and others concerned about protecting native pollinators and beneficials, as well as introduced but economically important pollinators (e.g., honeybees) and beneficials, in Hawai'i and the American Pacific Islands. The 2-day event on the island of O'ahu brought together 62 people from Guam, American Samoa, Saipan and Rota (U.S. Commonwealth of the Northern Mariana Islands), and five of the islands of Hawai'i.

Endeavors such as this always involve the cooperation, talents, time, and energies of a diverse group of people, including attendees themselves. As the WIPMC's contact person in Hawai'i, Cathy Tarutani, Education Specialist in the University of Hawai'i's Department of Plant and Environmental Protection Sciences and the WIPMC's comment coordinator for Hawai'i and the American Pacific Islands, was pivotal in making the workshop a success, contributing a huge number of hours to the program planning, communication with participants and coordination of their travel, coordination of presenters, identification of field tour locations, and many other details.

The first day of the workshop involved speakers and hands-on opportunities to learn about challenges faced by pollinators and beneficials and approaches to their protection. On day two the group ventured first to eastern O'ahu to witness beekeeping up close and then to central O'ahu, where participants saw plantings of cover crops that attract pollinators and beneficials and surveyed University of Hawai'i urban horticulture demonstration gardens.

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Carla Thomas

Challenges to Pollinators and Beneficials

The islands of Hawai'i and the Pacific Basin American territories have environments that are unique—and uniquely vulnerable. They are isolated from other land masses, yet their dependence on tourism and imported food and other goods facilitates invasions by non-native species and makes inputs to crop production more expensive. The mild climate supports crop production and pest pressures year-round. Local producers who supply fresh produce and specialty crops often farm small plots and have limited resources. Larger growers of high value commodities, who typically have more resources, face potentially devastating competition from growers in regions with lower land and labor costs. For all of them, it is important to learn about and develop IPM strategies so they can prevent unacceptable levels of pest damage using the most economical means while posing the least possible risk to people, property, resources, and the environment.

The Western IPM Center coordinated this outreach in response to needs expressed by stakeholders in Hawai'i and the Pacific Basin. Local Extension Specialists and agents had established outreach programs for farmers about cultural practices and pest management (including pest identification). But they had also identified a need to educate growers throughout this geographical area about how to apply the relatively new concept of conservation of pollinators and other beneficial species. This need was even articulated by growers themselves, who had become aware of the importance of taking action to maintain pollinator populations, especially following the arrivals of two recent, serious pests of honeybees, the varroa mite and the small hive beetle. This workshop was addressed not only to growers themselves but also to extension personnel and educators, who would be in a position to share what they learned back home.

Rick Melnicoe

Scott Nikaido, manager of the University of Hawai'i research apiary in Waimanalo, on O'ahu, lifts a frame out of a "super," the portion of a managed hive where bees store surplus honey.

Day 1: Presentations and Hands-On Demonstrations

Beneficial Insects: Who Are They and What Do They Do?

Helen Spafford, Assistant Professor of Entomology in the Department of Plant and Environmental Protection Sciences (PEPS), College of Tropical Agriculture and Human Resources (CTAHR), University of Hawai'i at Mānoa, set the stage on the first day of the workshop with an introduction to beneficial insects.

The Role of Beneficials. Beneficial insects provide benefits by 1) being natural enemies (predators of other insects, parasitoids, and weed seed predators), 2) pollinating plants, and 3) contributing to soil composition through decomposition and nutrient cycling. Some insects are pests in one life stage and beneficials in another life stage (i.e., the insect's larva eats the plant crop, but the adult is a pollinator).

Beneficial Insects and Spiders. Common insect predators in Hawai'i and the Pacific Basin include green and brown lacewings, ladybird beetles, ground beetles, rove beetles, and bugs. In addition to insects, all spiders are predators, targeting hoppers, aphids, grasshoppers, thrips, and caterpillars. Parasitoids include wasps and flies, which lay their eggs on or in insects, attacking eggs, larvae, pupae, and adults, and

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Director's Comments

This is the last Director's Comments column that I will be writing prior to retiring on July 1. Linda Herbst, who has served as associate director, will also be retiring. It has been our privilege to participate in the creation and development of the Western IPM Center. Over the past 12 years, we have worked with numerous scientists, extension personnel, growers, commodity organizations, and government agencies to address pest management issues in the West and United States. It has been gratifying to help bring together people with diverse interests to make the Center a successful and valuable part of many aspects of pest management programs. Since 2004, the WIPMC has directly funded $8,656,780 in support of competitive projects to promote IPM in the West. Additionally, we have funded three signature programs, many symposia and meetings, and brochures and other literature to educate stakeholders on current issues.

This past year has been a transition to new leadership of the Center. Kassim Al-Khatib will be the Director on July 1, and a new proposal was recently submitted to share Center leadership among three western universities. The intent is not to make major changes in the role and function of the Center. We have developed a program that works well and addresses western needs.

We completed the planning and held our first signature program workshop, "Protecting Beneficials in Hawai'i and the American Pacific: A Workshop on the Conservation of Pollinators and Other Beneficial Species" in April. The workshop and field tour were a phenomenal success (see lead article).

As of my deadline for this column, the budget for Agriculture is still being developed. The good news is the Regional IPM Centers are included in the Senate Appropriations Committee budget. Centers are also spelled out in the draft 2012 Farm Bill and have strong support from a number of commodity organizations, IPM Voice, and the land-grant universities' advocacy groups.

On a final note, I would like to thank my many colleagues, cooperators, and supporters who are the ones who have made this such a successful venture. I am certain that you will continue to participate with the new leadership to make this an even better program in the coming years.

—Rick Melnicoe

Western IPM Center 2012 Funded Projects

The Western IPM Center funded three work groups, two special projects, and seven publications/outreach projects, totaling $142,680.

Work Groups

Western Region Functional Agricultural Biodiversity Work Group and Tour
PI: Gwendolyn Ellen, Oregon State University

Western Region School IPM Implementation and Assessment Work Group 2012
PI: Carrie Foss, Washington State University

Crop Pest Losses and Impact Assessment Work Group
PI: Al Fournier, University of Arizona

Special Projects

Guide to the Submerged and Floating Aquatic Plants of the Northern Rocky Mountain Region
PI: Bryce Christiaens, Missoula County Weed District, Montana

Weeds Across Borders (WAB) "Because Weeds Know No Boundaries" Tour
PI: Anna Lyon, Okanogan County Noxious Weed Control Board, Washington

Publications/Outreach

Field Guide for Beneficial Arthropods in Summer Crops in the Arid and Semi-Arid Regions of the Southwest
PI: Lydia Brown, University of Arizona

Adopting IPM in Oregon Schools
PI: Aimee Code, Northwest Center for Alternatives to Pesticides

IPM Outreach for Control Methods in an Urban Environment
PI: Elena Cronin, 4-County Cooperative Weed Management Area (CWMA), Oregon

Integrated Pest Management Education and Outreach for Public Housing in Western States
PI: Dawn Gouge, University of Arizona

Weed Seedling Identification Guide for Montana and Northern Great Plains
PI: Fabian Menalled, Montana State University

Development of a Field Guide for IPM in Grapes for the Pacific Northwest
PI: Michelle Moyer, Washington State University

IPM Practitioner's 2012 Directory of Least-Toxic Pest Control Products
PI: William Quarles, Bio-Integral Resource Center (BIRC), California

Carla Thomas

Pollinators—*from page 1*

eventually killing the host. Most insects have one or more parasitoids. Weed seed predators include ants and beetles. Insect pollinators include honey bees, native bees, beetles, moths, and flies. Spafford summarized her talk by saying insects are abundant and diverse, they provide essential services, and can reap huge economic benefits. She ended with the question, "What can we do to help them do their job, or at least not hinder them?

Using Cover Crops/Insectary Plants to Enhance Above- and Below-Ground Beneficial Organisms

Koon-Hui Wang, Assistant Professor of Sustainable Pest Management in the PEPS department at the University of Hawai'i, spoke on the use of insectary plants to increase the presence and benefits of insects above and below the ground.

Rick Melnicoe

Koon-Hui Wang

What Are Insectary Plants? Insectary plants are plants that attract insects. Beneficial insectary plants are intentionally introduced into an ecosystem 1) to increase pollen and nectar resources for natural enemies of insect pests (e.g., hoverflies and parasitoids), 2) to attract pollinators, 3) to supply a food source for spiders, and 4) to act as trap crops for insect pests.

Insectary Plants and Practices That Do Not Support Establishment of Natural Enemies. Insectary plants can be weeds on field borders, can be planted intentionally through intercropping, or can be killed and serve as surface mulch to provide favorable niches for beneficial soil arthropods. Some practices do not support the establishment of natural enemies of arthropod pests. These practices include using broad-spectrum insecticides (even some organic products like spinosad and neem) and isolating crop production from flowering weeds and plants (e.g., through the use of weed mats or high tunnel screen houses).

Examples of Insectary Plants. The Apiacea (Umbelliferae) (carrot family) attract parasitic insects and parasitoids. They are excellent insectary plants, as they provide great numbers of tiny flowers required by parasitic wasps. Examples are fennel, angelica, coriander, dill, and wild carrot. Plants in the Asteraceae (Compositae) family produce showy composite flowers that are favorable for many predators and parasitoids. Examples include chrysanthemum, dandelion, lettuce, marigold, sow thistle, sunflower, yarrow, and zinnia. Plants in the mint family (Lamiaceae) attract predatory wasps, hoverflies, and robber flies. This family includes many herbs, such as basil, rosemary, sage, salvia, savory, marjoram, thyme, lavender, and perilla.

Some plants attract certain insects. For example, lady beetles, which eat aphids, scales, and mealybugs, are attracted to marigolds, Mexican tea, morning glory, oleander, and yarrow. Both the adult and larval stages of green lacewings (*Chrysopa* spp.), which eat aphids, various larvae, and the eggs of other insects are attracted to carrot, oleander, red cosmos, and wild lettuce. Assassin bugs, bigeye bugs, and minute pirate bugs are attracted to carrot, Mexican tea, oleander, sunn hemp, and cowpea. Plants that provide shelter for ground beetles include those that are low-growing, such as thyme, rosemary, and mint. Practicing no-tillage or retaining some weed borders around the main cash crop can also provide a favorable niche for ground beetles.

Criteria for selecting ideal insectary plants include 1) choosing plants for their attractiveness to beneficial insects, 2) choosing plants with an early and long bloom period, 3) selecting plants with low potential to host crop viruses or attract pest species, 4) choosing plants with low potential to become weeds, and 5) considering low seed cost and easy establishment.

How Insectary Plants Can Be Used. There are a number of ways insectary plants can be used, including

- As a *border crop* alongside the desired cropping area. Insects attracted to the insectary plants will also help other nearby crops or garden plants.
- As a *trap crop* to attract pests, reducing pest pressure on crop plants.
- *Intercropped as living mulch*, helping to reduce the density of pest insects and their negative effects on crop plants. Plan cover crop planting date to synchronize flowering with insect pest infestation.
- As a *pre-plant rotation crop* followed by conservation tillage (i.e., to serve as surface mulch/organic mulch to attract predators such as spiders and beetles).
- As *strip-till cover cropping* followed by clipping for surface mulch, reducing tillage and additional inputs of organic matter.

Other Benefits. Border weeds or cover crops serve as a food source for pollinators before the cash crop produces flowers. In addition, cover crops also enhance many below-ground beneficials, such as free-living nematodes, which play important roles in soil nutrient cycling and can help save cost on fertilizer use.

Addressing Resource Concerns with Plants

Kawika Duvauchelle, Natural Resource Specialist with USDA's Natural Resources Conservation Service, is stationed at the Hoolehua Plant Materials Center (PMC). Located on Moloka'i and serving the entire Pacific Island area, the PMC tests plants or develops plant-technology to address resource concerns; develops fact sheets, technical notes, and brochures; and offers demonstrations, presentations, tours, and training. Duvauchelle is responsible for plant selection and technology development studies.

"Tropic Sun" Sunn Hemp: Example of Hoolehua PMC Release. Among the 10 tested plants and germplasm released by the Hoolehua PMC is "Tropic Sun" sunn hemp (*Crotalaria juncea*), a legume that can be used as a cover crop or green manure. This plant was mentioned frequently during the 2-day workshop for its many benefits. In addition to attracting pollinators and other beneficial insects, sunn hemp can add 100 to 150 pounds of nitrogen per acre. It also increases organic matter, reduces root-knot nematode populations, and is nontoxic to livestock.

Using "Pollinator Pastures" to Attract Native Pollinators. Creating pollinator pastures involves identifying pollinator species, identifying plant species, determining peak flowering periods, determining the length of flowering periods, and determining the desired size of the "pasture." Duvauchelle explained there are several things to consider in choosing plants for pollinator pastures. The plants should 1) require low maintenance, 2) be a mix of native species, 3) be adapted to the climate, 4) be drought- and wind-tolerant, 5) be relatively easy to grow, and 6) be strategically placed. Examples of specific plants for pollinator pastures in Hawai'i and the Pacific Islands include 'ilima (*Sida Fallax*), 'uhaloa (*Waltheria indica*), 'ewa hinahina (*Achyranthes splendens*), and ko'oko'olau (*Bidens menziseii*).

Facilitating Biological Control of Insect Pests on Ornamental Crops

Robert Hollingsworth, Research Entomologist with USDA's Agricultural Research Service, is based at the U.S. Pacific Basin Agricultural Research Center in Hilo, Hawai'i. He focuses on control of insect pests using combinations of pest management tactics, including the use of biological agents and botanical insecticides.

Ornamental Production in Hawai'i. The ornamental industry is economically important in Hawai'i. In 2007 there were 1,628 farms in ornamental production (nursery, greenhouse, floriculture, and sod production), with a total value of $119 million. Major ornamental commodities in Hawai'i include orchids (cut and potted), anthuriums (cut and potted), *Dracaena*, and potted palms. Common pests on nursery plants include thrips, aphids, whiteflies, scales, mealybugs, mites, caterpillars, nematodes, slugs, and snails.

Biological Control. Biological control options include the classical biological control method of introducing exotic natural enemies, mass production and release of natural enemies, conservation and augmentation of existing natural enemies, the use of microbial pesticides (e.g., *Beauveria bassiana* and *Steinernema carpocapsae*), and planting resistant cultivars. Producers might be unaware that biological control is going on in their nursery, since pest populations can go up and down due to weather, natural enemies, dispersal, pesticides, and changes in plants.

Effects of Different Insecticides and Miticides on Beneficials. Insecticides and miticides that are hard on beneficials include organophosphates, organocarbamates, and many pyrethroids. Products that are easy on beneficials include pesticides with little residual effect (soaps, oils), pesticides that affect some types of insects and mites more than others, insect growth regulators, and systemic insecticides that are active via plant uptake.

Some Biological Control Agents. Effective biological control agents highlighted by

John Ruberson, University of Georgia, Bugwood.org

Minute pirate bug

Hollingsworth for ornamentals include:

- **Entomopathogenic Nematodes (*Steinernema carpocapsae*) (Millenium).** The nematodes are mixed with water and sprayed on crops, usually to control caterpillar pests. Juveniles burst from dead insects to seek out new hosts.
- ***Beauvaria bassiana*.** An insect-killing fungus used for thrips (which cause scarring, twisting, and loss of blossoms).
- **Predatory Mites.** Predators of thrips nymphs.
- **Minute Pirate Bugs (*Orius* spp.)** A ratio of one minute pirate bug to 20 thrips leads to control of thrips.

Minute pirate bugs are pollinators of the blush macaranga or Parasol Leaf Tree (*Macaranga tanarius*), which blooms year-round in Hawai'i. Individual trees have either male flowers or female flower and seed pods, but not male and female on the same tree. Blush macaranga will grow and bloom in pots, which can be moved around as needed to attract predators for thrips control in orchids and other horticultural crops in greenhouses.

Beneficial Insect Flashcards

Ted Radovich is an Assistant Specialist in the Department of Tropical Plant and Soil Sciences and UH, Mānoa and Hawai'i's State Coordinator for USDA's Western Sustainable Agriculture Research and Education program (WSARE). Radovich spoke about the biological control flashcards he helped develop (with Christina Theocharis, Jessica Radovich, and Mark Wright) on natural enemies of crop pests in Hawai'i. The series of 11 pocket-sized flash cards is entitled *Wanted Alive! Predators and Parasitoids: Identifying and Conserving Natural Enemies of Crop Pests in Hawai'i.*

Natural Enemies in Hawai'i. In Hawai'i, the import of natural enemies from outside the state is highly restricted, and there is currently no commercial source of natural enemies in-state. However, many beneficial insects have naturalized in Hawai'i. Two important strategies conserve natural enemy populations: cultivating flowering plants in and around production areas, and limiting pesticide sprays (including organic pesticides).

Natural Enemies Flash Cards. Developed to help growers and gardeners in Hawai'i identify natural enemies and conserve their populations, the cards highlight groups of predators and parasitoids found in Hawai'i. They include photos and information identifying each natural enemy, what pests it controls, and what plants encourage its presence.

Diane Clarke

Buckwheat can be used as a cover crop and attracts pollinators and natural enemies.

Predator cards include: hover flies (attack aphids, leafhoppers, mealybugs, thrips, and small caterpillars); lacewings (attack aphids, mites, thrips, mealybugs, caterpillars, whiteflies, and insect eggs); lady beetles (attack aphids, whiteflies, psyllids, mites, mealybugs, small insects, and insect eggs); minute pirate bugs (attack eggs and young larvae of corn earworm and corn leafhoppers, thrips species in flowers and on foliage, and spider mites); and predatory mites (attack spider mite adults, nymphs, larvae, and eggs; thrips; and small insects and their eggs).

Parasitoid cards include: Braconid wasps (attack aphids, tomato hornworm, various fruit flies, leafminers, diamondback moth, and armyworms); Encyrtid wasps (attack various insect eggs, larvae, or pupae including beetles, true bugs, moths, mealybugs, psyllids, cabbage loopers, and scales; also attack caterpillars and ticks); Ichneumonid wasps (attack larvae and pupae of diamondback moth, cutworms, and cabbage maggot); Pteromalid wasps (attack cabbageworm, diamondback moth, leafhopper and planthopper eggs, mealybugs, and caterpillar pests); and *Trichogramma* wasps (attack eggs of caterpillar [worm] pests, including cabbageworm, corn earworm, diamondback moth, and tomato hornworm).

A variety of flowering plants, including ornamentals, herbs, fruit trees, and vegetable crops, as well as buckwheat, attract these predators and parasitoids. Sunn hemp and composite flowers such as daisies, sunflowers, and marigolds, are among the flowering plants most frequently recommended on the flash cards. Each workshop attendee took home a set of the cards.

Meet the Pollinators: Global and Local Trends in Pollinator Diversity

Ethel Villalobos, entomologist in UH's PEPS department, is co-principal investigator for the University of Hawai'i Honeybee Project. Created in June 2008 to assist the Hawai'i Department of Agriculture with the control of the newly-arrived varroa mite, the project's goals include 1) honeybee colony health and management, 2) agricultural pollination needs and the development of pollinator-friendly farms, and 3) education and outreach to beekeepers and growers.

The majority of flowering plants rely on pollinators, and more than 200,000 species of animals are involved in pollen transfer, which leads to fertilization and fruit set. Vertebrate pollinators include bats and birds. Insect pollinators belong to four main taxonomic groups: 1) beetles, 2) butterflies and moths, 3) flies, and 4) bees (20,000 species). Only a few species of bees are social, and a great majority are solitary, with each female providing for her offspring. Endemic Hawaiian bees include 60 species of yellow-faced bees (*Hylaeus* spp.). *Hylaeus* are threatened due to habitat loss and narrow flower preferences. Alternative pollinators in Hawai'i agriculture include carpenter bees, leafcutter bees, and sweat bees; hover flies; and butterflies and moths.

Pollinators need a diversity of forage, suitable host plants for egg-laying, and refuges that are free from pesticides and have adequate moisture and temperature. A collection of unfavorable conditions in Hawai'i has come together to create unique challenges for pollination. A number of endemic bees are endangered, as are a number of endemic plants. There are few pollinators available for agricultural crops, and honeybee colonies have declined due to invasive honeybee pests. Besides the varroa mite, the small hive beetle, which arrived in 2010, has caused large losses among managed hives. (See the October 2011 edition of *The Western Front* for an article by Villalobos on the small hive beetle's impact on producers in Hawai'i.)

Diane Clarke

Sunn hemp, in addition to suppressing weeds and curbing erosion, attracts pollinators and beneficials, such as Trichogramma *wasps, which parasitize corn earworms.*

Villalobos concluded by saying more work is needed to safeguard native flora and fauna and to understand the contribution of agricultural pollinators. There is a need for public participation in making farm and urban environments safer for pollinators.

NRCS Technical and Financial Assistance to Benefit Pollinator Habitat

Cheryl Lambert, District Conservationist with NRCS, having previously worked on the central coast of California and in southern Arizona, is currently stationed in Hawai'i. Conservation of natural resources and sustainable agriculture are her main areas of focus.

NRCS Technical and Financial Assistance. Lambert outlined the technical assistance available to workshop participants, including evaluation for pollinator habitat; conservation planning and design and implementation of conservation practices; educational workshops; and conservation field trial support. Specific kinds of assistance relevant to the workshop audience included support with IPM, cover crops, field borders, hedgerows, pasture planting, and tree and shrub establishment. Financial assistance is available to those who participated in the workshop through a number of NRCS programs. Details are at ***http://www.nrcs.usda.gov***.

Mainland Pollinator Conservation: Case Studies and Questions for the Pacific Region

Eric Mader, Assistant Pollinator Program Director for the Xerces Society for Invertebrate Conservation and Assistant Professor of Extension, University of Minnesota Department of Entomology, spoke about the Society's work to conserve pollinators on the mainland and how lessons learned there might be transferred to the Pacific Region. The Society focuses mainly on endangered species, aquatic invertebrates, and pollinator conservation. Their agricultural pollinator conservation program on the U.S. mainland involves habitat restoration on farms, documenting at-risk pollinators, and applied research.

Bee Decline on Mainland and in Hawai'i. On the mainland, the European honeybee, which is a common managed-crop pollinator, has experienced a 50 percent decline in managed hives since 1950, and colony rental rates have sharply increased. Native bees are also in decline on the mainland, and in Hawai'i, at least 31 of 60 *Hylaeus* species are declining, endangered, or extinct. Mader said the loss of *Hylaeus* could be catastrophic for the survival of native plant species in low shrub communities.

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Participant Feedback: Outcomes, Impacts, and Potential Impacts

In a post-workshop survey, participants were asked how they would use what they learned. They were also asked to list impacts or potential impacts of the workshop for their work. Below are some of their replies.

How do you plan to use what you learned at the workshop in your work?

- Already ordered some seeds!
- Inclusion of beneficial insect conservation techniques in IPM training.
- Use Hawaiian pollinators and 'Tropic Sun' sunn hemp in plant rows for IPM.
- I now have a better framework for my work with Macaranga to supply thrips predators (understanding for which groups this work might be most important). Also, I made some important contacts. Finally, it occurs to me, for the first time, that these thrips predators might be important as pollinators on certain crops (in the process of eating pollen and eating thrips). After all, they are important pollinators for Macaranga. So we might get double-duty out of these predators (control of thrips AND better pollination of certain crops which typically have thrips in blossoms).
- Conduct trainings for Extension staff/community farmers: encourage planting of insectary-plants/cover-crops , encourage planting living-mulch, emphasize proper pesticide use:, i.e., time to spray/what to spray.
- I will use this information for outreach to agricultural producers, landowners, and the public and in conservation planning.
- Promote the idea of the maintaining insectary areas.
- I'd like to investigate alternative habitats for beneficials.
- Use the info in some of my presentations, including school garden training for teachers.
- Apply pollinator pastures in farming communities.
- More native plant testing and research.
- Integrating insectary plants into sustainable pest management program.
- I will incorporate 12 pages of notes into . . . Master Gardener public outreach classes on gardening. In these classes I plan to emphasize identification of beneficials/pollinators and specific plants one can use to attract beneficials/pollinators.
- Add information to future publications; extend information to growers.
- I have already talked to the farmers I provide pollination for about the pollinator pasture concepts as well as cover crops.
- Plan to look into planting border crops to attract beneficials to help with pests like thrips, aphids, mites, and mealies.
- Plan to try employing pollinator pasturing in and around the orchard. Hope to enhance the health of our resident honeybee colonies.
- We plan to set aside strips that aren't being farmed to allow flowering plants (such as daisies, sunn hemp) to grow. We have two beekeepers with hives on the farm. We will allow them to expand their hives to other locations on the farm if they want to.

Please list one or two impacts (or potential impacts) of the workshop for your work.

- Appreciated the talk about encouraging other vegetation (cover crops). The old school said to keep fields clean and free of other vegetation. I'm going to be changing my practices to keep up with the new knowledge.
- Reduction in pesticide use by using biological control and other IPM tactics.
- Better implementation of Macaranga as companion crop or hedgerow crop for other crops.
- More integrated approach to pest control with methods other than pesticides to control pests.
- Renewed enthusiasm for investigating alternatives to pesticides.
- Reduce chemical spraying. I didn't know that some of the things happening on my place were actually helping (e.g., "weeds").
- Teaching customers the need for benifical insects and why we need these insects in our environment.
- I will be putting in crops of sunn hemp and other plants.
- Greater knowledge of the types of beneficials/pollinators found in Hawaii. Greater understanding of the different methods to attract beneficials/pollinators.
- I met a number of people that I will call upon with questions and collaborations in the future.
- Able to identify and show others beneficial insects and how they can help to increase populations of beneficial insects. Able to explain honey bee pests and the status of research being conducted on bees and beneficials.
- Stop/avoid using broad spectrum insecticides and incorporating bee/beneficials friendly pesticide practices. Plant border crops or plants that will attract beneficials, which could possibly help us spray less, therefore saving time and money and the environment.
- More awareness of the importance of beneficials to the coffee crop. Will reduce the weed control spraying of certain areas that have large numbers of wildflowers growing on field edges.

Diane Clarke

The Importance of Native Bees. Even as bees decline, Mader said, there has been a 300 percent increase in global cropland requiring bee pollination since 1960. Native bees are of critical importance and can supplement honey bees if they are hard to acquire. Fifty to a hundred or more species of native bees are found in crops like sunflower or cranberry. Others are specialized for crops like berries, squash, apples, and alfalfa. Habitat is the critical ingredient. In one example, native bees fully pollinate California's Central Valley watermelons when more than 30 percent of the area within 1.2 kilometers of the farm is natural habitat.

Other Benefits. Improving pollinator habitat benefits other pollinators, such as Monarch butterflies. Soil and water quality benefit when pollinator plants are incorporated into buffer systems. Wildlife benefits too, since pollinator-produced fruits and seeds comprise 25 percent of the global bird and mammal diets. The same efforts that support pollinators also support predatory and parasitic insects. Soil fertility and crop productivity improve when flowering cover crop rotations are used on fallow fields. Crops such as buckwheat, crimson clover, and lacy phacelia, in addition to being nectar sources, can be used as green manure or as smother crops for weed control.

Wondering how lessons learned on the mainland may be transferred to the Pacific Region, Mader asked:

- How do we balance the needs of farmers, beekeepers, and native biodiversity?
- Are there other undocumented bee fauna native to the broader Pacific Region? How do we establish baseline conditions?
- How do we create affordable sources of native plant materials for habitat enhancement efforts?
- How do we foster greater dialog between Pacific region and mainland pollinator specialists?

Management Strategies of Honeybee Pests in Hawai'i

Ethel Villalobos of the UH Honeybee Project spoke again, summarizing the main threats to honeybee health in Hawai'i, which include pests (varroa mite, small hive beetle, and the fungus *Nosema ceranae*), pesticides (in-hive and agricultural insecticides and herbicides), and the lack of forage diversity.

Varroa Mite Control. There are few options for varroa mite control that work with Hawai'i's climatic conditions and year-round brood production and that allow for beekeepers to leave the honey "supers" on the bee boxes. (Supers are the part of the hive where honey is stored.) In 2009, Villalobos and her colleagues did a field test with a formic acid-based biopesticide for varroa mite control, with very encouraging results. The treatment leaves no residues in honey. Treatment thresholds and management recommendations need to be developed.

Diane Clarke

Rick Melnicoe

Small hive beetle monitoring trap.

Small Hive Beetle Control. Small hive beetle, which is indigenous to South Africa, has had minimal impact there, variable impact on the U.S. mainland, and intense impact in Hawai'i, where colony losses happen quickly and are large.

Control methods have included trapping, chemical treatment of hives, and soil drenching, none of which has been effective. Colony losses are still high.

UH researchers are studying the key elements that produce high population levels and methods that should be employed for control. They seek to understand the triggers for explosive population levels, factors that trigger invasion, and factors that trigger collapse. Explosive SHB levels may be promoted by such factors as climatic conditions, soils, colony characteristics, proximity to agricultural sites, alternative fruit hosts, and abundance of feral hives.

Colony characteristics being considered regard the balance of bees, space, and beetles. SHB levels vary rapidly. When the balance is altered by natural or humanly-induced events, the colony health can become unstable, and the more beetles there are, the more sensitive the system is. In addition, colony characteristics such as strength, age, and defensive behaviors by bees affect beetle impact.

In light of this, colony characteristics and colony management are very important in Hawai'i. Colony management is a powerful tool and is well-suited to Hawai'i's conditions. Intensive colony management reduces beekeeper-induced collapses, and it compensates for quickly changing conditions.

Farming with Bees: Extension Efforts and Grower Success

Scott Nikaido, who is working toward his M.S. degree under Villalobos, spoke about the UH Honeybee Project's outreach on farming with bees. Nikaido is the manager of the UH research apiary in Waimanalo on O'ahu. (See below for news about the group's visit to this facility on the second day of the workshop.)

The Importance of Honeybees in Hawai'i. Honeybees help increase yields and play an important role in the pollination of many vegetable crops in Hawai'i. Avocado, cucumber, Italian squash, lychee, macadamia nuts, and watermelon production in Hawai'i is dependent on bees. In 2008, these crops were worth $42.4 million.

The Need for Bee Outreach and Support. In 2007, the Varroa mite arrived to the islands, and honeybees are now scarcer. On O'ahu in 2008 and 2009, among managed hives, 275 colonies (65 percent) were lost. The extent of feral hive losses is unknown. The UH Honeybee Project provides information to farmers and beekeepers about pest control, encourages newcomers to beekeeping, and provides advice to growers who require bees for their crops. The goal is to teach growers and beekeepers how to use organic methods, find alternative farming practices that reduce pesticide input, and promote pollinator-friendly agro-ecosystems.

For growers who keep their own bees, project educators ask them to commit to weekly hive management, which includes basic beekeeping and honeybee pest monitoring. Weekly inspections follow a 16-item checklist and include looking at overall colony health, checking for small hive beetle, and treating for mites. Soft treatments to control pests are encouraged, including formic acid for mite control and beetle traps/colony manipulation for small hive beetle control.

Since insecticides are deadly to bees, the Project's outreach stresses how important it is for growers to find ways to minimize their destructive impact on pollinators. They encourage growers to avoid spraying crops when they are in bloom and at times of day when bees are most active. They should reduce pesticide drift, avoid contaminating water resources with pesticides or fertilizers, and pay attention to chemical formulations, using less toxic compounds. Growers are also encouraged to reduce or eliminate herbicide use by using alternative methods of weed control.

The outreach gives farmers tips about how to support other pollinators, like members of the Megachilidae family (leafcutter bees) and Xylocopa species (carpenter bees), providing bamboo and other types of nests for these solitary bees to encourage their presence and activities.

Hands-On Demonstrations and Panel Discussion

Between presentations, workshop participants had the opportunity to stop by a honey-tasting table with samples of different kinds of honey. The UH Honeybee Project and Jacquie Robson, Apiary Planner for the Hawai'i

Diane Clarke

Department of Agriculture's Apiary Program, presented an assortment of Hawai'i's honeys and information about services the Apiary Program offers for Hawai'i's beekeepers and growers. There were also hands-on demonstration tables with specimens of beneficial insects, beneficial identification cards, information about invasive pests of honeybees, packets of seeds for cover crops from the NRCS Hoolehua Plant Materials Center, and information on NRCS services and funding opportunities.

The first day of the workshop ended with a panel that included Jayme Grzebik, Assistant Extension Agent at UH, Mānoa's O'ahu Urban Garden Center in Pearl City; Howard McGinnis, a beekeeper and honey producer; and David Schell, general manager for farm operations for Island Princess, one of Hawai'i's largest macadamia nut growers and a manufacturer of specialty macadamia nut products. Panel members answered questions about management of pollinators.

> continued on page 8

Thank You, Rick and Linda!

Rick Melnicoe and Linda Herbst developed the Western IPM Center as an institution that strongly supports IPM in the West. We in the West are known for going our own way, and Rick and Linda have supported that individualism by listening to western IPM voices, implementing their excellent ideas, and facilitating projects and collaborations that have yielded the kinds of results described in this and previous reports.

As Center leaders, Rick and Linda created a flexible framework that works so well for the West, with its wide diversity of crops, densely—and sparsely—populated areas, immense public lands, and important natural resources. They created an environment that energized collaborations among IPM partners and focused on responding to stakeholder needs and delivering results.

Sudhir Vaikkattil

In March we asked some Center partners what they expect to miss when Rick and Linda have retired from the Center. Answers ranged from opportunities for laughter, to their leadership and ability to bring people together. Here is a sampling:

I truly appreciate the depth and breadth of Rick's and Linda's understanding of IPM in the West. They have such clear vision of IPM issues across the western states and territories. We'll miss the wealth of knowledge they hold and their willingness to work with everyone.

They are friendly, helpful, and supportive in all our interactions. I also appreciate Rick's efforts in keeping us regularly informed about all things IPM, and alerting us to related issues on the federal front.

Their "can-do" attitude. As many people have discovered, collaborations can be the dickens to pull off. Along the road to our upcoming workshop we have encountered some bumps. At each bump, Linda said, "We can make it work." This is pure gold.

Not only are they both wonderful people, but they have been very supportive of the "smaller states" through the grant programs and other assistance. They were always available to answer questions in a very personable way.

They exceeded my expectations in forming and managing the Western IPM Center. . . . Clearly, Rick . . . was an excellent choice for leading the IPM Center. He has a gift in terms of bringing communities together and listening to what they are saying.

As Rick and Linda retire, I'm sure that you join me in thanking them for their excellent leadership, support, judgment, and many other contributions to the success of the Center.

New Associate Director Carla Thomas and I both look forward to working with Center constituents and partners to keep up the momentum Rick and Linda started.

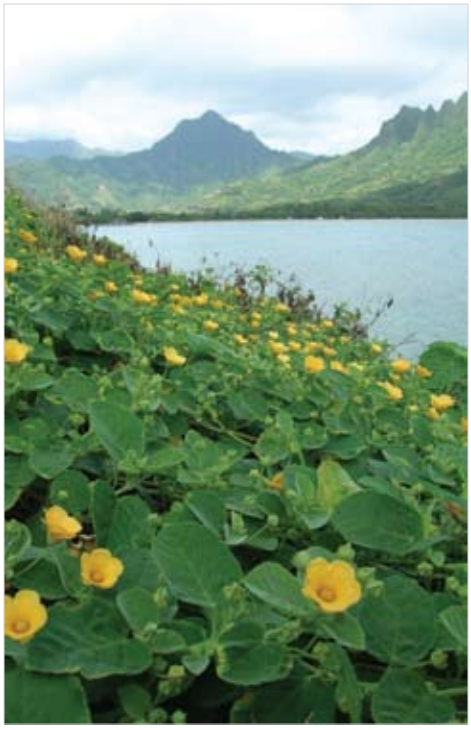
—Kassim Al-Khatib, WIPMC Director (starting July 1, 2012)

Pollinators—*from page 6*

Day 2: Tour

On day two, workshop participants boarded a bus and traveled to the eastern side of O'ahu.

The first stop was UH's 128-acre **Waimanalo Research Station**, where many participants suited up to get an up-close look at UH's research apiary. As Scott Nikaido, who manages the apiary, opened bee boxes, participants were able view, for example, the constructed frames on which the bees structure their honeycomb, the traps used by project researchers to monitor for small hive beetle, and the "queen excluder," a wire grate used to keep the queen bee in the hive, among other things.



Fores and Kim Starr

*'Ilima (*Sida fallax*) is a good choice for "pollinator pastures." It is indigenous to Hawai'i and is widespread on islands across the Pacific.*

At the next stop, **Pioneer Hi-Bred International**, in Kunia, company researcher John McHugh showed the group fields of cover crops planted with buckwheat and sunn hemp. Buckwheat is very fast-growing, with white flowers that are attractive nectar sources to natural enemy adults. It helps to suppress weeds and prevent soil erosion. Sunn hemp, in addition to suppressing weeds and curbing erosion, attracts *Trichogramma* wasps, which parasitize corn earworms. At Pioneer's Parent Seed station on O'ahu, sunn hemp cover cropping has resulted in an $80,000-per-year savings for the company, since they no longer have to treat for corn earworm.

The last stop on the tour was UH's **O'ahu Urban Garden Center**, in Pearl City. The 30-acre site, which hosts educational programs in urban horticulture for the public, has demonstration plantings that include a hedge maze, ecosystem-native plants, herbs, an idea garden, and vegetable and fruit trials. The Center is supported by about 100 volunteers, including UH Master Gardeners, who assist homeowners with gardening questions. For the workshop participants, Master Gardeners Brian and Mhel Cyr and Bob Speer joined Jaime Grzebik as guides to some of the Center's many features, such as the butterfly garden to encourage beneficial insects.

Update: IPM and Water Quality

The WIPMC is leading a signature program work group to develop multi-disciplinary curricula on "Best Management Practices to Reduce Pesticide Impacts on Water Quality in the West," adapted to different audiences and needs (e.g., Pesticide Safety Education Program educators, Master Gardeners, professional landscapers, and growers). To serve these audiences, work group participants have created 1-hour modules for 1) agriculture, 2) urban settings (parks, golf courses, etc.), and 3) urban settings (Master Gardeners/homeowners).

Draft curricula have been completed. These are currently being edited and will be peer reviewed in July and August. Final drafts are scheduled for completion in September/October, and piloting of the modules will begin with the different audiences in November. Use of the finalized modules is scheduled for early 2013.

Mark Your Calendar

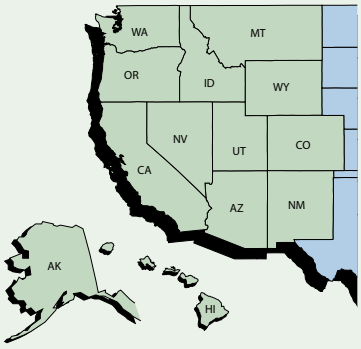
2012

- American Phytopathological Society Annual Meeting, August 4–8, Providence, Rhode Island. ***http://www.apsnet.org/meetings/annual/Pages/default.aspx***
- 2012 IR-4 Food Use Workshop, September 11–12, St. Louis Union Station Marriott, St. Louis, Missouri. ***http://ir4.rutgers.edu/***
- 6th National Small Farm Conference, September 18–20th, Memphis Cook Convention Center, Memphis, Tennessee. ***http://www.tnstate.edu/smallfarmconference/***
- Entomological Society of America 60th Annual Meeting, November 11–14, Knoxville, Tennessee. ***http://www.entsoc.org/am/fm/index.htm***

2013

- Western Society of Weed Science Annual Meeting, March 11–14, Catamaran Resort Hotel, San Diego, California. ***http://www.wsweedscience.org/default.asp***
- Entomological Society of America 61st Annual Meeting, November 17–20, Austin, Texas. ***http://www.entsoc.org/am/fm/index.htm***

Rick Melnicoe



Center Scope

The Western IPM Center enhances communication between federal and state IPM programs in the western United States: Alaska, Arizona, California, Colorado, Hawaii and the Pacific territories, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. It serves as an IPM information network, designed to quickly respond to information needs of the public and private sectors.

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

PROFILE

By Diane Clarke

Frank Zalom

Professor, Entomologist in the Agricultural Experiment Station, and Extension Entomologist, UC Davis

Frank Zalom is Professor, Entomologist in the Agricultural Experiment Station, and Extension Entomologist in the Department of Entomology at UC Davis. Since 2005, Frank has been the Western IPM Center's program manager for the USDA-National Institute of Food and Agriculture's Regional IPM (RIPM) grants program for the western region. The program awards approximately $650,000 per year in the West. RIPM grants fund research projects, extension projects, and research/extension projects. These grants seek to support the continuum of research and extension efforts needed to increase the implementation of IPM methods. Funding is awarded competitively to projects that develop individual pest control tactics, integrate individual tactics into an IPM system, measure the impacts of IPM adoption, and develop and implement extension education programs. Frank has also served on the Center's Advisory Committee.

Frank Zalom

Rick Melnicoe said, "Frank has been a key player in the development and management of the Western IPM Center. His unsurpassed knowledge of IPM, the research and extension system, USDA policies and procedures, state issues, and resource people throughout the West and the rest of the United States have helped us with countless issues." Rick added that Frank is always willing to lend a hand and provide sage advice. "Frank recognized, from their inception, the value of the Regional IPM Centers and how they could provide a mechanism to bring people and issues together. Without Frank's assistance, we would not have enjoyed all the successes we have had."

Historical Overview and IPM Leadership

Frank was born in Chicago and grew up in Arizona. He first became interested in insects when he took some entomology classes as an undergraduate student, but he didn't really get interested in IPM until he was well into his Ph.D. studies. This was the mid-1970s, and Frank said, "IPM was kind of radical at the time. My piqued interest in IPM went well with my long hair, moustache, and beads." Frank began his professional career as an Assistant Professor at the University of Minnesota, where he taught "Economic Entomology and Insects in Relation to Plant Disease" and conducted research on insect-transmitted diseases of vegetable crops.

In 1980, Frank joined the University of California Statewide IPM Program (UCIPM), newly funded by the California State Legislature. He served as Extension IPM Coordinator and Associate UCIPM Program Director for Research until 1986, when he became the program's Director. He served in that role until November 2001, when he stepped down to return to full-time research, teaching, and extension at UC Davis. Frank's colleagues characterize his approach to IPM as innovative and progressive but not dogmatic, promoting the economical use of biologically-based pest management alternatives. His leadership as Director of the UCIPM Program occurred during a critical period of its development. With its professional Cooperative Extension staff, Web site, and outstanding suite of publications, UCIPM came to be regarded as the prototypical state IPM program and has served to increase IPM use in a number of California's cropping systems.

Building Coalitions: California. While UCIPM Director, Frank interacted broadly with research colleagues, extension educators, growers, consultants, environmental groups, and public agency personnel in California, nationally, and internationally, advancing the science and use of IPM through building or contributing to coalitions, rather than through individual actions. For example, Frank co-chaired a task force that provided a UC analysis of the 1990 California "Big Green" ballot initiative. In the process, he co-authored the Report of the Vice President's Task Force on Alternatives to Targeted Pesticides, based on the database that was developed. That report was summarized for a special edition of the UC publication *California Agriculture* (see ***http://californiaagriculture.ucanr.org/landingpage.cfm?article=ca.v044n04p16&fulltext=yes***).

Building Coalitions: Nationally. Frank helped organize, and served as a group leader for, the Wingspread IPM Conference in 1991. During the conference, plans were formulated for the National IPM Forum that was held in Washington, D.C., in 1992, a seminal moment for the IPM community. Frank was co-organizer of the Forum, which was attended by 500 participants and speakers, including the U.S. Secretary of Agriculture and the U.S. EPA Administrator. This forum resulted in a call for a national commitment to IPM, a commitment the Clinton administration made in its statement of goals in 1993, calling for 75 percent adoption of IPM on U.S. farmland.

Frank has continued to be active in IPM leadership nationally. Among other contributions, he has served at different times as both Extension and Experiment Station Co-Chair for the Association of Public and Land Grant Universities' (formerly called NASULGC) National IPM Committee, and was co-principal investigator on the original USDA-CSREES Integrated Research, Education, and Extension Competitive Grants Program grant for $3.49 million that funded the Western IPM Center in 2002. In December, 2009, Frank was appointed the first Editorial Board Chair for Entomological Society of America's new Journal of Integrated Pest Management.

Building Coalitions: Internationally. Frank has hosted visiting students and scholars in his lab from 17 countries and has been engaged in a number of other IPM-related international activities during his career. For example, he received a National Science Foundation/ Czechoslovak Academy of Sciences Interacademy Exchange Scholarship in 1989, a Fulbright Scholarship in support of his 1992–1993 sabbatical leave in Spain, and was a Visiting Fellow of the Victoria (Australia) Department of Agriculture in 1995. Frank served on the USAID Pest Management Advisory Committee from 1994 to 2000 and on the Board of Directors of the USAID IPM Cooperative Research Support Program from 2001 to 2005. In 2005, he was co-PI on a USAID grant awarded for IPM research in Central Asia, and he leads the component goal of enhancing product lines of Central Asia bio-laboratories. The grant was renewed in 2010 for an additional 5 years at $1.25 million.

In 2007, Frank led a team of U.S. scientists on a 3-week exchange on the topic of "Integrated Pest Management Extension Opportunities for the U.S. and China." The exchange was sponsored by the USDA Foreign Agricultural Service Scientific Cooperation Exchange Program and the Ministry of Agriculture of the People's Republic of China. As part of this exchange, he presented seminars in Beijing, Fuzhou, and Shanghai. Frank currently participates in two UC Davis University Outreach and International Programs initiatives: the Iraq Agricultural Extension Revitalization (IAER) Program and the Afghanistan Sustainable

Agriculture Program (ASAP). He provides the IPM training for both of these programs, and has written a series of fact sheets that have been translated into Arabic and Pashto.

IPM Research, Extension, and Teaching

The overarching objective of Frank's research and extension program is the pursuit of knowledge that will advance the science and use of IPM.

Research. In recent years, Frank has focused his research primarily on California specialty crops, including tree crops (almonds, olives, prunes, and peaches), small fruits (grapes, strawberries, and caneberries), and fruiting vegetables (e.g., tomatoes). IPM strategies and tactics developed within the context of these systems include monitoring procedures, thresholds, pest development and population models, biological controls, and management with less toxic pesticides, many of which are incorporated into UCIPM's *Pest Management Guidelines* for these crops.

Emerging problems addressed within the IPM context of these cropping systems include issues with pesticide runoff mitigation and invasive species. Research on pesticide runoff resulting from orchard dormant sprays required a systems approach, and for that effort Frank assembled an interdisciplinary group, including horticulturists, ecotoxicologists, a hydrologist, and an analytical chemist, that has identified IPM alternatives and best management practices that are now widely used in California tree crop agriculture. Their research and public education efforts, which began in the 1990s, have contributed greatly to a 90 percent reduction in both dormant season organophosphate use and pesticide "hits" in surface waters.

Frank's lab has responded to six important pest invasions in the last decade, with research projects targeting glassy-winged sharpshooter, olive fruit fly, a new biotype of greenhouse whitefly, invasive saltcedar, light brown apple moth, and most recently, the spotted wing drosophila (*Drosophila suzukii*). The results of these studies are reflected in Frank's more than 290 journal articles and book chapters.

Extension. Frank has actively extended his research personally though presentations at meetings and field days, as well as through county Cooperative Extension staff, making more than 800 presentations at stakeholder meetings in California since 1980. Frank is a prolific contributor to UC Cooperative Extension publications on tree crops, small fruits, and fruiting vegetables, as well as those published by commodity boards and in trade journals. These include significant technical contributions to UCIPM's IPM Manuals for strawberries, grapes, apples and pome fruit, stone fruit, almonds, and tomatoes.

Teaching. Frank teaches ENT 110, Arthropod Pest Management, a 5-unit course offered in the winter quarter at UC Davis. The class is primarily comprised of undergraduate students with plant science majors and fulfills the IPM requirement for students taking the California Department of Pesticide Regulation exam to become licensed Pest Control Advisers (PCAs). Frank has also long been active in graduate education, having served as major professor for 11 entomology Ph.D. students, six M.S. students in the IPM and Entomology Graduate Groups, and one M.S. student in the International Agricultural Development Graduate Group.

Professional Honors, Awards, and Service

Frank has been the recipient of more than 20 university, state, national, and international professional honors and awards recognizing all aspects of his career, including being elected a Fellow of the California Academy of Sciences, the Entomological Society of America, and the American Association for the Advancement of Science. In 2011, Frank was elected to the national presidential line of the 6,500-member Entomological Society of America. He will serve as its Vice President-Elect (2012) and then Vice President (2013) before becoming national President in 2014.

Current Projects

Frank admitted, "I have way too many projects at the moment." One project he and his colleagues are concluding is an evaluation of "Community Perceptions of USDA-APHIS Emergency Response Programs." He has a postdoctoral scholar, Greta Lelea, and an M.S. student, Jen Sedell, who have community development/geography backgrounds working on the project. Through analysis of newspaper and other media accounts and also through interviews with affected people, they are examining the community response to the light brown apple moth and European grape vine moth emergency response programs in the Bay Area counties of California. Frank said, "There is a real story to tell here from the point of view of the various affected stakeholder communities. I have been impressed by the cooperation we have received from USDA-APHIS and the willingness of senior management to interact with us in the course of the study." On the science side, he said, the work he and his students and colleagues have done with biology and management of *D. suzukii* has been really interesting. "We have identified a yeast species that is highly associated with *D. suzukii* and is apparently used by their larvae as a protein source for development. The implications are really significant. We are also identifying insecticide resistance genes in *D. suzukii* that will help us confirm mechanisms," said Frank.

Concerns Regarding IPM

Frank's chief concerns about IPM are 1) getting IPM focused again on managing pests in a longer-term systems context, and 2) inspiring and then training a new generation of IPM specialists for research, extension, and the private sector. Frank said, "IPM is really applied ecology, looking at pests and management in the context of the pest's environment, whether it is an agricultural, a landscape, or a medically-important problem. It is not just about applying some least toxic pesticide, although that may be one component of its management." Frank said that understanding the basic biology of a pest and its interactions in the landscape is critical and that this concept is also important in training the next generation of IPM specialists. "They need to be versed in pest identification and pest ecology, and they need to have an understanding of assessing the risk of a pest and what options are available to manage it. IPM specialists, whether they are at the universities, at government institutions, or in the private sector (especially crop consultants) are not getting any younger, and there are not enough well-trained young people with even minimal experience coming along to replace those people who are retiring." He added that IPM is knowledge-intensive, so there needs to be a concerted effort to inspire and then train young people. "They need to know that there are opportunities, especially in the private sector, for an interesting and rewarding profession," he said.

> ***"[Students] are like your own kids. When they succeed, you just couldn't feel better."***

Blessed by Opportunities

Looking back on his career, Frank said, "I was blessed relatively early in my career by being surrounded by truly outstanding colleagues at the UCIPM Program. I think that many of these people will become legendary to the more recent IPM specialists, much as those in my generation thought of legendary UC researchers and extension staff that were the real pioneers of IPM." He added, "I like to think that we helped advance IPM in California to a higher level, although maybe it was all too often two steps forward and one step back. I also feel blessed having had an opportunity to collaborate with outstanding IPM specialists from throughout the country and the world. I don't know exactly how that happened, but I feel grateful for all of the friendships that I have established in the larger IPM community." Regarding his teaching, Frank expressed how much he likes the personal relationship that develops with students. "They are like your own kids," he said. "When they succeed, you just couldn't feel better. My most satisfying accomplishment has been seeing so many of my students join the IPM community all over the country and become successful."

Contact Frank Zalom at ***fgzalom@ucdavis.edu***.