United States Environmental Protection Agency

REGION/ORD PESTICIDES WORKSHOP SUMMARY REPORT

October 31-November 2, 2000
Chicago, IL

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FOREWORD

This *Region/ORD Pesticides Workshop* is the fifth in a series of Regional Science Topic Workshops sponsored by the Office of Science Policy in the Office of Research and Development (ORD) at EPA. Others in this series include:

Asthma: The Regional Science Issues
Communicating Science: Waves of the Future Info Fair
FIELDS
Nonindigenous Species

The objectives of the Regional Science Topic Workshops are to: (1) establish a better cross-agency understanding of the science applicable to specific Region-selected human health and/or ecological topics, and (2) develop a network of EPA scientists who will continue to exchange information on these science topics as the Agency moves forward in planning education, research, and risk management programs.

Each year the EPA Regions identify priority science topics on which to conduct workshops. The workshops address the science issues of greatest interest to the Regions on the selected topic area. Each workshop is planned and conducted by a team of Regional, ORD, and interested Program Office scientists, led by a Regional chairperson and facilitated by one or more Regional Science Liaisons to ORD. Participants maintain the cross-agency science networks they establish at the workshops through planned post-workshop projects and activities, such as the identification of collaborative research opportunities, creation of information sharing mechanisms such as interactive web sites, and development of science fact sheets for Regional use.

For additional information on any of the specific workshops or on the Regional Science Topic Workshop series in general, contact David Klauder in ORD’s Office of Science Policy (202-564 -6496).

EXECUTIVE SUMMARY

The Region/ORD Pesticides Workshop was held on October 31 - November 2, 2000, at EPA Region 5 Offices in Chicago. The workshop was chaired by David Macarus, Regional Science Liaison to ORD in Region 5, and David Klauder, Regional Team Leader in the Office of Science Policy/ORD. The workshop was organized into six sessions:

- IA. Exposure Issues: Indoors;
- IB. Exposure Issues: Spray Drift;
- IC. Exposure Issues: Vector Control;
- II. Highly Exposed and Sensitive Populations;
- III. Risk Management; and
- IV. Ecological Issues.

Regional staff presented four site-specific case studies as a way of illustrating the major science issues underlying typical problems confronting the Regions, namely indoor pesticide misuse, pesticide drift, use of pesticides for mosquito control, and the ecological impacts of pesticide residues. Representatives of the ORD and Office of Pesticide Programs (OPP) followed with presentations describing research studies, measurement tools, data, models and methodologies relevant to the Regional science issues. Subsequent discussions revolved around how the Regions could use ORD and OPP data and tools to support the activities and gaps identified in the case studies. The discussions also highlighted how additional field data and other Regional information could augment the development and validation of applicable ORD and OPP models and databases.

Break-out sessions followed each workshop session (consisting of the Regional case study and related ORD/OPP presentations) to identify: 1) how the Regions could use the science presented; 2) what scientific uncertainties limit EPA's ability to conduct assessments and take fully informed actions; and 3) what products or tools would help fill the gaps in science information. In addition to a list of science gaps, break-out participants identified candidate topics for post workshop "pesticide science discussion groups." The workshop organizers compiled these topics into five tentative discussion group topic areas. Region/ORD/OPP topic area discussion groups will meet during the first part of 2001 to discuss and develop appropriate informational tools, e.g., fact sheets for effectively communicating pesticide science information to identified Regional target audiences.

Participants expressed appreciation for the opportunity to view their own work in the context of other related activities across the Agency and for the opportunity to network with those doing supporting research. The workshop format was thought to be an excellent venue to identify how available science could support field activities and identify where further research is needed.

Call to Order: David Macarus, US Environmental Protection Agency, Region 5

Welcome: David Ullrich, US Environmental Protection Agency, Region 5

Introduction: David Klauder, US Environmental Protection Agency, Office of Research and Development, Office of Science Policy

HEALTH ISSUES

Session IA: Exposure Issues: Indoors

Case Study 1: Methyl Parathion Misuse

John Ward (R5)

Statement of the Problem

Unlicenced pesticide applicators illegally sprayed methyl parathion, a pesticide licensed for use on cotton, to control cockroach infestations in homes in several urban areas including Lorraine County, Ohio; Detroit, Michigan; Memphis, Tennessee; and Chicago, Illinois. The human health effects to residents and the requirements for identification and cleanup of the misused insecticide were the initial problems confronting Regional Pesticide and Superfund Program staff.

Background

Methyl parathion (MP), a pesticide registered for use on cotton and a few other crops, was illegally applied inside residences in Ohio, Louisiana, Mississippi, Tennessee and Chicago. MP continued to be found in homes over a year after application. While the outdoor environmental fate data show MP breaks down quickly (reported half life of ~ 5 days), there were no data on the breakdown indoors. Neither the Registrant ChemiNova nor OPP had data on indoor fate, and no predictive models were available.

In Loraine, Ohio, the first impacted area that was discovered, a coalition of State of Ohio Department of Agriculture Staff, EPA Regional Pesticide, and Superfund Toxicology Staff enlisted CDC and local public health officials to rapidly assess the extent and toxicological consequences of the pesticide misuse. Similar partnerships were formed as other areas of MP misuse were discovered.

In Ohio, the air and surface wipe samples taken in the homes showed little correlation. Attempts were made to conduct biological monitoring (blood and urine), but adequate laboratory capacity was unavailable. Risk assessors had to make a decision quickly, since thousands of people were being exposed in hundreds of homes. EPA and ATSDR finally agreed on a trigger level based on composite surface wipe samples, and the age and health of residents. One-and-a-half years later, when incidents arose in Mississippi, the CDC was equipped to handle large volumes of urine samples, so the criteria for evacuation and cleanup went through stages of environmental wipe sampling (for presence of methyl parathion) and testing of urine for paranetrophenal (PNP).

Over the five areas impacted, over $100 million was spent to evacuate, remediate, and move residents back into their homes in the affected communities. The reason for the similarity of misuse in several different areas is likely due to the effectiveness of MP in controlling cockroaches and other indoor pests combined with its comparatively low cost when purchased at bulk agricultural prices.

Important Science Issues

1. What are the best indoor measures of potential exposure to indoor applications of methyl parathion - air or surface wipe concentrations?

2. What is the fate of methyl parathion applied or tracked indoors?

3. What is the best solvent for extracting methyl parathion from surface wipe samples?

4. Why was so little toxicity observed among residents in Lorraine County, given the very high surface wipe and urinary PNP concentrations?

5. Which parts of the house are best to sample, for purposes of estimating exposures?

6. Which are the most significant exposure routes, i.e., inhalation, dermal, and/or oral (hand-to-mouth)?

Challenge to Addressing Science Issues

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) require pesticide registrants to supply human health and environmental fate studies for the planned uses. Since methyl parathion is not registered for use indoors, environmental fate and indoor exposure issues were not addressed in the data required for registration.

Major Science Needs

1. Improved wipe sampling solvents and methods.

2. Environmental fate data for indoor pesticides.

3. Better human health related effects of MP residues. Residues found did not necessarily relate to symptoms or illness reported by residents. Although families reported illnesses that suggested organophosphate poisoning, none were confirmed. In Chicago and Mississippi, PNP levels in urine did not closely correlate with environmental samples.

Conclusions and Next Steps
CDC has begun a long-term health study, which may provide some additional information.

The Movement and Deposition of Pesticides Following Their Application In and Around Dwellings, Dan Stout/Bob Lewis, US Environmental Protection Agency, National Exposure Research Laboratory

A field study was conducted to develop an analytical method to determine exposure to environmental pesticides, to examine the movement and deposition of the pesticide, to determine the fate behavior and translocation, and to examine collection tools.

Background
During or following residential applications, pesticides may translocate or move by drift, volatilization, or physical pathways such as track-in. The general characteristics that influence the fate, behavior and movement of pesticides out of doors are: its physical characteristics, the formulation type, the substrates to which it's applied, and environmental factors such as temperature, exposure to ultraviolet (UV) radiation and microorganisms. Furthermore, the primary routes of pesticide loss occur by vapor dissipation, residue bound particles, UV exposure and microbial degradation. However, pesticides that intrude or translocate indoors are not similarly exposed to such degrading factors and may result in residue concentrations in dwellings that are 10 to 100 times higher than those measured outside.

Study
The drift resulting from exterior perimeter applications to residential dwellings was evaluated. Microencapsulated formulations of the insecticides diazinon and chlorpyrifos, were applied by a licensed pest control operator to a total of ten residential homes. Applications of between 10-15 gallons of diluted pesticide formulation were applied per house, at a pressure of 30 psi. Measured wind speeds were ?3 mph. Deposition coupons consisting of cellulose filter papers were placed at intervals up to 50 ft from the foundation walls.

In another study, successive indoor and perimeter applications of the insecticides diazinon and chlorpyrifos were studied. Two applications were performed by the homeowner, in one residential home, approximately three months apart. Various samples were collected including: indoor air; vacuum dislodgeable dust from carpeted areas; and table-top, floor, child hand and toy wipes. On the exterior foundation, soil was also collected.

Results
Following perimeter treatments to the foundations of residential homes, insecticide residues of both cyfluthrin and diazinon were measured up to 50 feet from the point of application. Findings suggest that drift primarily resulted from large particles generated during application and that drift varied to a lesser degree with the physical characteristics of the active ingredients and their formulations.

In the second study, residues were shown to quickly disperse into air and onto surfaces throughout the dwelling following an application. Lifestyle patterns such as heating and air conditioning use and open or closed windows appear to impact indoor concentrations. In general concentrations increased immediately following each application and rapidly declined to levels higher than those measured prior to each application. Residues were measurable from children's toys and might serve as potential source of exposure.

Exposure Routes and Pathways: Indoor Factors and Scenarios, Linda Sheldon, US Environmental Protection Agency, National Exposure Research Laboratory

Objectives of the NERL Measurement Program are designed to:
? Identify pesticides, pathways, and activities that represent the highest potential exposures;
? Determine factors that influence pesticide exposures, especially to children;
? Determine approaches for measuring multimedia exposures, including those that account for important activities in homes, schools and daycare settings; and
? Generate data on multimedia pesticide concentrations, biomarkers, and exposure factors for inputs to aggregate exposure models.

Two approaches are used to estimate exposure:
1. The Direct Approach, which can involve:
? Measuring receptor contact (with chemical concentration) in the exposure media, over time;
? Personal monitoring techniques which are used to directly measure exposure to an individual during monitored time intervals (personal air, duplicate diet); and
? Biomarkers that are indicators of the absorbed dose that resulted from direct exposure.

2. The Indirect Approach, which can involve:
? Use of available information on concentrations of chemicals in exposure media;
? Information about when, where, and how individuals might contact the exposure media; and
? Algorithms and a series of exposure factors (i.e., pollutant transfer, pollutant uptake).

Priority Research Areas Identified

Total exposure assessments are conducted using a combination of direct and indirect approaches. Details were presented of the various approaches to systematically identify the data required to estimate exposures by each route, develop approaches for generating the required data, and to apply these to field studies to develop distributional data on exposure and the relevant exposure factors. A variety of algorithms and formulas, as well as data requirements, were described. To calculate each of the different exposure levels, the resulting priority research areas are:
? Pesticide use patterns;
? Distribution of pesticide residues;
? Dermal and non-dietary exposure assessments including micro and macroactivity approaches; and
? Dietary exposure assessments

On-Going Studies

The major studies and research activities either on-going or required to fully develop the assessments fall into three subtask areas:

1. Those that are targeted to develop and evaluate dermal exposure assessment approaches, including:
? Study to test the feasibility of using the macroactivity approach to assess dermal exposure;
? Study to identify important parameters for characterizing pesticide residue transfer efficiencies;
? Additional proof of concept studies required to complete development of methods and protocols for macroactivity assessment approach;
? Collection of pesticide transfer efficiency data for microactivity approach; and
? Study to investigate the distribution of pesticide residue on skin following contact with a contaminated surface.

2. Collaborative field studies, to:
? Enhance the EOHSI Children's Post-application Pesticide Pilot Study
? Enhance HUD National Survey of Environmental Hazards in Child Care Centers
? Characterize Human Exposure in Low SES Communities in the RTP, NC Area.
? Collaborate with CDC on Potential Pesticide Exposure of Young Children Living in an Urban Area in the Southeastern U.S.

3. In-House field and laboratory studies, including:
? Study examining pets as transfer vehicles of pesticide residues following lawn application;
? Coding the activity patterns of preschool children;
? Pesticide distributions in EPA test house;
? Children's Post-Application Diazinon Exposure Feasibility Study;
? Characterization of semi-volatile pesticides using 53-L environmental chambers; and
? Use of fluorescent tracer technology to investigate dermal exposure.

Session Questions and Responses

Question: How much work does it take to verify a model with human subjects?
Response: Based on the studies, 2 ½ years.

Question: Was breast feeding considered in the exposure studies?
Response: OPP has been asked to determine exposure via dietary ingestion and they are also looking at the route of breast milk for un-modified pyrethides.

Question: Were the cholinesterase levels changed in the methyl parathion incidents?
Response: Even in cases of emergency response, there were still no large decreases in cholinesterase, yet, they did have classic symptoms of diarrhea and vomiting. Therefore the question is whether or not the measurements were too conservative.

There was lots of anecdotal information (R5), even one suspected death, but actual data on these were unobtainable.

Question: When setting the screening levels for exposure, was age taken into account?
Response: Risk management safety factors were used to account for the inability of fetuses and infants to detoxify contaminants.

Question: How was a "significant" decrease in cholinesterase level determined?
Response: A baseline is first needed from which to determine a change. However, no baseline values were known for the Ohio area. There was a reduction seen in the occupational levels, for which baselines were already established.

Question: Was there an observed change in cholinesterase levels between acute and chronic exposure in methyl parathion?
Response: This has not yet been tracked.

Question: Is anyone looking at the specifics of the cases that triggered concern?
Response: Veterinarians in the area mentioned dog and cat deaths from organophosphate poisoning and these were investigated where possible. Odor complaints were investigated in Ohio. CDC also conduced Sudden Infant Death Syndrome (SIDS) study, but found no significant difference.

Session IB: Exposure Issues: Spray Drift

Case Study 2: Off-Site Movement of Pesticides

Raymond Chavira (R9)

Statement of the Problem

The EPA Regions are concerned about the potential for exposure to people and the environment resulting from the off-site movement of pesticides and their breakdown products following pesticide applications. For purposes of this paper, off-site movement is defined as the inherent physical airborne transport of pesticides and their breakdown products in either particulate, liquid, or vapor form beyond the target area where the parent pesticide is applied, including drift. EPA's Office of Pesticide Programs has the responsibility to license the use of pesticides and to ensure that pesticide use results in no "unreasonable adverse effects" to humans and the environment. While OPP efforts regarding off-site movement have focused primarily on controlling spray drift, an additional fraction of the pesticides applied eventually enters the air as vapor either through the application process or subsequently from evaporation from soil or plant surfaces (revolatilization). Additionally, particulate matter can be eroded from the soil surfaces by the wind or agricultural activities and further carry pesticides into the air.

Each year over 2500-plus drift incidents are reported. The Agency believes many incidents go unreported. Further, the Agency recognizes that off-site movement from spray drift will occur with nearly all pesticide applications. Hence, direct respiratory and dermal exposure from off-site movement is likely to be of concern for those individuals living and working near application sites. The California Air Resources Board has conducted pesticide ambient air monitoring under its state-mandated Toxic Air Contaminant Program for over 40 pesticides. The monitoring program consists of 4-6 week of 24-hour air measurements during a month of high use in a county of high use for each pesticide. Although the data set is not worst case, it may represent general population exposure in high use areas.

Although information on off-site movement may exist, it is not readily accessible or in a practical format for use by States, Regions, and Tribes. OPP decision products are primarily focused on the registration/re-registration of pesticides at the national level (rather than the quantification of impacts of pesticide use at the local level) to validate registration decisions. In this process, data are considered pesticide-by-pesticide. Yet Regions are frequently asked to assess impacts on a site-specific basis. Therefore, EPA Regions need tools to measure and estimate the extent of exposures and potential for human and ecological harm resulting from the actual off-site movement of pesticides.

Background

More than two hundred incidents related to off-site movement occur in Region 9 on an annual basis. The risk to individuals working, playing, and/or living in proximity to pesticide treated areas needs to be assessed. For instance:

? In September 1996, 247 workers in a grape vineyard were exposed to three pesticides which drifted from a nearby cotton field where an aerial applicator was applying the pesticides. The plane was applying a mixture containing chlorpyrifos, fenthropathrin, and profenofos to control mites and aphids. Based on statements from bystanders taken by State and County enforcement personnel, it appeared a slight breeze carried the pesticides toward the grape field where the chemicals came down on workers, many of whom tried to escape by running away. Victims exhibited a range of pesticide poisoning symptoms including vomiting and irritated noses and eyes. Twenty-two workers including three pregnant women were rushed to the hospital, treated and released.

? More recently, chlorpyrifos and propargite sprayed on an almond orchard drifted into a neighboring vineyard located a half-mile away, exposing 24 women farm laborers who were trimming vines. The farm workers complained of nausea and burning eyes, and residue analysis indicated exposure to the pesticides applied to the almond trees. It was reported that the helicopter pilot denied any drift and accused the workers of faking their illnesses.

? In California, pesticide exposure-related health symptoms have been documented without corresponding monitoring or exposure data. (California is the only Region 9 State with systematic gathering of health data pertaining to potential pesticide exposures). Ames and Stratton (1991) have identified health symptoms “consistent with” the toxicological characteristics of organophosphate sprays at the agricultural urban interface (AUI).

? Two recent vapor drift incidents in California required the evacuation and closure of a school (Cuyama in Santa Barbara County) and evacuation of part of a town (Earlimart in Tulare County) as a result of the fumigant metam sodium. California has developed guidelines and additional measures for materials such as metam sodium, methyl bromide, and 1,3-dichlorpropene (1,3-D), but compliance with these measures appears problematic given the number of vapor drift incidents related to these fumigants.

? Both rural and urban residential communities are often interlaced with actively cultivated fields and farm land where a relatively high volume of chemicals is used for pest management and soil amendment. Exposure to airborne pesticides and their breakdown products is a major concern for residents in these communities. In response to community health concerns real or perceived, the communities of Lompoc (pop. 40,000) and McFarland, California (pop. 8,000) have garnered EPA, State, and local attention and involvement.

? A residential drift incident occurred recently whereby a homeowner sprayed a malathion product while children where playing in a pool next door. The corresponding odors were such that the parents had their children stay inside. One child (an asthmatic) experienced coughing and wheezing, although the cause of these symptoms could not be directly attributed to the use of a pesticide product.

Pesticides are undesirable in the general environment for many reasons: smell, appearance, and danger to wildlife and non-target plants. The public commonly wants to know, “Are we safe?” Lompoc residents continue to exhibit frustration at the inability of agencies to answer what appears to be a fundamental question, i.e. "What are the impacts of the use of pesticides in the Lompoc Valley on the health of the community?" The inability of authorities to give simple, definitive answers to these questions continues to erode the credibility of participating government agencies. Under the current pesticide regulatory/enforcement paradigm, the burden is on the community to convince regulators that their symptoms are associated with a particular pesticide, yet, tools necessary for the public and regulators to assess exposure either do not exist or are far from practical use (i.e. implementation of exposure assessment tools on a widely accepted scale).

Important Science Issues

1. Fate and Transport. Despite a growing knowledge base for the reactivity and transport of pesticides, the degree to which each of these fate and transport processes occurs is largely unknown. Moreover, a complete mass balance of the fate of field-applied pesticides does not exist in the open literature. Once in the air, pesticides may remain in the gaseous state, partition onto particulate matter, be scavenged by water droplets, undergo degradation reaction, or be resuspended onto soil, plant, and other surfaces. While it appears that primary spray drift may not be chemical dependent, vapor drift is related directly to the chemical properties of the pesticide and its carriers. Fumigants such as methyl bromide, metam sodium, and 1,3-D have been detected in ambient air following applications. In addition, ester formulations of phenoxy ester herbicides as well as defoliants may volatize and drift under high temperature conditions.

Estimates in the scientific literature of the amounts of pesticides which migrate "off-site" from the point of application range from a few percent up to 90 percent depending on the method of application (aerial vs. ground equipment, application height, and droplet size) and local environmental conditions, e.g., wind speed. The preponderance of data in OPP environmental fate databases indicate that typical losses due to primary spray drift only fall within 1 - 10 percent. However, certain application approaches and unfavorable local conditions may result in considerably greater losses through spray drift and volatilization. With regard to the efficacy of pesticide spray applications, losses to soil and peripheral non-target foliage may be as high as 60 to 80 percent under non-ideal conditions (Cheng, 1990). The US Office of Technology Assessment (1990) has estimated that up to 40 percent of all pesticides applied can move off-site through spray drift, misapplication, volatilization, leaching, and surface transport.

Finally, the odors associated with pesticide use provide physical evidence of chemical movement and exposure at an undetermined level often below what, if available, current sampling and analytical methodologies can measure. However, the toxicological significance of these levels is subject to much debate among various stakeholders.

2. Air Monitoring and Modeling Studies In or Near Agricultural Areas. Most pesticide air monitoring studies have been focused on either long-range transport of persistent organochlorine (OC) compounds or immediate off-target spray drift. Studies located in or near agricultural areas are generally short-term, seldom lasting more than a year primarily due to costs.

More important to the Regions, land-use patterns which have allowed urbanization adjacent to agricultural lands have increased concerns about off-site pesticide movement from agricultural pest control operations. Agricultural chemicals constitute a unique class of air pollutants which are intentionally released into the environment and for which there is minimal or no environmental monitoring data routinely gathered under existing regulatory programs. Therefore, it is difficult to convince an already wary public that pesticides are safe when we do not have an ongoing National Monitoring Plan (FIFRA §20) to identify the ultimate fate and impacts of these chemicals at specific locations and under local physical and meteorological conditions.

3. <u>Methods and Tools to Assess Exposures Resulting from Off-Site Movement</u> An understanding of the extent and magnitude of exposures to non-target organisms resulting from nearby pesticide applications is key to the formulation of effective responses to these incidents by government officials. The Regions and States have very limited access to reliable tools which integrate fate, transport, and monitoring/modeling data (science issues 1 and 2 above) to estimate pesticide exposures soon after an incident is reported. Likewise, cheap, readily available biomarker test methods which can be used to assess the extent and magnitude of exposures to humans and ecological organisms resulting from the off-site movement of pesticides are essential.

Challenges to Addressing the Science Issues

With regard to off-target movement, EPA has made significant strides in recent years in risk assessment pertaining to spray drift, and will soon offer new drift labeling guidance. The development and submission of a large data set by the industry's Spray Drift Task Force, the successive collaborative development of the AgDRIFT model, and its imminent integration into risk assessment specific to drift, represents a significant refinement of OPP's ability to accurately estimate impacts from spray drift. However, EPA has not developed a systematic approach to characterizing other forms of off-target movement that result in airborne pesticide residues.

While new label language is forthcoming, the effectiveness of label restrictions is limited by the paucity of tools available to applicators and enforcement authorities to assess compliance with application and field conditions as required by the label. Enforcement personnel require drift tools to assess compliance. For instance, soil, wipe, dust, and air residue samples are not routinely taken to assess off-site movement because of the lack of methods and laboratories available to conduct such tests. In addition, tests for biomarkers of exposure are nonexistent or too costly, and available exposure models do not consider all critical local variables, e.g., pesticide application methods, quantities applied, multiple chemicals and multiple exposure routes, local climate, etc.

Major Science Needs

1. Standardized sampling and analytical methodologies to measure pesticide exposures.
2. Demonstration of these methods in the field supported by a QA Performance Evaluation Program.
3. Collection of ambient and near-field (i.e. fence-line) air levels over a relevant exposure period.

4. Assessment of the impact of multiple pesticides (parent and breakdown products, diluents and carriers) used simultaneously. Ambient air samples have been collected in California and elsewhere, these data need to integrated into a cumulative exposure model.
5. Data analyses designed to associate air levels with pesticide use data (temporal/spatial), crop patterns, application method, and quantity applied (qualitative and/or quantitative). Uncertainty analysis should be conducted, if possible.
6. Develop model from empirical data to estimate a chemical's subcooled liquid true vapor pressure and solubility under varying field conditions. Incorporate these values into models, as needed.
7. Atmospheric reactivity data to estimate the half-life or atmospheric lifetime of parent to primary transformation or breakdown product.
8. Develop model for estimating the extent of dry and wet deposition into ecologically-sensitive areas.
9. Develop tools to assess the association between pesticide use and near-field ambient levels. These tools should be practical enough for use by applicators and enforcement authorities.
10. Develop a predictive exposure model incorporating indoor/outdoor drift influences including an estimation of the extent of outdoor-to-indoor penetration.
11. Field validation of models which predict off-site movement. These studies should be conducted post-registration and by independent entities.
12. Better assessment methodologies/tools to estimate non-target exposure to pesticides (and breakdown products) on non-occupational residents and ecological receptors.
13. Validate exposure and fate and transport chemical mass balance models to address multiple routes and multimedia exposure issues.
14. Develop biomarkers to assess exposure (gold standard). Critical for exposure analysis and comparisons between other exposure and baseline data.
15. Develop air-based screening levels derived from toxicological data to assess near-field acute, sub-chronic, and chronic exposure scenarios.
16. Methodology for calculating inhalation cumulative risks for toxics i.e. (HAPS) while including the contribution from pesticide products both in indoor and outdoor environments.
17. Methodologies to determine the effectiveness of mitigation efforts designed to reduce off-target chemical movement .

The Regions would use the data resulting from research in these areas to (1) better understand pesticide exposures and risks associated with off-site movement of pesticides, (2) assess the cumulative effects of the multiple airborne pollutants in both rural and urban communities; (i.e., mixture of agricultural and non-agricultural air pollutants), and (3) develop potential performance measures to meet GPRA, i.e., to reduce exposures to pesticides by xx percent from 2000-01 levels by 2004-5. (What are the current levels? Are they increasing, decreasing or staying the same?)

Conclusions and Next Steps

As public concern about pesticide issues increases, the Agency must continue to improve its risk assessment methodologies and risk mitigation strategies to better estimate and reduce risks to humans and the environment from exposures to the off-site movement of pesticides. The EPA Regions urge OPP and ORD to continue to develop more refined risk assessment tools for use in decision-making for pesticide registration and to respond to public concerns. EPA must strive to develop more accurate estimates and measurements of pesticide exposures to non-target organisms, especially humans, under different application and local environmental conditions and to use these data in making registration and re-registration decisions.

Models for Estimating Exposure, Haluk Ozkaynak, US Environmental Protection Agency, National Exposure Research Laboratory

A description was presented of many of the modeling tools used to estimate exposures, and of the steps needed for a modeling analysis. These were further detailed and illustrated by the successive speakers. Several types of modeling tools exist that depend on the need and application, and type of data available.

Example models include:

? Conceptual models;
? Screening or regulatory models – these go beyond conceptual models and use fixed values;
? Physical or mechanistic models – these include process/emission; fate and transport; multimedia, multi-pathway concentration; microenvironmental exposure; and PBPK/dosimetric models;
? Statistical Models – these are population exposure models and can be empirical, semi-empirical, or stochastic models.

Specific elements or data used in models can include:

? Sources of contaminants or stressor formulation: - i.e. chemical, microbial;
? Transport/transformation routes – dispersion, kinetics, thermodynamics, spatial variability, distribution, meteorology;
? Environmental – air, water, dust, soil, and groundwater;
? Exposure – pathway, duration, frequency, magnitude;
? Individual/community/population – statistical profile, reference population, susceptible individuals, susceptible subpopulations, population distribution;
? Dose – target, absorbed and applied; and
? Effect – acute, chronic.

<u>Example Model</u>

In a microenvironmental exposure model, personal exposures (E) are the weighted sum of pollutant concentrations (C_i) in the key microenvironments ME_i, with the fraction of time spent (F_i) in the ME_i and are expressed as: E=? $C_iF_{i.}$

Typical microenvironments include indoor (homes, offices, schools, etc.), outdoor (residential lawn/yard, recreation area), and in-vehicle (car, bus, public transport) areas.

Developing the analysis of a microenvironment requires:

? Identification of microenvironments and population groups of concern;

? Estimating microenvironmental factors (sources/emissions, penetration, infiltration, track-in, resuspension, volatilization, decay, migration and human exposure, contact and transfer rates);
? Predicting ME concentrations for different time average; and
? Predicting exposure distributions of different population cohorts and sensitive groups.

The steps needed for performing a modeling analysis include:
? Selecting the appropriate mechanistic and stochastic models required to predict the source-concentration-exposure-dose relationship;
? Investigating the potential exposures to multiple pesticides (what, where, when, why and by whom);
? Selecting or developing and applying aggregate and/or cumulative exposure and dose models;
? Implementing techniques to evaluate conditions that result in high-end exposures to pesticides of concern (subjects, locations, sources);
? Obtaining data on physiological factors/metabolic rates for PBPK models or health effects assessments;
? Incorporating sensitivity, variability and uncertainty analysis in modeling;
? Conducting formal evaluation of modeling methods and results using field measurement data; and
? Developing/implementing new methods of measurements, and model refinement data.

Overview and Application of the AgDRIFT Model for Agricultural Spraying, Sandy Bird/Steven Perry, US Environmental Protection Agency, National Exposure Research Laboratory

The AgDRIFT Model is a computer-driven program that was developed to analyze primary drift with a near-field focus. It was developed as an ecological assessment tool and is applicable to human exposure issues.

Background

Aerial application of pesticides using aircrafts results in a variety of dispersal patterns depending on air-current disturbances created by the aircraft and the environment. The aircraft generates vortices and downwash, whereas the environment can contribute crosswind and evaporation. The AgDRIFT Model is equipped with libraries of variables such as aircraft type, drop size distribution, and metrological components, and allows input of dozens of data through user-friendly, pull-down menus.

The capability of AgDRIFT was demonstrated using the 1996 example from the session Case Study, where primary drift exposed nearby workers. An aerial (fixed-wing) application on 80 acres of cotton, of three different chemicals, was made by through six passes over the field, during a light wind. The data were entered into AgDRIFT, including pesticide label instructions, crop information, and a variety of other parameters, and a deposition curve was determined. This curve defined the concentration of the pesticide relative to the distance from the field. A second curve demonstrates that a simple variation in the boom height of the aircraft applicator from 6 meters to 3 meters reduced the air concentration at 2 meters above the ground by approximately 32%. This illustrates the potential impact of a single variable and stresses the importance of accurate data, and it demonstrates the utility of the AgDRIFT program for addressing actual field situations and for developing appropriate mitigation approaches.

Research Directions

There is currently no ongoing, funded research program for AgDRIFT, but suggested further research directions that may enhance the program include:

- ? Determining mechanistic ground/orchard sprayer parameters;
- ? Determining medium range drift capabilities;
- ? Establishing seamless linkage to ecological exposure;
- ? Developing human exposure tools and/or integration into human health modeling frameworks; and
- ? Linking primary and secondary drift modeling.

The AgDRIFT program was developed through a CRADA involving the USEPA/ORD, USDA, and the pesticide industry's Spray Drift Task Force. The model is available from Mr. David Esterly (env.focus@mindspring.com) or Dr. Milt Teske (milt@continuum-dynamics.com).

Multimedia, Multipathway Aggregate Exposure Modeling, Haluk Ozkaynak, US Environmental Protection Agency, National Exposure Research Laboratory

Background

Aggregate exposure modeling is used to predict the distribution of pesticide exposures of urban or rural populations. The Stochastic Human Exposure and Dose Simulation (SHEDS) model is a multimedia, multipathway model that uses a probabilistic approach to assess exposures. SHEDS is a user friendly windows-driven, computer program which allows the user to input a multitude of pesticide application and environmental data to obtain exposure rates that are influenced by various routes of transmission. Necessary for the use of this model are inputs such as the environmental concentration of pesticides, census data, activity patterns, food consumption, exposure factors, and application rates.

SHEDS is currently under development and refinement by EPA/NERL, where program goals are to:

- ? Develop probabilistic source-to-dose human exposure models;
- ? Model exposures of general and susceptible sub-populations; and
- ? Develop models that support aggregate and cumulative exposure analysis, inputs to exposure measurements, variability and uncertainty analysis, prospective and retrospective exposure assessment, and risk analysis and risk management.

The benefits of developing these multimedia, multipathway modeling programs are to:

? Provide new human exposure and dose estimating models for assessing population health risks;
? Generate an integrated source-to-dose modeling framework for addressing complex exposure assessment problems;
? Provide more realistic exposure assessment methods than some of the currently used screening level regulatory models; and
? Respond to SAB concerns about severe limitations across EPA in the scientific foundation for multimedia, multipathway models.

Future Research and SHEDS Development

More research is needed to refine the SHEDS program, and testing of the model with larger data sets is necessary. Specifically, further needs include:

? Completing the aggregate and cumulative SHEDS;
? Integrating SHEDS with NERL's Exposure Related Dose Estimating Model (ERDEM) and NHEERL models;
? Refining or reformulating of ERDEM to include key metabolic and physiologic parameters for children. Also, model OP pesticides, incorporate a front end to simulate and test impacts of exposures, and include modules for sensitivity, variance and uncertainty analysis;
? Developing a source-to-dose modeling framework with SHEDS and other models and platforms;
? Refining and evaluating SHEDS as new measurements become available;
? Simultaneous collection of activity data, residue data, dosimeter data, and biomonitoring data;
? Comparing macro and microactivity approaches;
? Comparing against new measurement studies;
? Comparing against other models; and
? Evaluating each component of the model.

Additional information and research is needed to reduce the uncertainties of inputs and of the model as a whole including:

? Pesticide usage information;
? Human activity patterns;
? Pesticide concentrations and residues;
? Refined Exposure Algorithms;
? Exposure factors; and
? PBPK Modeling.

A first generation version of the SHEDS model (version 3.1) *for internal use only at this time*, can be obtained from Dr. Haluk Ozkaynak, at EPA/ORD/NERL (MD-56) 79 T. W. Alexander Drive, RTP, NC 27711.

Spray Drift and Risk Management Tools, John Kinsey, US Environmental Protection Agency, National Risk Management Research Lab

Pesticides are classified by a variety of properties including: physical state, formulation, target organism, chemical composition, toxicology, timing, uptake area, mode of action and range of use. Physiochemical properties and application methods contribute to the amount and deposition of chemical drift. A variety of methods are used to prevent, control, reduce and mitigate drift, including modification of equipment and agricultural management practices. A literature review was conducted of drift risk management studies and the relative efficiencies of various techniques and the results indicate:

? Adequate models are available to estimate primary drift and the volatilization of surface and soil-incorporated pesticides and soil fumigants. Other emission rate and factors are highly uncertain.
? Atmospheric transformation processes and products are poorly understood. These transformation products can be more toxic than the parent compound.
? The sinks of airborne pesticides are inadequately characterized; of particular importance are deposition and re-emission processes.
? No standardized methodology is available to assess either atmospheric emissions or control effectiveness.

Future Research Needs

A review of literature and results revealed the need for further research to:

? Improve characterization of secondary drift, volatilization losses, and atmospheric transformation using remote sensing (e.g., FTIR, LIDAR, etc.) and other automated analyzers (e.g., portable GC/MS, GC/IMS, etc.);
? Characterize the fine particle resuspension and long-range transport associated with pesticide application;
? Further improve sampling and analysis methods for current use pesticides; and
? Develop an improved spray nozzle design incorporating a rotary atomizer and "satellite" droplet extractor/impactor.

Session Questions and Responses

Question: Several definitions of primary and secondary drift were used, should there be a single definition?

Response: Yes, there needs to be a consensus definition.

Question: Field drift complaints occur where existing control techniques could have been used. Would there be a benefit to explaining cost/benefit ratios to farmers who are losing considerable amounts of their pesticide applications, and thus money, to drift?

Response 1: This would be difficult since theoretical standards are not defined for various control techniques. Currently, there are consistent numbers established for methods of aerial spraying.

Response 2: The AgLite program does give some theoretical calculations for control techniques.

Question: How will the Air Act impact agriculture?

Response: It is not known whether the agencies or States will make regulation more stringent.

Session IC: Exposure Issues: Vector Control

Case Study 3:New York City Spraying of Malathion to Control Mosquitoes Carrying West Nile Virus

Henry Rupp, US Environmental Protection Agency, Region 2

Statement of the Problem

In the summer of 1999, there was an outbreak of disease in New York City and surrounding areas caused by mosquito-borne transmission of West Nile virus. City officials decided to try to control the outbreak with ground-based and aerial spraying of malathion. Questions remain regarding the decisions to spray, the choice of the pesticide, when and how to spray, and how to communicate the rationale for these decisions to the public when the science supporting them was and still is incomplete.

Background

The summer of 1999 was a dry one. Not many people were thinking about mosquitoes or about mosquito-borne disease. After all, New York City (NYC) had not, in the memory of man, had an outbreak of mosquito-borne disease, the nearest major epidemic having occurred in the Camden (NJ) area in 1964. Mosquitoes were for New Yorkers something they had to put up with at the New Jersey shore or out on Long Island. Lacking exposure to mosquitoes and disease, they were unprepared for the events that took place in the late summer of 1999. In fact, no one was prepared, nor could they have been.

When what was first diagnosed as St. Louis encephalitis (SLE) was discovered, thanks to an alert physician who noted a cluster of similarly diseased patients in Queens, NYC's response to the apparent SLE outbreak was prompt. The situation gained an extra dimension when what was initially thought to be SLE became a West Nile-like virus and was finally determined to be in fact West Nile virus (WNV), a disease never before seen in this country. The city was forced, given the number of cases that appeared and the dispersion of these cases, as well as the deaths that resulted, to go to a commercial vendor of mosquito control services. They also called on the Centers for Disease Control and Prevention (CDC), an agency with wide experience of mosquito-borne disease epidemics. The response recommended that the city needed to spray adulticides for the control of disease-bearing mosquitoes. The insecticide of choice for aerial applications was malathion, an insecticide that had been in use in mosquito control for some fifty years in the United States and had been widely used for the control of mosquito-borne disease in the past.

Malathion, applied at 3 ounces per acre, has been an effective mosquito control agent and has been used for mosquito control with minimal reports of human health problems. As an organophosphate, however, malathion is a controversial insecticide and is the target of anti-pesticide activities. Because of the continuing nature of the WNV outbreak, there were repeated sprayings with a subsequent chorus of protests from the anti-pesticide people. [One might note parenthetically that the issue was rendered moot in 2000 when NYC switched to Anvil® 10 + 10

(10% sumithrin + 10% piperonyl butoxide + co-solvent)]. However, even this change did not satisfy those opposed to the application of insecticides, so that some of the questions raised by the operations of 1999 still remained unanswered.

Important Science Issues

1. *Relative risk to humans of spraying vs. not spraying.* The anti-mosquito spraying operations of 1999 (and those of 2000) raise interesting questions, not all of them scientific. Those who oppose the application of insecticides for control of the vectors of WNV like to point out that X number (ranging from 1,500 to 15,000) people died from influenza in a given year and nobody sprays for them, so why are they spraying when only seven people die of WNV. Similarly it has been pointed out, purportedly to put WNV deaths in perspective, that on the first day of the year 2000 six people were murdered in NYC, only one less than the number of those who died from WNV. This is an ethical issue as well as a political one, a question scientists should be happy they do not have to answer.

   There are risk/benefit questions that do have a scientific component, i.e., what are the relative risks of adverse human health effects associated with exposures to the sprayed insecticides vs. those of contracting the disease transmitted by vectors, e.g., mosquitoes, for which the insecticides are being used to control? How do we factor in concerns about global warming and the potentiated opportunity for other previously considered tropical diseases to develop in the United States.

2. *Application techniques*. Another question that arises is the efficacy of application of insecticides by ground ULV application. How effective can an insecticide cloud be when it is hemmed in by row houses that present an impenetrable barrier? The technology has not yet been developed that can allow an insecticide cloud to travel along the ground, rise vertically for, say, thirty feet, travel horizontally for the depth of the house and then descend into a back yard that might, or might not, harbor mosquitoes. The use of aerial ULV applications of insecticide seems to create more furor than ground ULV applications, and in 2000, aerial applications have been limited to marginal areas where ground application equipment cannot provide appropriate mosquito control. Studies done in the past for control of *Aedes aegypti* (the yellow fever mosquito and a carrier of dengue and dengue hermorrhagic fever) have indicated that ground ULV is not the most effective technique for the control of peridomestic mosquitoes. We need, therefore, studies to determine which is the more effective technique and what risks are associated with each technique so that informed judgments may be made.

   If one is a person concerned about the economic efficacy of an operation, one might question the value of spraying in areas like that noted in the previous paragraph. These concerns involve perception (the appearance of doing something) and reality (the value of doing something that may be in fact meaningless). These are areas that lie outside the scope of ORD’s concerns, but they are areas that may well color our judgment of what it is we believe should be done in similar situations.

3. *Potential environmental and associated economic impacts.* There are, however, questions that are appropriate to the disciplines of R&D. Case Study #2 considered drift as it relates to agriculture and home gardening. In this arena, drift is economically undesirable, in addition to presenting greater risks of injury due to the fact that agricultural pesticides are generally more toxic than insecticides used for mosquito control. In the agricultural environment the pest is defined by its target environment: a field, an orchard, a home garden. In mosquito control there are no precisely defined limits of where one may find mosquitoes since the crop is man and man is not lined up like a row of cabbages in a field. Because man is the rationale for the spraying, the presence of man can conflict with areas where insecticides should not be used because of their adverse impact on other environmental elements, e.g., aquatic habitat, food crops, schools, hospitals. Drift (off-target movement) in the mosquito control arena has generated concerns from people for whom Long Island Sound is an economic resource. There have been claims that the 1999 spraying adversely affected the harvests of lobster and crab fisherman. These claims, regarding the impacts of drifted insecticides on crustaceans, need to be addressed with long-term studies. The risk/benefit question asked above (#1) should be expanded to include these environmental and economic considerations, also associated with the use of pesticides to control mosquitoes.

4. *Risk to sensitive populations.* Another area of concern in both 1999 and 2000 was the question of risk to sensitive populations. One might ask what number of sprays – either aerial or ground – constitutes excessive exposure. EPA, in its preliminary risk assessment on malathion, has indicated that malathion applied at 3 ounces per acre cannot be construed as a carcinogen. However, what about persons who are denominated as "chemically sensitive"? Are there methods or models that can predict the results of their exposure to repeated applications of not only malathion but also the synthetic pyrethroids?

5. *Indirect human exposures.* In addition to direct routes of exposure, people may be exposed indirectly through consumption of contaminated food. In 2000 the subject of food residues arose because of ground ULV applications in areas where bodegas sold fruits and other produce displayed outside the store. There was a concern about synthetic pyrethroid residues in light of repeated sprayings and the impact on those purchasing exposed fruit. One would have to do market studies to determine the extent to which residues on street-displayed fruits and vegetables were a significant exposure route to sprayed pesticides.

6. *Exposures and risks to metabolites and breakdown products.* Malaoxon and isomalathion are degradation products of malathion. Malaoxon appears to be more toxic than the parent compound while impurities like isomalathion are found to be less toxic than both the parent or malaoxon or are present at levels which do not pose a residue concern when technical formulations are stored appropriately. OPP risk assessments have taken into account conversions to these by-products.

   Malaoxon forms in the environment at ambient temperatures, while isomalathion typically forms within malathion containers when stored under elevated temperatures. Data indicate that storage in the dark at both 68 and 100 degrees F for two weeks results in no increase in isomalathion, whereas storage at 130 degrees F for this time period results in increases of isomalathion from 0.05 to about 0.20 %. However, the Regions have confronted situations in which storage conditions are more severe or occur over longer time periods than those tested. Therefore questions remain. How does one test for isomalathion? At what levels of isomalathion should containers not be used? Should these containers be considered hazardous waste and disposed of accordingly?

Challenges to Addressing Science Issues

Decisions must be made to spray, not to spray, when and where to spray, etc., in the absence of a clear scientific understanding of all the issues. Under these circumstances, the decision-making atmosphere is always charged with different social, political, and economic concerns and special interests. We need to continue to work with ORD and OPP to identify and reduce the critical data gaps so that the EPA Regions can make more fully informed decisions and effectively communicate them to the public.

Major Science Needs

1. Are there scientifically sound methods for conducting relative risk assessments?
2. How can exposures to people and environmental organisms be limited?
3. What are the best ways to measure and/or model concentrations in breathable air, nearby waters, on soil and food products within the range of pesticide fall-out?
4. What methods exist to measure or model actual exposures to humans and environmental organisms following spray applications?
5. What is the best way to communicate the scientific rationale for decisions made regarding whether to spray, what, when, and how to spray?

Conclusions and Next Steps

Those who live in the trenches of the pesticide wars need good scientific support on which to base decisions about whether to spray, and if so, when to spray, what to spray, and how to spray. We also need help in translating the science behind our decisions to the public, a public with differing levels of understanding of the issues and one with multiple social and economic agendas.

Panel Discussion on Comparative Exposures and Risks

Mosquito-Proof New York City, James Miller, New York City/Department of Health

Statement of Problem

In the summer of 1999, 62 human cases of West Nile virus (WNV) were detected in New York City, and were clustered in time and geography. Confirmation of WNV did not occur until late in the season (September 3rd) and thus the Health Department response became an *emergency operation*. A dry, warm summer, and minimal flushing of street drains and other mosquito breeding grounds, made for ideal conditions for a large mosquito outbreak. Since broad-spectrum control of mosquitoes had not occurred for years, a full-scale control program was necessary. The only recent mosquito-related outbreaks were three cases of locally transmitted malaria in 1993. Faced with these disease-bearing mosquitoes, the only immediate recourse was adulticiding the effected areas. A secondary intensive education campaign was undertaken to enlist the public's help in reducing mosquito breeding grounds. Personal insect repellents were also distributed. Twenty-five percent of the treated sites were pre-and post tested to determine the effect on the mosquito population. The following year, an increase in the number of WNV cases showed a shift in the location of effected areas. Those areas most effected in 1999 were lower in 2000. Pesticide application programs proceeded as follows:

1999: Adult control by aerial and limited truck application of malathion.
2000: A more comprehensive program was initiated which included source reduction, larval control, adult control by truck spraying and aerial application of Anvil.
2001: Expected expanded source reduction, larval control and unknown spraying.

Future Considerations
The immediacy of the situation left several important issues unresolved, and created others that will require further research and planning, specifically:

? The Department of Health acknowledged that harm may be caused by the pesticide application, and an education program was instituted, by mail and fax, to broadcast alerts to all NYC physicians and hospitals the on potential symptoms of exposure; and establishing 24-hour hotline, website, and fact sheets with pesticide information. Over 200 reports of possible reactions were reported.
? Two retrospective studies of asthma cases and emergency clinic visits during the critical period have been initiated to determine possible connections to the spraying.
? The New York Department of Health was faced with shifting its role from being an agency responsible for regulating others, to one that was the regulated as they took on the responsibility for application of the pesticide. Coordination between various agencies relieved the burden of a single agency, and future programs will involve a coordinated effort.
? Environmental issues such as the persistence of malathion in the environment and impact on non-target species needs to be further investigated.
? Further research is needed on exposure issues such as the impact of multiple sprays, drift and sensitive populations.
? A better understanding is needed of the risk of WNV versus the benefit of spraying.

West Nile Virus: Evaluating Risk, Roger Nasci, Centers for Disease Control and Prevention

In late September 1999, CDC confirmed cases of West Nile virus (WNV) in New York City (NYC). The Center for Disease Control's role in the WNV epidemic was one of vector identification, surveillance and evaluation of control. Three populations were targeted for surveillance:

Mosquitoes: CDC conducted surveillance from September 2nd through October 29th, testing over 32,000 mosquitoes from over 1800 locations. Fifteen (15) WNV isolates were found, 14 in New York and 1 in New Jersey.

Birds: Positive antibody responses were found in both domestic and wild bird species. In north Queens, 30-50% of those tested were seropositive.

Humans: A door-to-door sero-survey of humans resulted in an estimated 2.6% seroprevalence. Twenty percent (20%) of those infected reported previous symptoms from mild to moderate. A subclinical to clinical infection rate of 4:1 was estimated.

Results of the survey supported the decision to use adulticides, and a public education campaign was launched to reduce exposure to mosquito bites and to reduce mosquito-breeding sites.

Malathion Application for Control of West Nile Virus Vectors: Pesticide Risk and Exposure, Kevin Sweeney, US Environmental Protection Agency, Office of Pesticide Programs

EPA's role in the West Nile virus epidemic is two-fold: First, the Agency serves as a consultant role to the EPA Regions and States on issues regarding labeling and pesticide risk to humans and the environment. Second, EPA prepares informational materials on mosquito control and pesticides for distribution to regulators and the general public via hard paper copy and the Internet.

In this case study, the insecticide malathion is used to demonstrate how risk is assessed by EPA for non-occupational, residential, bystander exposure to mosquito control adultidicing. The hazard of malathion to humans is determined from the existing toxicology database. For human risk assessment, toxicity endpoints are selected that represent the highest dose of the chemical administered to test animals resulting in a "No Observable Adverse Effect Level" (NOAEL), that is, frank toxicity is not observed in the test animal at the dose tested. For malathion, the Agency selected the two NOAELs based on the likely route of exposure. For the dermal route of exposure (skin contact from residues deposited on the turf etc. in residential settings), a 21-day rat dermal study was selected; for the inhalation route (from exposure to ULV malathion fog at the time of application), a 90-day rat inhalation study was used. Margins of Exposure (MOEs) are calculated.

In preparing the risk assessment, two target populations were chosen: 70 kg adults and 15 kg toddlers age 1-6 years. The exposure routes assessed included oral (hand-to-mouth in toddlers only), dermal, inhalation, and an aggregation of the possible exposures. For each exposure scenario and the aggregate of all exposures, the risk to residential bystanders to mosquito adulticide application was low and did not exceed the Agency's level of concern.

Malathion has known toxicity to fish and invertebrates, however, risks can be mitigated through restrictive labeling. Results indicate that avoiding aquatic habitats, avoiding spraying during peak activity of bees, and reducing drift are effective in reducing risks to non-targets.

For malathion applications, benefit estimates are difficult to quantify. Spraying kills the adult mosquitoes and reduces the infected population, but the probability of disease transmission is not yet quantified, and thus it is difficult to quantify a benefit that can be weighed against the pesticide risk. However, CDC is working hard to qualify and quantify the risk of WNV transmission in humans.

Exposure Implications: Methods, Measurements, and Models, Daniel Vallero, US Environmental Protection Agency, National Exposure Research Laboratory

A discussion was presented on the role of the various ORD labs (NERL, NHEERL, NCEA, NRMRL) and their contributions to the elements of risk assessment: source, fate, exposure, dose, response, risk and risk management. Minimal overlap exists, though collectively the labs provide a comprehensive approach to addressing needs and resolving ambiguities in each of the areas. A combination of human exposure measurements and exposure models provides for an iterative approach for human exposure research. The approach for developing and evaluating appropriate measurements and models involves:

- Assembling available data & models;
- Developing a conceptual understanding of how exposures occur and developing algorithms describing the exposure;
- Assembling the algorithms into a model;
- Testing the model against research and regulatory needs to identify gaps and uncertainties;
- Developing human exposure (HE) measurement programs to fill gaps and needs, and to test models;
- Conducting the HE measurement studies;
- Analyzing measurement data and refining algorithms; and
- Updating and testing the model for regulatory and research needs.

A review of current programs concluded there is:

- Potential for collaborations between Regions and Labs;
- Need for improved and better use of methods;
- No such thing as a “one size fits all” experimental design; and
- No such thing as a “one size fits all” exposure model.

Session Questions and Responses

Question: Why did NYC switch from malathion to Anvil?
Response: CDC had the same question. The partial answer given was that the applicators that were contracted did not express an interest in spraying malathion.

Question: Are West Nile virus and SLV mutually exclusive?
Response: Chances are very low that a mosquito is infected with both viruses.

Question: What constitutes a case of WNV?
Response: Laboratory confirmation is needed to corroborate clinical symptomology and nerologic symptoms of meningitis.

Question: What were the actual numbers that gave a 2.6% seroprevilance?
Response: A denominator of approximately 50,000, with 62 confirmed cases, 20% of which tested positive and reported possible symptoms.

Question: What species of birds are affected by WNV?
Response: Crows and bluejays are in the same Family and have an approximate 98% mortality rate, though 70 other species have been found with the virus. A total of 14 of the 17 Orders of birds have been killed by WNV. Studies have shown that the first evidence of the virus was not in crows. Crows have been the primary target of surveillance because of their roosting behavior and large size, and the ease of finding those killed. However, solitary birds such a warblers have been shown to be affected. There is also some evidence of bird-to-bird transmission. Other mammals known to be affected include rabbit, chipmunk, bats and squirrels.

Question: Why did the hot spots of virus detection change?
Response: Not sure. There could be less of a reservoir (crows), as the Audubon Christmas bird count was lower in 1999, and this would be consistent with typical patterns that are seen with the tendency of disease to fluctuate with its host. Host populations either decreased or seroconverted. It is unlikely that it was due to pesticide persistence.

Question: In the hot spots with the highest numbers, was there any trend in demographics, i.e., age, socioeconomic status?
Response: These were reviewed and no significant difference was noted.

Session II: Highly Exposed and Sensitive Populations

Pesticides and Worker Health, AnaMaria Osorio (OPP)

The topics discussed relative to pesticides and worker health included: surveillance of pesticide intoxication cases, health care provider initiative, national health surveys, pesticide exposure pilot projects, and outbreak investigation reports. Through public health surveillance (the ongoing systematic collection, analysis, and interpretation of data), prevention and control measures can be implemented. Examples of Occupational Health Surveillance and Population-based Occupational Health Surveillance were illustrated. In States such as California, where there are mandatory reporting requirements, the data available for reports are more complete. CDC's Sentinel Event Notification System for Occupational Risk (SENSOR) for pesticide-related intoxications was described. The Rutgers University and Tribal Medicine pilots were two special projects highlighted in the presentation.

Case Study

In an outbreak investigation reported on a pesticide drift episode among greater than 1000 grape field workers in California, where there was aerial application of Curacron, Danitol, and Lorsban pesticides over an adjacent cotton field. Preliminary health data indicated 244 workers were exposed to pesticide drift. Issues of concern resulting from this episode include:

? The need for coordination between agencies and organizations;
? Clinician need for knowledge regarding pesticide illness evaluation and case reporting;
? Problems with the evaluation of a mobile, non-English speaking, contract and/or non-unionized workforce;
? Evaluation of adequacy of aerial pest control efforts (chemicals & delivery); and
? Importance of emergency preparedness and hazard awareness at the worksite.

Exposures to Children, Chris Saint, US Environmental Protection Agency, National Center for Environmental Research

The STAR Program provides grants for ecological and human health through formal peer review and solicitation. Information on these studies can be found at www.epa.gov/ncerqa. Research related to child health falls into two areas: 1) Centers of children's environmental health & disease prevention research, and 2) studies of children's aggregate exposure to pesticides. A number of example projects were discussed.

Health Center Studies

Several other programs are coordinated through five different child health centers that focus on asthma. Each has an intervention project that targets reducing exposure, and all have close ties with the community and local health departments. Three programs and several studies were highlighted:

? University of Washington (UW)– This program is based in the farm community of the Yakima Valley and evaluates child exposure based on the take-home pathways of parents who are agricultural workers.
? University of California, Berkeley – In cooperation with UW, a similar program is looking at farm communities in the Salinas Valley.
? New York – This is an epidemiology study investigating the effects of pesticides on children living in inter-city homes in East Harlem.

SHELD Study
This is a four-year study which is looking at dust, air and drinking water, for a range of VOCs, ETS and ten different pesticides. The study involves 800 school aged children attending two public schools in Minneapolis.

US/Mexico Study
These studies are measuring the exposures of two populations of rural children in Arizona and Texas to OP pesticides and metals. Both studies include monitoring of children's exposure-related behavior.

Pet Transmission
A study at the Mississippi State School of Veterinary Medicine involves methods development, looking at dips and collars and the efficiency of pesticide shampoos. This study will provide quantification of availability of residues. The final report is due at any time, and a second grant will address activities related to exposing children to these pesticides.

Exposures to Children, Linda Sheldon/Chuck Steen, US Environmental Protection Agency, National Exposure Research Laboratory

In general, reliable data do not exist for estimating exposures to children. Protocols for exposure analysis are not well developed and evaluated; approaches for dermal and non-dietary ingestion are uncertain; and data are limited on exposure and activity patterns, especially for young children. The research objectives of FQPA are to improve assessments for children's exposures to pesticides through:
? Identifying pesticides, pathways and activities with the highest potential for exposure;
? Determining key exposure factors;
? Developing approaches/protocols for measuring exposures by all relevant pathways;
? Demonstrating protocol reliability through field studies; and
? Developing a core set of high quality, reliable data on exposure factors.

Several areas of research and analysis were conducted to determine the utility of existing data, data gaps, and to identify ongoing and needed research.

Data Assessment - In order to assess exposures, there must be an iteration between methods and models. A data assessment was conducted through evaluation of the literature, workshops, and identification of greatest uncertainties and highest potential risks. Data on children's exposures and activities are limited, and default assumptions for exposure assessments are highly uncertain. Dermal and non-dietary exposure are two pathways with very high potential for exposure.

Identification of Gaps – Significant gaps in data and models were identified, specifically:

? Age/developmental benchmarks for categorizing children's exposure;
? Contaminant use patterns in locations where children spend time;
? Activity pattern data, especially for young children;
? Distribution of contaminants in specific locations;
? Population exposure data on children; and
? Approaches and factors for estimating dermal and non-dietary exposure.

A summary was presented of research activities to address these gaps. On-going studies include:

? Multimedia, multipathway studies of chronic exposure to children;
? The Minnesota Pesticide Study (100 kids in 3-12 homes; concentration in environment and biological samples; limited location and activity information); and
? CTEPP (300 preschool children; concentration in environment and biological samples; location and activity information).

Planned Studies in method development include:

? Urine collection methods from young children;
? Evaluation of whole body dosimeters;
? Immunoassay for OP metabolites in urine;
? Testing of videotaping methods;
? Refinements of Transferable residue methods;
? Biomarkers for pyrethoid pesticides; and
? Field studies in daycare/residences after pesticide application (environmental measurements and biomonitoring to evaluate procedures).

Collaborative studies currently supported by the government:

? National Survey of Environmental Hazards in Child Care Centers (HUD);
? Exposures and Health of Farm Worker Children in California (STAR Grants);
? Potential Pesticide Exposure in Young Children Living in an Urban Area in the Southeastern U.S.;
? Kid's Border XXI Study (STAR Grant); and
? Kid's in Schools (OPPTS).

Measuring the Effects of Exposures to Children, Pauline Mendola, US Environmental Protection Agency, National Health and Environmental Effects Research Laboratory

Government initiatives and funding have been established to research health effects in children related to pesticides. The importance of studying children and establishing baseline parameters for children separate from those for adults is necessitated by their:

? Vulnerability – There are critical developmental windows in which children may be particularly sensitive to exposure.
? Differential exposure – Children drink and eat more, breath more and are more active in different ways and, thus, adult models do not necessarily fit.
? Physiological differences – Children may lack specific enzymes and capacity to detoxify contaminants.
? Medical Care – Though children go to the doctor more often, they are also the highest group of uninsured individuals in the US and this may result in skewed samples.

There are many important considerations for the design of research studies on potential pesticide-related illnesses, including:

? Identifying the characteristics of the person(s) and agents to which they may have been exposed.
? Determining the biologic plausibility of the observed effect. Is it reasonable to think that exposure to an identified compound could have caused the effect in question?
? Knowing the mechanism of action for suspect compounds to help target health endpoints for surveillance.
? Determining whether the health effects in question are most likely the result of chronic or of acute exposure.

Case Study

The Border XXI initiative, "Pesticide Exposure and Potential Adverse Health Effects in Young Children Along the US-Mexico Border," has three phases. Phase I involved gathering information and building capacity to conduct research studies along the border, including developing GIS capability in all border States. Phase II is ongoing and consists of pilot studies. Phase III will involve more in-depth studies which will be based on the results of Phase II.

In Phase I, a workshop was held to address the needs for pediatric health endpoints that could plausibly be associated with pesticide exposure, "Assessment of Health Effects of Pesticide Exposure in Young Children," El Paso, Texas, December 1997 (EPA/600/R-99/086). This workshop focused on health endpoints from five domains: Respiratory, Immune, Developmental, Cancer, and Neurobehavioral.

In Phase II, many studies have confirmed the willingness of parents and clinics to participate in pilot efforts. More than 20 pilots have been conducted including research on:

? The immune response assessed by collecting urine and blood before and after administering the MMR (measles/mumps/rubella) vaccine;
? Children in agricultural communities that exhibit flu-like symptoms, concentrating on periods when chemical use is high but flu virus prevalence is low (October and June); and
? The general health of children in homes in close proximity to agricultural fields.

The study of pesticide-related health effects in children is in its infancy. Many people have compared this body of literature to the initial investigations of lead exposure thirty years ago, before we had strong biomarkers and clear ideas about the association of lead exposure with adverse developmental effects. In terms of public health, some developmental disorders appear to be increasing in children and there are increases in immune system diseases such as asthma and allergy. There is a general sense that the environment is degraded and some "environmental" factors may be responsible for these childhood disorders. While there is public concern about children's exposure to pesticides, there is very little data in this area.

The **President's Task Force** on Environmental Health Risks and Safety Risks to Children (co-chaired by Carol Browner, EPA Administrator, and Donna Shalala, Secretary of Health and Human Services), called for planning and development of a longitudinal cohort study of children. This initiative was supported in the Child Health Act of 2000 (PL 106-310). Currently, one of the model hypotheses for the proposed study is related to pesticide exposure. A longitudinal study is ideal for such purposes because it can account for exposure over time, during critical windows in child development, and it can measure a variety of health endpoints.

Session Questions and Responses

Question: Were there exposure criteria or a standard set by FQPA?

Response: Don't know. On the toxicity side, protocols first need to be developed to answer the question. FQPA's goal is to reduce the uncertainty.

Question: In the STAR pilots, is there testing for effects on neurological behavioral development?

Response: These are planned, but there is presently no money available for collection of these data. There was preliminary talk regarding such a study at the workshop in El Paso, including which tests and measures should be used, but nothing has been finalized.

Question: Has there been any discussion on possible links and study of ADD (Attention Deficit Disorder)?

Response: There is a great interest in following ADD in the longitudinal studies; it is estimated that 100,000 families would be the necessary target for study. This study would also need to include the influence of medications on affected children.

Question: How do the pilots feed into the larger projects and funding of Border XXI?

Response: Border XXI is still in Phase II where preliminary results are anticipated. After reviewing the Phase II results, the needs for further research will focus on the exposure issues (can we identify the "high risk" children?) and then whether a full scale epidemiologic study of health effects is warranted given the current state of the science. The aim is to avoid spending large sums to measure the wrong variables.

Session III: Risk Management

Treatment of Pesticides in Drinking Water, Tom Speth, US Environmental Protection Agency, National Risk Management Research Laboratory

A variety of technologies, used in different combinations, are designed to remove pesticides from drinking water. The choice of which technologies are used is influenced not only by the type of contaminant, but the history of the treatment facility – when they were established, what technologies were first instituted, and what new technologies are complementary. Lists were presented of over 40 regulated herbicides and of treatment technologies relative to the proportion of surface and ground water treatment plants that use them.

Examples were discussed of several treatment technologies, including factors that effect performance, predictors of performance, and detailed data analysis on the efficacy of each technology. Conclusions on the study of various drinking water treatments are:

? Conventional treatment should not be expected to remove pesticides from drinking water.
? Softening can remove select pesticides, but usually by a base-catalyzed reaction.
? GAC can remove most pesticides, especially for low-solubility (nonionic) pesticides.
? PAC can inexpensively remove most pesticides to a certain extent, especially for seasonal contamination.
? Air stripping can remove volatile pesticides (fumigants).
? Oxidation processes, especially ozone or advanced oxidation, can transform pesticides.
? Reverse osmosis and nanofiltration membranes (thin-film composites) can remove most pesticides.

Current ORD Research on pesticide removal involves:

? Screening-level studies for CCL contaminants, endocrine disruptors, and OPP pesticides; and
? Field-scale work for those pesticides that need more rigorous data as determined by the screening-level studies.

Session Questions and Responses

Question: What is the DBP Rule?

Response: It is a recent USEPA effort to set regulations regarding disinfection practices. It balances the need for microbial control with the formation of disinfection byproducts.

Question: For the data presented on chlorination or oxidation removal, does it imply that it creates a compound or removes one?

Response: Both; the data on byproducts was not incorporated in the original study, but this is an important issue, i.e., glyphospate and oxidation.

ECOLOGICAL ISSUES

Session IV: Ecological Issues

Case Study 4: Lake Apopka Birdkill Winter 1998-1999

Anne Keller, US Environmental Protection Agency, Region 4

Statement of the Problem

A large number of birds died at Lake Apopka between December 1998 and March 1999. The Region and others are attempting to understand the cause(s) of this massive bird die-off.

Background

The St. Johns River Water Management District in Palatka, FL, is in the midst of a 20-year plan to restore the water quality of Lake Apopka to its pre-1950 status. The lake has been severely impacted by the draining of lake bottom for farming in the late 1940s. Maintenance of dry land required constant pumping of nutrient-laden water off of the property into the lake. The District, in cooperation with the Natural Resource Conservation Service (NRCS), purchased the farms in order to decrease this back-pumping into Lake Apopka, and secondarily, to provide wetland habitat for resident and migratory birds. The farmland purchase was completed in July 1998. As the fields accumulated rainwater and seepage from the lake, herons, egrets, wood storks (endangered species) and white pelicans flocked to the area. Audubon Society's December bird count at Lake Apopka set a record for number of species recorded at an inland location. Then hundreds of birds began to die. In total, over 500 pelicans, three dozen wood storks and many other species died on-site. Other bird deaths in the southeastern U.S. have also been attributed to Lake Apopka although there is no proof that these animals actually spent time along the lake.

In January 1999, the USFWS began a criminal investigation into the cause of these deaths because migratory birds and endangered species were involved. EPA joined the effort to determine what killed the birds after publication of a USFWS press release that the area might pose a human health threat. To date, soil, sediment, water, fish and bird samples have been analyzed by several agencies and interested organizations, including EPA Region 4.

Analytical results indicate that chlorinated pesticides were present in soils and tissues, both fish and bird, and may be the cause of death of these birds. Dieldrin, toxaphene, chlordane, DDD and DDE are among the pesticides that were detected, often in high concentrations, in the soils and animal tissues. These long-lived compounds were used extensively in past farming practices but are currently banned. Necropsies were not able to identify a single cause of death. Several veterinarians at both universities and agencies looked for signs of disease as well as poisoning from various pesticides. No evidence was found indicating the presence of disease or cholinesterase-inhibiting pesticides. Most stomachs were empty, but the birds were not totally emaciated.

Important Science Issues

There is very little information about the toxicity of toxaphene to wildlife, and none on the toxicity of degradation products of toxaphene to wildlife. In particular, there are no data on the toxicity of toxaphene accumulated via the food chain rather than from oral doses under experimental conditions. Analytical methods and interpretation of analytical results, particularly for degraded toxaphene, is very problematic. Many variations on the method are available and some appear to yield higher results.

Regional Involvement with the Problem

EPA Region 4 scientists provided advice and technical support to District staff as they designed a second study of the soil contaminants in farmland soils which took place during the summer and fall of 1999. The focus was on better determining the distribution and concentrations of pesticides on the property based on over 1200 samples of soils, sediments, fish and bird tissues. EPA Region 4 provided assistance with quality assurance and analytical issues and interacted with other agencies to determine how many new fish and bird samples should be analyzed. As a member of the Technical Advisory Group, EPA played a role in evaluating the results of the study and in discussing the tasks that were assigned by the District to its contractor, Exponent, once all the data were collected. Exponent's draft report on the cause of the avian mortalities has been reviewed by EPA Region 4, ORD and others. A meeting was held on October 11, 2000 to discuss the contractor's conclusions, their acceptability, and how the findings may impact the management of this large property that was purchased to restore a wetland for migratory birds.

Major Science Needs

- Determine toxicity of toxaphene degradation products/metabolites to fish and wading birds – chronic and acute;
- Determine route of exposure of birds to "toxaphene" and other chlorinated pesticides on the site – including organic soil, fish;
- Evaluate analytical procedures for toxaphene in highly organic soils – sonication vs. extraction, solvent efficiency, etc.;
- Develop better interpretation of chromatograms – including the use of congeners, quantifying degradation products, and evaluating interferences;
- Evaluate sublethal impacts of metabolites on wading birds; and
- Determine cumulative effects of exposure to multiple pesticides – dieldrin, toxaphene, chlordane, and DDT.

Conclusions and Next Steps

A District contractor has presented a draft report that suggests more analytical work and better interpretation of chromatograms is required to clarify whether this birdkill was caused by pesticides or disease. The Technical Advisory Group will provide comments on the report which may be modified to address specific issues raised by this group of Agency cooperators and citizens. Meanwhile, the USFWS has not released its data or publicly withdrawn from its criminal investigation.

Environmental Databases, Office of Pesticide Programs, Dan Rieder, Office of Pesticide Programs

Databases of EPA's Environmental Fate and Effects Division (EFED) include:

Toxdata contains information on the toxicity of pesticides to terrestrial and aquatic animals and plants, specifically: birds and wild mammals (not lab mammals); freshwater and estuarine fish and invertebrates; terrestrial plants (crop species); and aquatic plants (algae and vascular, but no rooted aquatic vegetation). It contains over 700 pesticides and over 14,000 records; most of the data come from studies submitted to pesticide registrations. Some of these are government-funded studies, published studies, but include any other scientifically sound data.

EIIS (Ecological Incident Information System) contains reports of adverse field effects (*not* field study results). It contains over 2900 reports of incidents on many terrestrial and aquatic species. Each report is evaluated and a “certainty” factor is assigned representing the degree to which information contained in the report showed cause and effect. Sources of reports include States, federal agencies, wildlife rehabilitation centers, and registrants. Incidents reported are mainly wildlife mortality, however some are reports of debilitation and recovery. Included are only those reports in which there is a suggested link between a pesticide and the effects.

Fate Database contains fate and transport information on pesticides (near completion), and contains fate data for over 150 chemicals. The sources of data are from studies submitted to support pesticide registration. Included data vary depending on kind of study, but are generally conditions of study, duration, media used, methods and results. Specific information contained in the database includes: Hydrolysis and photolysis degradation rates and degradates; aerobic and anaerobic metabolism rates and metabolites; bioconcentration in fish tissue; and mobility in soils and sediment.

PGSWD (Pesticide in Ground and Surface Water Database) will contain information on pesticide residues in groundwater or surface water. Key elements of the database include: location information, water type/use; sample time/date, QA/QC tags (LOD, LOC, recovery), purpose of sample collection, and contact person/agency. The database is still under development and a beta version is expected to be ready for data entry by late FY 2001.

6a2 water database contains reports of detections of pesticides in groundwater or surface water that were reported under FIFRA section 6a2. Detections must be submitted individually if detection exceeds the MCL, and may be aggregated if they are less than the MCL but greater than 1/10th the MCL These data are useful to identify problem pesticides and areas, and to confirm assessment, but are not useful statistically.

Two other databases were mentioned: 1) **PGWDB** (Pesticides in Groundwater Database) which contains documents of compiled results of ground water monitoring studies and a compilation of supporting reports; it is not automated; and 2) **Fate Oneliner** which is no longer supported.

Pesticide Ecological Risk Assessment, Dan Rieder, US Environmental Protection Agency, Office of Pesticide Programs

Risk characterization is the integration of exposure and effects data. EFED typically compares the levels of exposure expected in the field (exposure data) to laboratory derived toxic effects data. The Risk Quotient (RQ) is a ratio of exposure data to effects data, and provides risk managers with an indication of situations where the presumed risk suggests the need for mitigation, further study, or further refinement. EFEDs Level of Concern (LOC) is the threshold with which the RQ is compared to determine which pesticides exceed a critical risk threshold. Sample LOCs for aquatic organisms and terrestrial organisms were presented.

Aquatics

Examples of effects data were presented for freshwater and aquatic organisms, estuarine and marine organisms, and the general parameters were discussed that guide the use of effects data by EFED. Sample RQ calculations were presented for aquatic organisms and birds. An overview was presented of the types of models used to estimate wildlife exposures. For aquatic organisms, EFED uses a tiered approach with two models. Both models estimate the runoff from a 10 hectare field into a 1 hectare pond, two meters deep.

1. The **GEN**eric **E**xpected **E**xposure **C**oncentration (GENEEC) model uses Koc and degradation half-life to estimate the runoff. It provides estimated peak, 96-hour, 21-day and 56-day average concentrations.
2. The **P**esticide **R**oot **Z**one **M**odel and **EX**posure **A**nalysis **M**odel **S**ystem (PRZM/EXAMS) is a combination of a pesticide transport model and an aquatic dispersion model. The transport model (PRZM) estimates how much pesticide moves to the edge of a field with runoff and eroded soil. The dispersion model (EXAMS) projects the distribution and dissipation of the pesticide in the pond. It provides estimated 1 in 10 year peak, 96-hour, 21-day, and 60-day average concentration.

Key issues for aquatic organisms are:

?? Accounting for sediment toxicity; and

? Exposure models for water bodies other than small ponds.

Terrestrial

For terrestrial organisms, two models approaches are used:

Approach 1 is used to quantify possible ingestion of residues on vegetative matter and insects, based on a "nomogram". The nomogram is a set of estimated residues relative to a known application rate.

Approach 2 is used for granular and bait applications, and is based on field-testing that related mortality to an application rate. It is intended to account for exposure via multiple routes (not just direct ingestion).

Key issues for terrestrial organisms are:

? How to take into account and quantify and routes of exposure other than dietary;

? How to move from pesticide on food to dose;

- Assessing chronic risk from granular formulations;
- Collecting data to characterize animal behavior relative to exposure.

Key issues for **all** organisms are:

- How to account for uncertainty at Level 1 and still have a viable screen;
- Determining how many species are needed to characterize inter-species sensitivity differences;
- Improving test design for dose-response curves in chronic tests;
- Estimating exposure duration, particularly laboratory versus field;
- Testing additional species (more invertebrates, reptiles, amphibians); and
- Moving from individual to population, and determining community effects estimates.

Overview of Aquatic and Terrestrial Toxicity Databases & Introduction to ORD Wildlife Strategy, Rick Bennett, US Environmental Protection Agency, National Health and Environmental Effects Research Laboratory

Three databases which house a variety of aquatic and terrestrial toxicity data, are currently under development by NHEERL.

ECOTOX is a source of toxicological effects data for aquatic and terrestrial species. The database is a combination of AQUIRE, TERRETOX, and PHYTOTOX databases, and it contains primarily peer-reviewed literature, plus data from OECD, Russia, and USEPA OPP. There are over 250,000 toxic effects records from 15,000 references for 9,024 chemicals and 4,900 aquatic and terrestrial species. ECOTOX web search features include: unrestricted access, FAQs, HTML user manual, output in delimited or tabular formats, unlimited input for chemical and species search parameters, and use of Netscape 4.X or higher browser features. *Search parameters* include: chemicals, species, test conditions, test results and publication criteria. ECOTOX can be reached through www.epa.gov/ecotox

TOXRES (Toxicity/Residue) is designed to link toxic residues to tissues residues for aquatic organisms exposed to inorganic and organic chemicals. There are over 3,000 effect and no-effect endpoints for survival, growth and reproductive parameters for invertebrates, fish and aquatic life-stage of amphibians (74% are survival endpoints). TOXRES contains over 500 literature references on approximately 200 chemicals and 190 freshwater and marine test species. It is anticipated to be available on the web in December 2001. Future plans include integrating wildlife data.

EVISTRA (**EV**aluation and **I**nterpretation of **S**uitable **T**est **R**esults in **A**QUIRE) is a designed to present results that (a) were obtained from AQUIRE and (b) were evaluated for suitability and quality and interpreted when necessary. A draft guidance document titled "Guidance for Evaluating Results of Aquatic Toxicity Tests” is available at: www.epa.gov/med/databases/evistra.html. Water quality criteria document tables are planned to be available on the web site in October 2001.

Other available databases are:
The US Geological Society (USGS) houses the Contaminant Exposure and Effects for Terrestrial Vertebrates (**CEE-TV**) database which links necropsies to biomarker endpoints and tissue residues. It can be reached through www.pwrc.usgs.gov/ceetv. This site provides linkage with the USGS breeding bird surveys and Christmas bird count.

Exposure Factor and Toxicity Database at Cal/EPA at www.oehha.org/cal_ecotox

***EXTOX*NET** (EXtension TOXicology NETwork) at the University of California, Davis, at http://ace.orst.edu/info/extoxnet

Aquatic and Terrestrial Exposure Models, Larry Burns, US Environmental Protection Agency, National Exposure Research Laboratory

A variety of models were presented in the context of Office of Pesticide Programs use for regulation and writing of pesticide labels. Models can extend new chemical submission data to field conditions. All models presented are mechanistic models, based on process and pathways, and consider the fundamental physical and chemical properties of the active ingredient.

For conceptual models:
- Regional scale sets the framework;
- Small watershed at the farm scale sets the PRZM/EXAMS “scenario”;
- Ecosystem scale defines the processes and phenomena for modeling; and
- Conservation of mass is the organizing principle throughout.
- Several models were discussed, such as the Formal Ecosystem Conceptual Model, the Pesticide Root Zone Model (PRZM), and the Exposure Analysis Modeling System (EXAMS) in the context of the Lake Apopka Case Study. Also presented was the process of integration of these models with data management systems, and the use of algorithms to determine exposure and characterize risk.

Nonpoint Source Assessment in Agricultural Watersheds and Stream Riparian Zones: Modeling and GIS, Mohamed Hantush, US Environmental Protection Agency, National Risk Management Research Laboratory

Soil and groundwater pollution potential indices and dynamic pesticides’ transport and fate models were presented using the Lake Apopka case study as an example. General routes of pesticide transport and fate were described, including volatilization, adsorption, degradation, passive root uptake, advection and dispersion. Estimates and calculations of these components were explained.

The utility of the models within a Geographical Information System (GIS) demonstrated with application to a different site (Mid-Atlantic coastal plane watersheds) of somewhat similar soil characteristics. The results were linked to the Lake Apopka area by analogy. A GIS facilitated the incorporation of soil and climate data, drainage rates, and pesticide chemical properties into the pollution assessment framework. The integrated modeling-GIS framework provides an effective tool for management of pesticides in watersheds. Lumped-parameters and physically based dynamic models were presented for transport and fate of pesticides in soils and wetlands. Preliminary model runs were made to estimate the cumulative impact of historical annual applications of selected pesticides on soil and wetlands contaminations in agricultural areas to the north of Lake Apopka.

Conclusions from this analysis specific to Lake Apopka are:

? The NPS models are potential tools for assessment of relative importance of different exposure pathways;

? Exposure to pesticides at soil surfaces is more likely in poorly drained landscapes, as predicted by NPS models, where soil retention of pesticides is greater than in moderately to well drained soil landscapes;

? Groundwater vulnerability to pesticides is more likely in moderately to well drained soil landscapes;

? Contaminated soils may be contributing to residues of chlordane, DDT, and toxaphene in wetlands at Lake Apopka, as predicted by the soil-wetland interface model;

? Recycling of contaminated waters in wetlands to the lake during the years of agricultural use may have contributed to pesticide residues in the waters; and

? The contributions of contaminated sediments and atmospheric depositions at Lake Apopka are unknown, but could be significant.

Current and Future Implications of Biotechnology to Chemical Pesticide Use, Bob Frederick, US Environmental Protection Agency, National Center for Environmental Assessment

In the last 10 years, there has been a large increase in the development of Genetically Modified Organisms (GMOs), particularly for agricultural and medical uses. A common agricultural example is plants modified through molecular biology techniques to contain a naturally occurring pesticide producing gene, normally found in the bacteria *Bacillus thurigensis* (Bt). Several diverse views prevail regarding GMO's:

The **Environmental Protection Agency** (EPA) believes that the use of biotechnology can reduce our reliance on chemical pesticides, resulting in a win for agriculture and a win for the environment.

The **Biotechnology Industry Organization** (BIO), a trade association of the biotechnology industry, believes GMOs in agriculture are beneficial because :

? Herbicide tolerant crops give farmers greater flexibility and safer, more innovative choices in pest management;

- They promote conservation tillage; and
- Bt crops reduce pesticide use.

The **Union of Concerned Scientists** (UCS), a non-profit *environmental advocacy group*, believes biotechnology is "a very powerful technology…able to produce combinations of genes that have never been produced before… [Yet] it's far from clear what the impact will be on the environment and on humans who consume them".

The **Entomological Society of America**'s position is that genetically engineered crop plants that express insect pest resistance traits could facilitate a shift away from reliance on broad-spectrum insecticides toward more biointensive pest management.

Risk Assessment

There are challenges for risk assessment of GMOs including assessing the "absolute" risk and assessing the relative risk. Given the complexity of ecological systems, the sources and significance of variability in effects are many (geographic site, scale, cultivar, ecological interactions). Defining "significant" effects will depend upon our ability to conduct long-term experiments and to increase confidence in negative results. Finally, it is difficult to find appropriate baseline comparisons in conventional counterparts for this relatively new technology.

Agricultural Concerns

There are specific concerns related to agricultural GMOs and the environment. Specifically they may:

- Result in unintentional gene transfer to surrounding crops or native species;
- Reduce agricultural efficiencies due to monomorphic crops;
- Produce adverse impacts on indigenous species (non-target pests), such as killing beneficial species that may consume the GMO;
- Result in evolution of target and other pests which may produce enhanced insect tolerance to biopesticides; and
- Increased chemical use, particularly in the cases where GMOs are herbicide resistant. Some believe farmers will become comfortable with an injudicious use of chemicals knowing it will not affect their crop.

Current Trends

From a review of data on the use of pesticides and GMOs for the last five years (1996-1999), adopters of GMOs used fewer acre-treatments of pesticides than non-adopters. Generally:

- Genetically modified crops have been adopted enthusiastically in the United States over the last five years;
- The prediction of chemical use reduction accompanying GM crop use, appears to be true;
- With the current "volatility" in general acceptance of the technology, it is difficult to predict what the future trends of environmental impacts (positive or negative) may be; and
- Targeted monitoring and research will improve the robustness of environmental risk assessment and further the safe use of biotechnology products in the future.

Remaining Issues

- ? With biotechnology adoption rates of more than 50% for certain crops in some areas of the US, what impact will a return to conventional crops have on environmental loads of pesticides/herbicides?
- ? How will the reductions in chemical use be reflected in environmental concentrations? Is there sufficient existing information to allow targeting sites for data collection (e.g., heavy use areas where the largest reduction in volumes are occurring)?
- ? How do we weigh the trend for a decrease in pesticide/herbicide use against other potential environmental impacts from genetically modified crops?

Session Questions and Responses

Question: Is there a connection between the ECOTOX and TORES database?
Response: There will be an internet link.

Question: Is there a distinction between EXOTOX, ToxNET and AQUIRE?
Response: The ToxNET data are whatever are available, and there may be overlap. Most are industry-submitted information.

Question: There are a lot of data, should we put a premium on validation similar to human health information? Should EPA provide a screening mechanism?
Response 1: EVISTRA database will be a subset of the AQUIRE database that has been evaluated and interpreted to provide high quality information for use in environmental decisions.
Response 2: This is particularly an issue for old data sets that may have few data points, thus low stringency. There needs to be some decision on whether EPA should make the call.

Question: What could EPA do to look at toxaphene since the only data available is from old studies? Is someone doing studies to evaluate the problem?
Response: ORD is looking at artificial degradation of toxaphene in soil, and trying to emulate longer-term scenarios looking at toxaphene shift, degradation and toxicity.

Question: Is anyone looking at lab testing to determine how the patterns of brain chemistry appeared in the dead birds?
Response: There is a feeding study on mallards, but it may not be current.

Question: Since the chemicals were found in birds and not in the fish, were other pesticides evaluated besides toxaphene?
Response: There are also detectable residues of DDT and dieldrin in this system, and in the fish and bird samples. Although DDT and dieldrin were present, the evidence seems to indicate that they were less likely the cause of death.

Question: What is the theory behind the criminal investigation?

Response: There is a question regarding potential mismanagement of the original cleanup before the land was purchased, or whether there was deliberate dumping. The Fish and Wildlife Service is required to do a criminal investigation whenever endangered species are involved.

Question: Do you see a possibility that the agricultural industry will contribute to research in the safety of biotechnology?

Response: The industry is eager to help, but they are faced with a credibility issue on whether the research would be tainted if they provide the funds. Seed companies do perform risk assessments and submit the data to agencies for approval of the product.

Appendix I: Break-Out Group Summary

HUMAN HEALTH: Indoor Exposure Issues

1. What are the uncertainties in our knowledge which limit our ability to draw decisive assessment conclusions and take fully informed actions to prevent or mitigate pesticide problems?

- Information on how to identify clusters;
- Centralized data from kids at daycare and pediatric centers;
- Education for communities on how to consider pertinent poisons;
- Absence of baseline data;
- Absence of test kits (rapid and cheap field tests); and
- Information on how to use of pets as indicators.

Specific information on:
Chemicals
- ? Henry's law
- ? phase
- ? partitioning

Processes (Physical and chemical)
- ? transport (+micrometeorological and climatological)
- ? fate (measurement method and actual fate)
- ? source/application characterization

Targets
- ? susceptibles
- ? receptor location/proximity
- ? penetration
- ? presence of sentinel species
- ? dose

2. How might the Regions use the science described in this session to respond to the issues raised in this case study?

To assess the severity of exposure
- There are uncertainties in understanding the link between known exposure (absorbed dose) and health effects (ambient does not equal absorbed dose);
- Science can be used to calculate potential exposures;
- These must focus on behavior; and
- There is a need to transfer this science.

3. Are there other opportunities to integrate science into the Regional decision making?

- ORD is looking for increased exposures/Regions see these; there needs to be an exchange of information on what data are needed and what are available;
- Make better use of existing programs such as that of Dan Horochec (Univ. IL), Cook Co. Pediactric Clinic. He reports results of his health evaluation of increased exposures (all chemicals) mostly on children, that are often referred by the Regions.

4. What scientific **fact sheets** or **other tools** would be useful to the Regions in carrying out their mandates, e.g., enforcement of pesticide regulations and communicating relevant science information to interested communities?

- Develop sensitivity analyses;
- Establish cut-off points for actions;
- Develop alerts for local health communities;
- Develop urban pesticide outreach;
- Establish links from veterinarians to public health community for reporting of "sentinel events";
- Education programs for recognition of pesticide poisoning;
- Development of tools to address scale changes (local vs large, i.e. watershed).

HUMAN HEALTH: Exposure Issues from Spray Drift

1. How might the Regions use the science described in this session to respond to the issues raised in this case study?

- To identify what happens and where (air monitors) using AgDrift, SHEDS, and technical review;
- To develop effective responses for:
  - ? decontamination
  - ? evacuate/closure
  - ? measurements/methods
- To develop proper exposure tracking methodologies;
- To evaluate CDDs – Breakdown products, mixtures; and
- To evaluate best use for and effects on adjacent land.

2. Are there other opportunities to integrate science into the Regional decision making?

Discussed with other questions.

3. What are the uncertainties in our knowledge which limit our ability to draw decisive assessment conclusions and take fully informed actions to prevent or mitigate pesticide problems?

- Particle penetration (outdoor and indoor);
- Definition of drift: multiple factors, e.g. harm threshold also biotech products;
- Primary and secondary drift combined and linked to local GIS; cumulative effects;
- Linkage research – exposures to pesticide applications;
- Linkage – transport to human exposure, thresholds for health effects (need to collaborate);
- Predictive tools to target outreach;
- Using exposure parameters, or use data from States;
- Proximity of fields, dwellings, effect of buffers; and
- Pesticides remaining in soil.

4. What scientific **<u>fact sheets</u>** or **<u>other tools</u>** would be useful to the Regions in carrying out their mandates, e.g., enforcement of pesticide regulations and communicating relevant science information to interested communities?

- Monitoring techniques:
  ? GCIMS
  ? Immuno Assays- quick method
  ? Wipes – need better locations
- Model activity patterns of children

HUMAN HEALTH: Exposure from Vector Control Options

1. What are the uncertainties in our knowledge which limit our ability to draw decisive assessment conclusions and take fully informed actions to prevent or mitigate pesticide problems?

- What are the results of environmental spraying and implications to the lower end of food web/chain?
- What should agencies do when public health comes head-to-head with environmental risks?
- What is the influence of religion (globally)?
- What are effects of multiple spraying (risks)?
- More measurements of (outdoor and indoor) pesticides via spraying.
- Is turning air-conditioning off effective in reducing exposure; what about restarting?
- What is the efficacy of spraying, especially ground spraying without aerial?
- What is/are ideal droplet sizes, and what is the best way to deliver these?
- Almanac/maps of occurrence within a year showing the spread of disease and mosquitoes.
- When is it safe allow children and pets out after spraying?
- Include secondary information sources, e.g. web sites, or fact sheets.
- Communication of risk of disease vs. risk of control.

2. How might the Regions use the science described in this session to respond to the issues raised in this case study?

- ORD research is focused on FQPA, fate and transport models to EC;
- Use of air measurements;
- Use of data on residential penetration of fine particles;
- Understanding residues and comparison between products;
- Addressing the issue of the effects of syn pyrethroids that are not well characterized; and
- Using NHANES data.

3. Are there other opportunities to integrate science into the Regional decision making?

- Need "rapid-response" team;
- RSC program;
- Involvement in research planning process is of limited value;
- "Institutionalized" means to communicate scientific information to Regions where needed;
- Need a coordinated group for information exchange.

4. What scientific **fact sheets** or **other tools** would be useful to the Regions in carrying out their mandates, e.g., enforcement of pesticide regulations and communicating relevant science information to interested communities?

- ORD studies for indoor exposure and relate these to the public;
- ORD data on risks to cats and dogs to adulticiding;
- CDC information transmission of WNV from wild mammals to humans; and
- Implication on other wildlife, especially non-targets such as bees.

HUMAN HEALTH: Highly Exposed and Sensitive Populations

1. How might the Regions use the science described in this session to respond to the issues raised in this case study?

To elucidate:
- Physics (data scare on mechanism, differing scales – needed to validate model).
- Is the model tool sensitive enough to use?
- Additional complexities when scale increases.
- Time lag from incident to response.
- Absence of direct causal link.
- Decrease in toxic response (time, detection, baseline).
- Decrease awareness and diagnosis.
- Social/cultural factors.
- Demographic profile.
- Details are needed on acute vs. sub chronic; ecological; and multiple and causal.

2. What are the uncertainties in our knowledge which limit our ability to draw decisive assessment conclusions and take fully informed actions to prevent or mitigate pesticide problems?

- What activities does EPA do that are most effective in modifying behavior (what is/is not working)?
- How to address pesticides that are EDCs + inerts.
- Most sensitive endpoint notation in IRIS regarding what endpoints are included?
- Mechanistic data for adverse health effects.
- Knowing D/R curve (information on severity of effect + acute to chronic) to help determine action.
- Increase rate of reviewing new data and putting into IRIS; need to flag less-rigorously developed risk numbers (e.g. HEAST values).

- WNL: qualitative risk relationship to quantitative pesticide.
- What is the generic risk versus risk comparison?
- What are the endpoints: case/mort/sero conversion?
- What is the cost of morbidity symptoms (e.g. influenza vaccine)?
- Risk perception (obscure pathway, voluntary exposure, routine).
- Are acute exposures underestimated (e.g. droplet distribution, drift is different – 1% available for inhalation, 20 minute exposure)?
- What proportion of exposed individuals are sensitive (respiratory, not organo phosphate)?
- What is the difference in persistence and chronic exposure (breakdown products)?
- Inert ingredients need study.

3. Are there other opportunities to integrate science into the Regional decision making?

Discussed with other questions.

4. What scientific **fact sheets** or **other tools** would be useful to the Regions in carrying out their mandates, e.g., enforcement of pesticide regulations and communicating relevant science information to interested communities?

Discussion combined with other exposure topics.

Suggested Workshop Follow-up on Health

- Brief senior managers on what was learned at the workshop.
- Executive summary of workshop report.
- Paper on how Regions can access opportunities for collaboration, e.g. Community Science Council.
- Invite ORD on OECA call.
- ORD work through Regions to do community research.

ECOLOGICAL ISSUES

1. What are the uncertainties in our knowledge which limit our ability to draw decisive assessment conclusions and take fully informed actions to prevent or mitigate pesticide problems?

- Brain concentrations of pesticides not fully explained.
- Research ended and pesticide was banned, so how did exposures occur – ingestion, dermal?
- Degradation products – different susceptibility.
- Were there other exposures of birds during migration (upper Midwest summers)?
- Missing some fish data.
- One hot spot (1%) found, are there others?
- Methodology for identifying degradation products.
- Mechanisms for recognizing and responding to incidents.
- Best resolution for GIS-Mapping pesticide application?
- Use of constrains model for larger applications.
- List of which office in EPA knows about a given compound.
- Very difficult to ascertain pesticide application data.
- Interagency coordinated evaluation of utility of ecological toxicology.

2. How might the Regions use the science described in this session to respond to the issues raised in this case study?

Discussed with other questions.

3. Are there other opportunities to integrate science into the Regional decision making?

- Developing call contacts within the Agency;
- Get data useful for modeling;
- Historical aerial photography from EPIC/NERL; and
- When States/Feds buy up farmland to restore natural environments, EPA should advise/help to dispose of on-site pesticides.

4. What scientific **fact sheets** or **other tools** would be useful to the Regions in carrying out their mandates, e.g., enforcement of pesticide regulations and communicating relevant science information to interested communities?

Discussed with exposure topics.

Appendix II: Proposed Discussion Groups

PESTICIDE SCIENCE DISCUSSION GROUP 1

EVALUATING and REDUCING PESTICIDE EXPOSURES
I. RESIDENTIAL APPLICATIONS

Target Audience: Public

Volunteers:
Donald Baumgartner
Terry Harvey
Rick Hertzberg
Mark Johnson
Robert Koethe
Kelly Leovic
Dan Stout
Nicolle Tulve

Topics for Consideration:

?? Indoor applications
  a. Routes of exposure
  b. Persistence/half life on different surfaces, e.g., hard surfaces, carpet, furniture
  c. Relative effectiveness of different avoidance and exposure reducing approaches
    1) starting with proper application methods
    2) special emphasis on children (including activity patterns) and pets
2. Outdoor applications
  a. Routes of exposure, including tracking indoors
  b. Persistence/half life under different climatic conditions
  c. Relative effectiveness of different avoidance and exposure reducing approaches
    1) starting with proper application methods
    2) special emphasis on children (including activity patterns) and pets

PESTICIDE SCIENCE DISCUSSION GROUP 2

EVALUATING and REDUCING PESTICIDE EXPOSURES
II. AGRICULTURAL APPLICATIONS

Target Audience: Public

Volunteers:
Ray Chavira
John Cicmanec
Carol Kemker

Topics for Consideration:

1. Workers
   a. Routes of exposure
   b. Relative effectiveness of different avoidance and exposure reducing approaches
      1) starting with proper application methods
      2) observing and responding to weather variables
      3) precautions to avoid bringing residues into workers' homes
2. Residents/Schools/Other located adjacent to agricultural fields
   a. Routes of exposure
   b. Relative effectiveness of different avoidance and exposure reducing approaches
      1) starting with proper application methods
      2) observing and responding to weather variables
      3) precautions to avoid bringing residues into homes/schools/other

(NOTE: There may be sufficient overlap in information related to workers and residents that they can be combined.)

PESTICIDE SCIENCE DISCUSSION GROUP 3

EVALUATING and REDUCING PESTICIDE EXPOSURES
III. MOSQUITO CONTROL

Target Audience: Public

Volunteers:
Donald Baumgartner
Fatima El Abdaoui
Carol Kemker
Robert Koethe

Topics for Consideration:

?? Description and relative efficacy of different mosquito control methods, e.g., habitat modification (in rural and urban areas), behavior modification, integrated pest management, larvacides, adulticides, aerial vs ground spraying, personal repellants.

?? What you see and hear during different types of community spray applications.

?? Relative effectiveness of different pesticide avoidance and exposure reducing approaches. Include special emphasis on children (including activity patterns) and pets (when to let out after spraying).

?? West Nile Virus

a. Maps showing spread (When will it get to my town?)
b. How do I reduce my likelihood of being exposed to the virus?
c. How do I know if I have been exposed?

PESTICIDE SCIENCE DISCUSSION GROUP 4

EVALUATING and REDUCING PESTICIDE EXPOSURES
IV. PESTICIDE APPLICATORS

Target Audience: Applicators (residential and agricultural)

Volunteers:
John Kinsey
Robert Koethe
Renee Sandvig

Topics for Consideration:

1. Reducing personal and public exposure, what applicators should tell their clients.
2. How to recognize symptoms of pesticide exposure.
3. How to observe and respond to key variables such as wind shift and moisture.
4. How to use "spotters" or monitors for observing drift.
5. Use of tools, such as AgDRIFT, to modify and reduce drift and subsequent exposure.
6. Ideal droplet size and best way to deliver it.

?? Reading and using chemical labels properly.

PESTICIDE SCIENCE DISCUSSION GROUP 5

PESTICIDE HEALTH RISKS for HEALTH CARE PROFESSIONALS

Target Audience: Health Care Professionals (human and veterinary)

Volunteers:
John Kinsey
Robert Koethe
Renee Sandvig

Topics for Consideration:

?? How to recognize symptoms of pesticide exposure.
?? How to report cases and possible trends to proper authorities.
?? Identify and explain the Central Medical Exam Centers, providing contacts.
?? Detail record keeping needed to document cases.
?? Describe patient sampling and sample preservation, what may be useful for future analysis.
?? Provide guidance in explaining to patients about risk, risk reduction, and health benefits of pesticide use.
?? Relative risks of pesticide toxicity vs. diseases controlled by pesticides.

Appendix III: Pesticides Workshop Participant Evaluation Summary

Most participants found the content of the workshop to be very useful. In addition to the excellent quality of material presented and ORD resources identified, valuable contacts were established between the Regions and ORD. It was the majority opinion that the case studies were an excellent mechanism for presenting the Regional science issues. Comments from the Regions suggested that it would be useful to focus on presentations illustrating in detail how to quickly solve real-life problems in Human Health and Ecosystem pollution with less emphasis on heavy modeling. Participants felt the breakout groups were effective; however, one per day would have been adequate. A common desire was expressed for a question and answer discussion period after each presentation.

The use of *PlaceWare* did detract from the learning experience in some cases. Suggestions for future use of *PlaceWare* included: 1) use a Local Area Network (LAN); 2) including a second screen with *PlaceWare* communications, and 3) distribute an electronic copy of presentation slides to *PlaceWare* participants prior to the workshop.

Greater ORD involvement in regular pesticides meetings via conference calls would facilitate continued interaction on science issues. The list of participants produced for the workshop will be used to maintain and establish contacts. Interest was expressed for a list of web sites for information on current research and results.

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Appendix V: Slides from Presentations

1.	*Opening Remarks*	**David Klauder**
2.	*Methyl Parathion Misuse*	**John Ward**
3.	*The Movement and Deposition of Pesticides Following Their Application In and Around Dwellings*	**Dan Stout/Bob Lewis/Renee Falconer**
4.	*Exposure Routes and Pathways: Indoor Factors and Scenarios*	**Linda Sheldon**
5.	*Models for Estimating Exposure*	**Haluk Ozkaynak**
6.	*Drift from Agricultural Fields to Nearby Homes, Farms,and Gardens*	**Ray Chavira**
7.	*Overview and Application of the AgDRIFT Model for Agricultural Spraying*	**Sandy Bird/Steven Perry**
8.	*Multimedia, Multipathway Aggregate Exposure Modeling*	**Haluk Ozkaynak**
9.	*Spray Drift and Risk Management Tools*	**John Kinsey**
10.	*New York City Spraying of Malathion to Control Mosquitoes Carrying West Nile Virus*	**Henry Rupp**
11.	*Mosquito-Proof New York City*	**James Miller**
12.	*West Nile Virus: Evaluating Risk*	**Roger Nasci**
13.	*Malathion Application for Control of West Nile Virus Vectors: Pesticide Risk and Exposure*	**Kevin Sweeney**
14.	*Exposure Implications: Methods, Measurements, and Models*	**Daniel Vallero**
15.	*Pesticides and Worker Health*	**AnaMaria Osorio**
16.	*Exposures to Children*	**Chuck Steen/Linda Sheldon/Chris Saint**
17.	*Measuring the Effects of Exposure on Children*	**Pauline Mendola**
18.	*Treatment of Pesticides in Drinking Water*	**Tom Speth**
19.	*Lake Apopka Birdkill: Winter 1998-1999*	**Anne Keller**
20.	*Environmental Databases, Office of Pesticide Programs*	**Dan Rieder**
21.	*Pesticide Ecological Risk Assessment*	**Dan Rieder**

22. *Overview of Aquatic and Terrestrial Toxicity Databases & Introduction to ORD Wildlife Strategy* — **Rick Bennet**

23. *Aquatic and Terrestrial Exposure Models* — **Larry Burns**

24. *Nonpoint Source Assessment in Agricultural Watersheds and Stream Riparian Zones: Modeling and GIS* — **Mohamed Hantush**

25. *Current and Future Implications of Biotechnology to Chemical Pesticide Use* — **Bob Frederick**