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Pesticides and Salmon, Part 1
Something Smells Fishy

Dr. Allan S. Felsot, Environmental Toxicologist, WSU

Something's fishy in the waters of the Pacific Northwest. According to regional newspapers, salmon are losing their sense of smell, and genetic males are posing as females (1, 9). Move over dams, loss of quality habitat, excessive fishing, and global warming. Pesticides are the latest smoking gun in the saga of diminishing salmon returns.

But the white knights have descended to rescue the salmon in distress. The Washington Toxics Coalition (WTC) and the Northwest Coalition for Alternatives to Pesticides (NCAP) have teamed up with the Pacific Coast Federation of Fishermen's Associations (PCFFA) and the Institute for Fisheries Resources (IFR) to sue the Environmental Protection Agency (EPA) for violations of the Endangered Species Act (2, 7). Specifically, the advocacy groups have seized upon the recent reports of sick salmon to back their demand that the EPA consult with the National Marine Fisheries Service (NMFS) over its decisions to register pesticides that may affect salmon.

That's right, *"may"* affect. Never mind that "may affect" implies a probability that can never be zero. The Endangered Species Act (ESA) specifically mandates federal agencies to initiate consultations with NMFS and/or the Fish and Wildlife Service (FWS) if any of their actions could potentially jeopardize the continued existence of any endangered or threatened species.

Multiple species of salmon have been listed as endangered or threatened under the ESA provisions. The affected habitats include practically the entire state of Washington and the western corridors of Oregon and northern California because they have waterways that harbor breeding salmon upon their return from the ocean. NMFS is in charge because they have jurisdiction over ocean-inhabiting species, and EPA registers pesticides that may get into salmon-bearing habitats. So, as the lawsuit proclaims, EPA must initiate consultation before taking any action that might endanger ESA-listed species. The suit further argues that ten years after the first listings of salmon species, EPA has neglected its obligations.

The plaintiffs allege that pesticides may affect or are likely to ad-

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versely affect listed salmonids and/or their critical habitat. Moreover, EPA registrations and ensuing product labels were developed in the absence of information about some of the "subtle but real impacts" of pesticides on salmonids. And for the coup de grace, "the U.S. Geological Survey (USGS) has found concentrations of pesticides in Pacific Northwest rivers and streams at or above levels that are associated with detrimental changes in fish growth, development, behavior, and reproduction."

Now, I can't tell you what goes on behind closed doors, and perhaps EPA had dragged its feet on initiating consultations as the lawsuit alleges. But I can tell you that EPA, together with NMFS and several state agencies, has initiated action plans for dealing with the pesticide issue. And I can also tell you that, contrary to advocacy group perceptions, EPA does make a provision in its risk assessments for endangered species.

Why should NMFS be the only entity that must use sound science?

The lawsuit states, "NMFS has a statutory duty to use the best available scientific information in an ESA consultation." Is NMFS the only entity that must use sound science? Let's take a look at the science behind those smoking gun issues recently publicized in the newspapers. Specifically, let's focus on the evidence against one of the most frequently mentioned pesticides, diazinon.

The Logical Framework of Risk Assessment

If NMFS is required to use the "best available scientific information" to figure out whether pesticides are harming salmon, then it is reasonable to expect them to follow the prescriptions of risk assessment, as this is the universally accepted methodology of the scientists who generate all the data.

In practice, risk assessment is a four-part process that is partially scientific and partially social. The first three components of risk assessment are scientifically determined: hazard identification, determination of dose/hazard relationship, and characterization of environmental exposures. The fourth component, characterization of the risk, is partly socially determined. Risk characterization is stating the likelihood that harm would be manifested. "Harm" can be relative, because it is dependent upon social definitions of what impacts are "harmful" as opposed to those that are biologically insignificant or socially tolerable. When social pressures are great, hefty (not necessarily science-based) safety factors can be incorporated into risk characterizations.

Hazard Identification
The Nose Knows

Some fish species have an extremely sensitive olfactory sense. A number of papers in the last several years have concluded that some fishes' ability to smell may be affected by very low doses of pesticides. The effects of the insecticide diazinon (residues of which are more frequently found in urban watersheds than in agricultural watersheds) have been of particular interest (8). U.K. researchers studying Atlantic salmon concluded that diazinon doses as low as 1 ppb could affect the normal nerve signals recorded in the nasal tissue responsible for sensing female reproductive priming pheromones (10). Hitting closer to home, NMFS scientists reported that diazinon at levels of 1 ppb affected the ability of the Chinook salmon nose to detect an alarm pheromone exuded when predators are nearby (11).

The reports from the U.K. (10) and NMFS (11) scientists were remarkable because they identified a hazard heretofore not much studied. Furthermore, the hazard was reported to occur at environmentally relevant concentrations—levels that are over 100-fold less than the reported LC_{50} for diazinon-exposed fish species related to salmon.

As is customary with hazard identification research, several hypotheses have been proposed to describe

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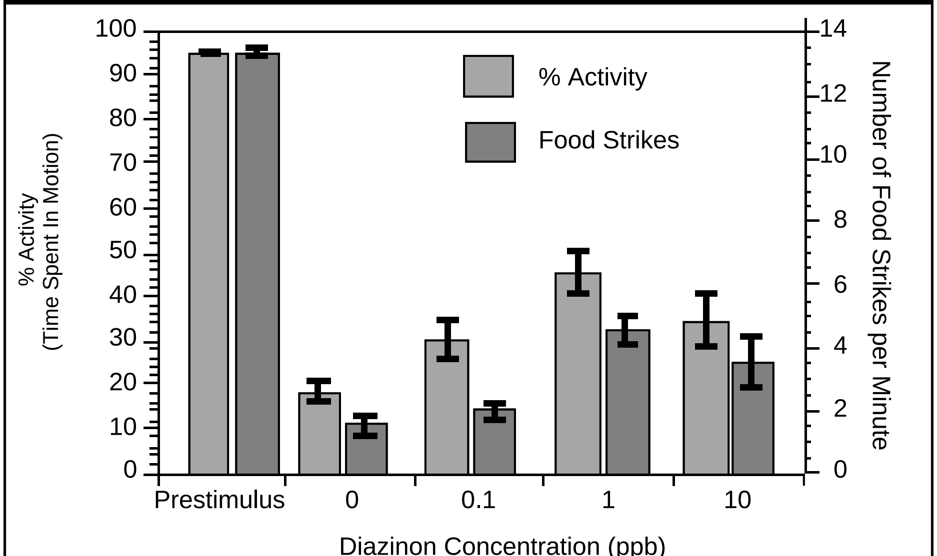
how diazinon disrupts salmon smell (11). First, the insecticide may bind to the nasal receptor proteins, reducing the ability of the pheromone molecules to bind. Second, the insecticide may alter the activation properties of the receptors. Third, the insecticide may move into the sensory cells (which are really specialized neurons) and modify intracellular signaling events. It is not known if any of these actions are related to the ability of diazinon to bind to and inhibit the enzyme acetylcholinesterase, the usual mechanism of toxicity associated with organophosphorus insecticides.

Whatever the mechanism of toxicity, the U.K. and NMFS research is commendable for identification of one of the most sensitive physiological and behavioral hazards identified to date in fish. As noted above, hazard identification is the first step in the four-part risk assessment process.

FIGURE 1

Effect of diazinon on anti-predator behavior of Chinook salmon under laboratory conditions.



Vertical bars represent 95% confidence intervals (CIs) calculated from the data presented in reference 11. CIs that overlap are not significantly different from one another with a probability of 95%. Anti-predator behavior is still significantly expressed after diazinon exposure. There is no clear relationship between reductions in the expected behavior and increasing dose.

Dose-Response Relationship

Getting Nosy about Predator Avoidance

Having described diazinon's remarkable hazards to salmon olfaction, we can move to step two, determining the relationship of dose to response, or how the magnitude of olfactory responses and resulting behaviors varies in relation to diazinon concentration.

Whatever the mechanism of diazinon's action on the nasal tissue, an increase in effect would be expected with increases in dosage up to a maximal response. For example, salmon should stop swimming activity and remain motionless when they sense alarm pheromones emitted by other salmon attacked by predators. Similarly, warned salmon should strike at food less often when they sense the alarm pheromone. These predator avoidance responses should diminish as the dosage of diazinon is increased; the responses should begin to look more like the behavior of fish not exposed to the pheromone.

While I am in agreement with the NMFS researchers that antipredator behavior was affected by doses of 1 ppb diazinon, I do not agree with popular accounts of the research suggesting that salmon populations are being affected by diazinon (5). First, predator avoidance behavior was not wiped out by diazinon (Figure 1). Indeed, it was still significantly different than the behaviors exhibited by fish before exposure to the alarm pheromone. Even fish not exposed to diazinon moved about to some degree and struck out at food. Fish exposed to 1 ppb diazinon exhibited somewhat more of these behaviors.

My second problem with how the NMFS research has been viewed is that no one has noted that the average responses of fish at the 10 ppb dose were actu-

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ally lower than at the 1 ppb dose. Unless some unexpected mechanism of toxic effect is operational, or alternatively, the maximum effect on behavior is reached at 1 ppb diazinon, the results do not show an unequivocal dose-response relationship.

Dose-Response Relationship

Statistical Spins on Reproduction Behavior

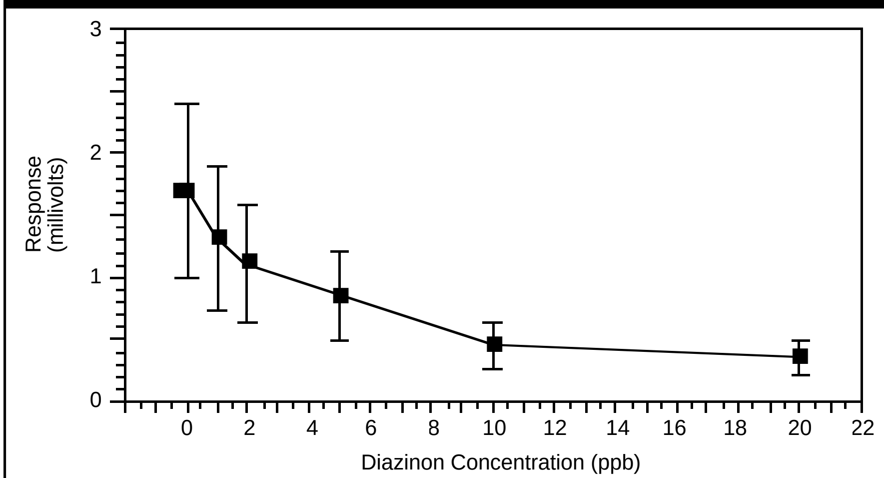
While the relationship between diazinon dose and magnitude of predator avoidance behavior may be somewhat hazy, diazinon's effect on salmon smell is given plausibility by U.K. research on the Atlantic salmon (10). Slicing open the male salmon's nasal cavity to expose receptor-rich nasal tissue (called olfactory rosettes), the U.K. team recorded the electrical potential (called an electro-olfactogram, EOG) when the tissue was exposed to female reproductive priming pheromone and then to a series of increasing doses of diazinon. Electrical signals increased in the presence of the female pheromone, but progressively higher doses of diazinon seemed to inhibit the response (Figure 2).

While I agree with the U.K. researchers that diazinon did impair olfactory responses to the priming pheromone, I disagree that levels of 1 ppb were sufficient to definitively cause the effect. Perhaps when salmon survival is at stake the argument over whether 1, 2, or 5 ppb diazinon causes an effect is trite, but remember we're trying to decide whether diazinon at levels *known to occur in the environment* has adversely impacted their populations.

As the saying goes, the devil is in the details, and in this case understanding just what doses cause stuffy salmon noses requires a short statistical detour. Researchers measure behaviors (and other sublethal effects) on individual fish, and individuals react a little differently from one another even in the presence of a toxicant. Determining whether responses are actually changing parallel to dose (as opposed to being random events) is complicated by the fact that a researcher measures a distribution of possible effects at each level of exposure. Thus, researchers use statistical techniques to determine how much overlap occurs between the distributions of behavioral measurements recorded at two or more doses. The gold standard for deciding whether two or more distributions of responses are sufficiently different because of dose or just due to chance alone is to determine if the overlap is 5% or less. When distributions overlap by no more than 5%, the researcher declares the responses at each dose significantly different from one another at the 95% level of confidence.

FIGURE 2

Change in response (millivolts of electrical potential) of Atlantic salmon nasal tissue exposed to increasing doses of diazinon and then to female pheromone.



Vertical bars represent 95% confidence intervals (CIs) that were calculated from the data given in the text of reference 10. Overlapping confidence intervals indicate that the responses are not significantly different from one another at a probability of 95%. The NOEC, based on a comparison between 0 ppb diazinon and other concentrations, seems to be 5 ppb.

When researchers publish their data, they show the average responses and only indicate the distribution of all responses with an estimate called the variance, which can be expressed in

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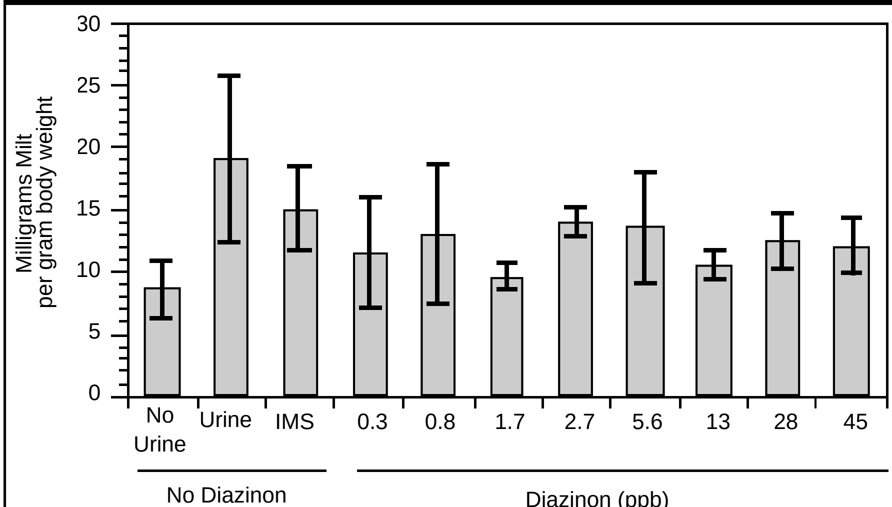
several forms. Numerous statistical techniques are available to determine whether the variance associated with the average responses for various doses are significantly different. However, different techniques of analyzing data can lead to different conclusions about whether two distributions of measurements meet the 5% criteria and are therefore a dose-related effect.

Researchers often don't show their raw data when they publish, but you can figure out what is significant by examining the variance terms. In doing so, I graphed and conducted a statistical analysis of EOG data reported by the U.K. researchers (Figure 2). Contrary to their conclusion that 1 ppb inhibited olfactory response, I cannot conclude any significant effect occurred until doses higher than 5 ppb were introduced to the fish nasal tissue.

FIGURE 3

Effect of diazinon on milt secreted from Atlantic salmon.



Milt production is stimulated by exposure to the reproductive priming pheromone excreted in urine of ovulating females. IMS is the solvent used to dissolve the diazinon. Vertical bars represent 95% confidence intervals (CIs) calculated from the graphical data presented in reference 10. Note that the unexposed primed fish (designated Urine and IMS) excreted significantly more milt than the unprimed fish (No Urine), but the amount of milt expressed was not significantly different from the milt expressed by fish exposed to diazinon (with the exception of the fish exposed to 1.7 ppb).

Milking the Milt Data

Nevertheless, doses of diazinon between 5 and 20 ppb inhibit electrophysiological measurements of olfaction. The next question is what biological relevance would such inhibition have? When salmon are primed by the female reproductive pheromone, which is released in the urine of ovulating females, circulating blood levels of male steroid hormones like testosterone are increased, consequently stimulating increased production of milt. Milt is the sperm-containing fluid that salmon secrete to fertilize eggs. Researchers can forcefully express the milt from the male and measure its weight.

The U.K. researchers noted that males exposed to diazinon for five days followed by a three-hour exposure to female urine had lower levels of reproductive hormones than unexposed males. They hypothesized that milt production would also be affected. Upon "milking" the diazinon-exposed fish, the researchers concluded that "there was no significant difference in the level of expressible milt when compared to fish not exposed to female urine" (10).

The researchers' conclusion was based on comparing milt levels in fish exposed to diazinon and fish not exposed to diazinon with milt levels in fish prior to exposure to urine. While their conclusion is unarguable, the graphical presentation of the data begged the question of whether the milt production in primed diazinon-exposed fish was really different than the production in primed unexposed fish. I re-analyzed the data to calculate the variance, and then I examined the overlap of the distributions of milt weights to determine whether there was any overlap among unexposed and exposed fish. Using the 95% confidence interval, I noted that the overlap in distributions of milt weights from every diazinon exposure level except one were too great to affirmatively conclude that unexposed and exposed fish produced different

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amounts of milt (Figure 3). Thus, the U.K. research in my opinion cannot be used to conclude that reproductive potential of Atlantic salmon has been affected as a consequence of olfactory inhibition by increasing doses of diazinon.

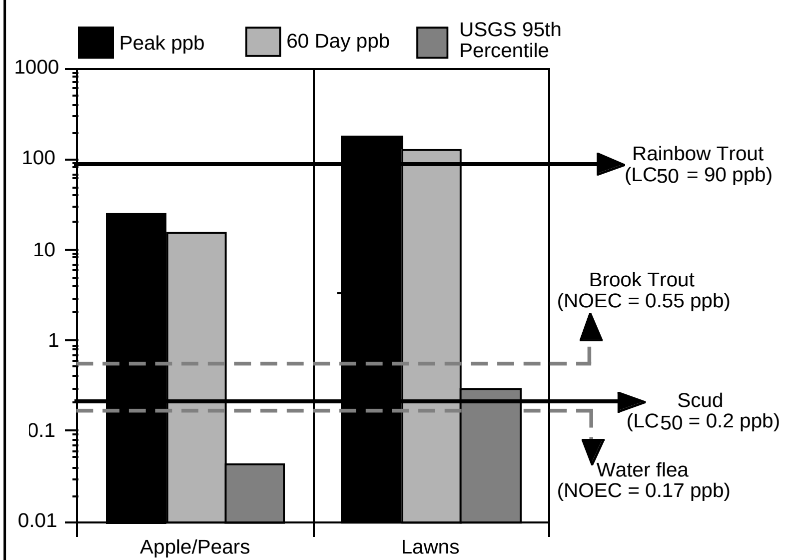
Exposure: Virtual and Real

My analysis aside, let's take the NMFS and U.K. research reports at face value and assume that fish may be impaired by diazinon at doses of 1 ppb but not at 0.1 ppb. Step three in risk analysis is determining the range of exposures in the environment. Two sources of data are available for this exercise—real measurements and computer-simulated data.

When assessing ecological effects during the pesticide registration process, EPA uses computer models that simulate how much pesticide may run off and drift into a pond. The resulting residues, called estimated (or expected) environmental concentrations (EECs), vary somewhat among different pesticide use patterns. For example, EPA simulated diazinon residues in a six-foot deep, one-acre pond following three applications to a fruit orchard and to a lawn (6). The peak or initial residues in the hypothetical pond affected by the lawn treatment were over five times greater than the residues from the fruit orchard (Figure 4). Even at 60 days after application, diazinon residues were estimated to be 160 ppb in the pond following the lawn application.

FIGURE 4

Diazinon residues in pond water following application to orchards and lawns, and the most sensitive fish and aquatic invertebrate species that EPA used to characterize risk.



EPA estimated the concentrations using computer simulation models (6). Actual data measured (expressed as the 95th percentile residue) by the USGS are shown for 40 U.S. streams draining agricultural watershed (shown with apple/pears) and for 11 U.S. streams draining urban watersheds (shown with lawns). Risk is characterized by the ratio of the estimated or measured environmental concentration to the most sensitive species for acute (96 hours) and chronic (21-60 days) exposures. If the residue concentrations bars are below the line representing the no observable adverse effect concentration (NOEC), then EPA considers the risk of adverse effects from chronic toxicity below their level of concern. However, for acute toxicity to endangered species, the lines for the LC50 must be at least 20 times lower than the bars depicting concentration.

While EPA takes a very conservative approach to estimating environmental residues, real monitoring data are collected by the U.S. Geological Survey in its National Water Quality Assessment Program program (NAWQA) (8). These residue measurements form a database that encompasses over 1000 separate monitoring sites. The highest diazinon concentration reported in the database was 3.8 ppb. Pertinently, there were large differences between urban and agricultural stream sites (6, 8). Diazinon was found in only 24% of agricultural sites with a 95th percentile concentration of 0.042 ppb (Figure 4). In other words, 95% of all diazinon detections were 0.042 ppb or less. In stark contrast, diazinon was detected in 50% of urban stream sites with a 95th percentile concentration of 0.24 ppb (Figure 4). For both agricultural and urban stream sites, half of the samples contained diazinon at or below its detection limit (0.002 ppb).

Urban Uses Are the Problem

Although EPA's modeled EECs for diazinon seem in the right direction (i.e., applications to lawns result in significantly greater residues than applications to fruit

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orchards), the numbers do not characterize stream reality. Using such numbers makes for an extremely conservative risk characterization.

EPA presumes four categories of risk that cover acute and chronic toxicity, endangered and non-endangered species (Table 1). Risk is characterized by calculating a risk quotient (RQ), which is essentially the ratio of the EEC to some toxicological endpoint for the most sensitive species tested. Exposures are considered acceptable (i.e., below EPA's levels of concern, LOC) if the RQ is below a predefined value that has a safety factor incorporated into it (Table 1).

For example, to characterize diazinon, EPA divided the EECs in pond water for orchard and lawn uses by the LC_{50} for rainbow trout (90 ppb) and an aquatic crustacean known as a scud (0.2 ppb). Thus, any diazinon concentration protective of scuds should also be protective of Chinook and Atlantic salmon, which were reportedly affected by 1 ppb but not 0.1 ppb diazinon. The resulting RQs for the acute high risk category, which is presumed protective for non-listed species, skyrocketed above EPA's LOCs for both fish and invertebrates (Figure 4). Application scenarios for lawns were worse than for apples and pears. Because the acute high risk presumption was exceeded, the characterization for endangered species didn't stand a chance of being concluded "safe" (Table 2).

When the USGS data are used to calculate the RQs, the risk to fish does not exceed EPA's levels of concern. However, if the more sensitive invertebrates are considered, levels of concern are exceeded for the risk presumption categories of acute restricted use, acute endangered use, and chronic risk. RQs were over five times higher for urban uses of diazinon than for agricultural uses.

The bottom line is that the research on diazinon's impact on salmon olfaction does not change the characterization of its ecological risk. With or without the research, diazinon was in big trouble.

TABLE 1

EPA Risk Characterization Guidelines (6).

Presumed Risk Category	Risk Quotient Calculation*	Level of Concern	Effective Safety Factor
Acute High Risk	EEC/LC50	0.5	2
Acute Restricted Use	EEC/LC50	0.1	10
Acute Endangered Species	EEC/LC50	0.05	20
Chronic Risk	EEC/NOEC	1	1

***EEC=estimated environmental concentration; LC50=concentration of pesticide lethal to 50% of test subjects in 96 hours; NOEC=no observable adverse effect concentration**

TABLE 2

Calculated Risk Quotients for Acute and Chronic Exposures to Diazinon.

Exposure Scenario	Exposure Duration	Fish	Aquatic Invertebrates
Apple/Pear	Acute	0.28	126
Apple/Pear	Chronic	28	121
Lawns	Acute	2	912
Lawns	Chronic	235	928
USGS 95th percentile			
Urban Sites	Acute	0.01	1.2
Urban Sites	Chronic	0.44	1.4
Ag Sites	Acute	0.0005	0.21
Ag Sites	Chronic	0.08	0.25

Apple/pear and lawn exposure scenarios from reference 6; RQs for USGS 95th percentile calculated for this essay.

Is EPA a Victim?

In response to its own risk assessment, EPA did not sit on its hands. A little jawboning with diazinon's manufacturers led to voluntary removal of all urban indoor and outdoor uses of diazinon by 2003. Furthermore, some agricultural uses were also voluntarily dropped. Ironically, diazinon dietary exposures were safely below EPA's LOCs. Thus, diazinon seems to be

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the first OP yanked from a major use market largely owing to concerns of excessive ecological risk.

While diazinon smells stinky when ground through EPA's risk assessment mill, its hypothesized effect on salmon populations is dubious. Diazinon has been in use for nearly forty years. We now know that low levels of pesticides have been running off into streams since the beginning of their use. Therefore, a hypothesis of diazinon or any other pesticide affecting salmon populations would have to account for the much larger returns during the 1970s and 1980s than during the 1990s (3, 4). The hazards of diazinon over the years have not changed, but our detection capability and monitoring intensity have.

The hazards have not changed, but our detection capability and monitoring intensity have.

EPA is being sued because a coalition of groups have seized upon the hypothesis that low levels of diazinon affect salmon's sense of smell. They argue that EPA has not consulted with NMFS over these sublethal effects. I hate to come to EPA's defense, but the lawsuit seems much ado over a problem that has already been solved. Diazinon is gone from the market that generated the most exposures. EPA's overly conservative risk characterization methodology provides plenty of protection for salmon. Why waste money on lawyers when it could be used to fund further research that tests the interesting hypotheses about the remarkable olfactory capabilities of salmon?

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$ection 18$

Valuable Any Way You Look At 'Em

Jane M. Thomas, Pesticide Notification Network Coordinator, WSU

For the past two years the Pesticide Information Center (PIC) has taken a monetary look at Section 18 exemptions in Washington State. "Section 18s" are short-term pesticide registrations that allow a pesticide to be used in the case of an emergency condition. Section 18s provide for pesticide use outside the full-blown registration process provided for in Section 3 of the Federal Insecticide Fungicide and Rodenticide Act. For each Section 18 that is granted in Washington (27 in 2000), someone must gather data and prepare the initial request. The request is reviewed by the Washington State Department of Agriculture (WSDA) and is then passed along to the Environmental Protection Agency (EPA) where it must be reviewed again. With any luck, EPA grants the request and a Section 18 exemption is issued. All of this takes a bunch of time. Time on the part of the original requestor, WSDA, and EPA. The old catch phrase "time is money" begs the question, "Is it worth it?" We think so.

Section 18s take a lot of time and effort. Are they worth it? We think so; these numbers prove it.

Economic data is included with every Section 18 request that is submitted to EPA. In this annual look back, we use this data to figure the value of Section 18s to Washington agriculture. Typically the economic estimates are given as net-per-acre returns but they may often include more than one set of numbers. For example, a Section 18 for pesticide use on strawberries may include one set of numbers assuming that the strawberry field has a three-year life span while another set assumes a four-year life. Other Section 18s will provide two sets of numbers assuming different percentage losses (examples include blueberry, sugarbeet, Christmas tree, and cranberry Section 18 requests made in 2000). All this just serves to underscore that these estimates are just that: estimates.

The total estimated worth of the year 2000 Section 18 exemptions to Washington agriculture is (drum roll, please) $466 million. This is up from over $447 million in 1999 and $443 million in 1998. While $466 million sounds like a significant savings, and it is, even this estimate is likely to be low for the following reasons:

- When two sets of economic data or a range is provided, we always use the lower value in our calculation.
- In some cases the estimate only includes the use on one crop. For example, with the Section 18 for the use of Switch on caneberries, economic data was only provided for raspberries, and thus this was the only acreage included in the estimate.
- Three of the 27 Section 18 packages didn't contain economic data that could be used to generate an estimate. These included the Section 18s for Bayer's Bee Hive Pest Control Strips in honey bee hives, Pirimor 50DF on twenty-five vegetable seed crops, and Gramoxone Extra on pea seed.

So a big thanks is due to all the preparers and reviewers of Section 18 packages, both inside and outside WSDA and EPA. $466 million—it's worth thanking about.

*Jane M. Thomas is the Pesticide Notification Network Coordinator and is also known as Her Royal Highness the Queen Bee of Labels. She reigns from the Tri-Cities campus of WSU and can be reached at **jmthomas@tricity.wsu.edu** or (509) 372-7493.*

WSDA Section 18 Pesticide Compliance Project Update

Deborah Bahs, Washington State Department of Agriculture

Any actions that delay or block the intended use of a Section 18 pesticide could prove economically devastating to Washington agriculture. The Washington State Department of Agriculture (WSDA) believes Section 18 pesticides are at great risk to third party lawsuits under the Endangered Species Act. While WSDA does not suspect Section 18 pesticides are affecting threatened and endangered fish species, it is imperative that WSDA verifies this with a solid review process and valid compliance data to forestall additional federally mandated protections.

In March 2000, WSDA implemented the Section 18 Pesticide Use Compliance Project to prove that the existing WSDA Section 18 pesticide registration and compliance activities are adequately protective of threatened and endangered fish species. (See related article, "Defending Section 18s" in *AENews* No. 169, May 2000.)

What Is a Section 18?

A "Section 18 pesticide" is a pesticide that has been granted an emergency exemption from registration by the U.S. Environmental Protection Agency (EPA) per Section 18 of the Federal Insecticide, Fungicide & Rodenticide Act. This exemption, approved by EPA, allows the use of a pesticide for an unregistered application in an emergency.

Project Phase One

During the first phase of the project, WSDA focused on collecting evidence that the Section 18 granting document, pesticide label, and applicable state laws and rules are being followed in critical fish habitat areas. WSDA conducted fifty-eight systematic Section 18 pesticide use compliance inspections. The inspections covered ten Section 18 pesticides affecting eight crops.

WSDA found through these fifty-eight inspections that the pesticides were being mixed, loaded, and applied according to granting document and label requirements, but that Worker Protection Standards (WPS) requirements were not routinely followed. The most common violations were failure to adhere to Restricted-Entry Interval (REI) requirements for short-term activities, not wearing all of the required protective clothing, and a cavalier approach to managing the posting of treated fields.

Of the fifty-eight applications inspected, fifty-six (ninety-six percent) were in compliance with label requirements and applicable laws and rules. WSDA issued Notices of Correction to the two growers cited for non-compliance and required that both growers initiate appropriate corrective action.

Project Phase Two

The second phase of the project began on November 13, 2000, when WSDA formally requested pesticide application and distribution records from individuals and dealers. WSDA is spot checking these documents to determine if records are being kept correctly and to further assure that the pesticides were used properly. The results of this review will augment the data gathered in the Phase One compliance inspections.

Unlike the site visits in Phase One, preliminary results from Phase Two record reviews indicate significant areas of concern. Numerous pesticide application records failed to supply the information required by the Washington Pesticide Application Act. Some indicated failure to apply Section 18 pesticides properly. WSDA has no evidence to suggest that any of these violations resulted in Section 18 products entering critical fish habitat, but proper use of Section 18 pesticides in all respects is critical for maintaining the availability of Section 18 pesticides to Washington growers. Phase Two is targeted for completion by the end of March, 2001.

Phase Three and Beyond

In Spring 2001, the third phase of the project, WSDA will continue to conduct use compliance inspections

...continued on next page

Section 18 Compliance, cont.

Deborah Bahs, Washington State Department of Agriculture

and records review on Section 18 pesticides, adding the Entiat and Wenatchee River watersheds for a more complete picture of Section 18 pesticide use compliance. WSDA expects to enhance the information gathered in the 2001 Section 18 pesticide use compliance inspections with an affiliated water-sampling program. WSDA is currently exploring the possibility of coordinating water sampling and analysis with several ongoing water quality assessment programs.

SECTION 18 COMPLIANCE PROJECT SCORECARD

Phase One (03/17/00 - 08/30/00) Final

	Olympia	Yakima	Spokane	Cumulative Total
Pre-Notification Calls	120	60	0	180
Inspections Completed*	36 (30%)	22 (37%)	0	58 (32%)
Number in Compliance**	36 (100%)	20 (91%)	0	56 (96%)

Summary of any significant non-compliance issues: WPS restricted entry violation (1); Application violations verified through records call-in (1)

***Expressed as a percentage of pre-notification calls.**

****Expressed as a percentage of completed inspections.**

WSDA encourages review of Section 18 granting documents and labels to assure that these pesticides are used in accordance with requirements. It is crucial for Washington agriculture to have an expeditious Section 18 pesticide registration program to manage emerging pest or disease problems or mitigate the loss of previously available pest control tools.

Deborah Bahs is the Section 18 Use Compliance Project lead for WSDA. She can be reached at (360) 902-2037 or ***dbahs@agr.wa.gov****. Additional information about the project is also available on the WSDA website at* ***http://www.wa.gov/agr/pmd/pesticides/compliance.htm#sect18comp****.*

WSDA Waste Pesticide Collection

The Washington State Department of Agriculture periodically collects waste agricultural and commercial grade pesticides from residents, farmers, business owners, and public agencies free of charge. The goal of this program is to properly dispose of unused or unusable pesticides, eliminating these as potential sources of contamination to the environment. Since disposal is complex, participants must register prior to an event to allow WSDA and the waste contractor to determine the types and amounts of pesticides that will be collected. To register, or for more information, contact WSDA at **(877) 301-4555.** For a complete schedule, point your Internet browser to **http://www.wa.gov/agr/pmd/pesticides/WasteSchedule2001.htm**.

Additional waste collection events are scheduled for this summer (in Bremerton, Seattle, Bellevue, Long Beach, Grays Harbor, Forks, Port Townsend, and Shelton) and fall (in Prosser, Underwood, Longview, Othello, and Orondo).

Collection Site Nearest City	Collection Event Date	Registration Deadline	Inventory to WSDA Deadline
Yakima	April 23 & 24	March 8	March 22
Pasco	April 25	March 8	March 22
Spokane	April 26	March 8	March 22
Oroville	May 15	March 27	April 9
Okanogan	May 16	March 27	April 9
Wenatchee	May 17	March 27	April 9
Mount Vernon	May 22	April 2	April 24
Puyallup/Tacoma	May 24	April 3	April 25

For information on pesticide *container* collection, see the schedule and information on page 14.

Forest Vegetation Management

Public Perceptions of Risk, Trust, and Acceptability

Dr. Robert G. Wagner, Department of Forest Ecosystem Science, University of Maine

Improved public communications about forest vegetation management programs is needed to increase support for these important efforts. A key to improving communication strategies and methods of public involvement is a better understanding about how the public perceives the risk and acceptability of vegetation management technologies. Understanding how public perceptions differ from those of forest managers also can be valuable when developing communication strategies. Recent research from Canada provides some insight into these issues.

Public perceptions of risk and acceptability for nine alternatives to controlling forest vegetation were evaluated in a survey of 1,500 people in Ontario (1). The proportion of respondents indicating whether an alternative was difficult to control, potentially catastrophic, a problem for future generations, and a personal worry determined perceptions of risk for each vegetation management alternative. Ranking of alternatives from highest to lowest perceived risk was: aerially-applied herbicides, biological control, ground-applied herbicides, mulches, prescribed fire, heavy equipment, cover cropping, manual cutting, grazing animals (3).

Public acceptance was lowest for aerially-applied herbicides (18%) followed by ground-applied herbicides (37%), biological control (57%), prescribed fire (57%), mulches (65%), heavy equipment (72%), cover cropping (80%), grazing animals (82%), and manual cutting (89%). Public acceptability of various agents for biological control differed depending on the proposed agent. Natural plant toxins were viewed as most acceptable (73%) followed by microorganisms (42%), genetically-engineered organisms (39%), and viruses (21%).

There was a strong correlation between risk perception and acceptability of the alternatives for the general public and those in timber-dependent communities. These results suggest that stronger public support can probably be achieved for forest vegetation management programs that include non-herbicide alternatives.

Differences between the Ontario public and three groups of forestry professionals (government biologists, government foresters, and industry foresters) also were examined (4). Forestry professionals tended to be less supportive of some environmental values and forest management goals, to perceive everyday and forestry activities to be less risky, to be more trusting of science and government, and to be more accepting of forestry activities than the general public. Among the three groups of forestry professionals, industry foresters tended to be most different from the public followed by government foresters and government biologists. These differences reveal potential sources of conflict and miscommunication between the public and forest managers.

An analytical approach was used to determine which factors (perceptions of risk, environmental values, trust in forest managers, and support for forestry goals) were the best predictors of public support for herbicide use (2). Trust in those who manage decisions about the application of forest herbicides had the strongest influence on the level of support for herbicide use. Environmental values had the next strongest influence through its effect on support for timber management goals, perceptions of risk, and trust in management. This analysis suggests that current levels of trust in forest managers do not provide sufficient public support for future timber production that relies only on herbicide technology. Understanding how trust in forest managers is built and maintained appears to be vital for developing public acceptance of forest vegetation management programs.

Dr. Robert Wagner is with the Department of Forest Ecosystem Science at the University of Maine. This essay summarizes several published papers and was presented as an abstract at the 4th Pacific Northwest Integrated Vegetation Management Conference November 15, 2000. Dr. Wagner can be reached at ***bob_wagner@umenfa.maine.edu*** *or (207) 581-2903.*

...references on next page

Forest Management, cont.

Dr. Robert G. Wagner, Department of Forest Ecosystem Science, University of Maine

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2. Mertz, C.K., J. Flynn, R.G. Wagner, and W. Burns. (in preparation) Attitudes toward herbicides and forest vegetation management: a structural model analysis. Decision Research, Eugene, Oregon.
3. Wagner, R.G., J. Flynn, R. Gregory, C.K. Mertz, and P. Slovic. 1998a. Acceptable practices in Ontario's forests: Differences between the public and forestry professionals. New Forests 16: 139-154.
4. Wagner, R.G., J. Flynn, R. Gregory, and P. Slovic. 1998b. Public perceptions of risk and acceptability of forest vegetation management alternatives in Ontario. Forestry Chronicle 74(5): 720-727.

Forestry Symposium

The First International Precision Forestry Symposium will be held on the campus of the University of Washington in Seattle June 17 through 19, 2001. The symposium is sponsored by the University of Washington College of Forest Resources' Precision Forestry Cooperative and supported by the American Society for Photogrammetry and Remote Sensing and the USDA Forest Service. The conference will offer perspectives on the emerging technologies and innovative applications that natural resource professionals are beginning to implement in forest management. Topics will include remote sensing, tree measurement, automated systems, monitoring, road design, and decision support systems. The conference fee is $295 before May 1, 2001. For more information, phone (206) 543-0867, e-mail **ForestCE@u.washington.edu** or point your Internet browser to **http://www.cfr.washington.edu outreach/prefor/index.html**.

NW Consortium Presents 9th Annual

Food Safety Conference

May 30 - 31, 2001 • Best Western University Inn • Moscow, Idaho

Mark your calendar now for the ninth annual Food Safety Farm to Table Conference, to be held in Pullman, Washington, and Moscow, Idaho, May 30 and 31, 2001. The Northwest Food Safety Consortium, a group of faculty from Pacific Northwest universities who work on food safety education and research, design this program to serve a wide audience of professionals who work with the food we all eat.

Offering a broad spectrum of information on all aspects of food safety "from the farm to the table," this conference is useful for Cooperative Extension faculty, agricultural producers, food service managers, veterinarians, HACCP coordinators, food processors, clinicial microbiologists, nutrition and health educators, food retailers, and public health professionals.

Topics this year include updates on the pathogens making news today; speculation on the pathogens of tomorrow (including a perspective on "mad cow disease"); a look at the role of water in food processing and food safety; practical discussion of Hazard Analysis and Critical Control Point (HACCP) implementation; and some alternative theories on antimicrobial resistance. Special attention will be given to the role of consumers in food safety—their perceptions and how best to educate them.

The Food Safety Farm to Table conference relies on support from the faculty and staff of the University of Idaho Cooperative Extension System and the Washington State University Cooperative Extension. For registration or more information, contact Ann Brelsford at WSU Cooperative Extension, P.O. Box 646230, Pullman, WA 99164-2921, (509) 335-2921, or annb@wsu.edu, or see the web page:

http://foodsafety.wsu.edu/farmtotable/

2001 Pesticide Container Recycling Schedule

Washington Pest Consultants Association

Washington Pest Consultants Association organizes an annual series of collection dates and sites for empty pesticide containers. The table below shows April and early May dates only; a full schedule is being developed for dates through October. These dates and locations will be made available through the electronic version of *AENews* (**http://www.tricity.wsu.edu/aenews**) as soon as they are established. All dates, times, and locations are subject to change; use the contact information to confirm. For general questions, or to host an event at your farm, business, or in a central location in your area, contact Northwest Ag Plastics representative Clarke Brown at (509) 965-6809 or David Brown at (509) 469-2550 or **dbrownwash@msn.com**.

DATE	TIME	LOCATION	SPONSOR	CONTACT	PHONE
4/23	10a-1p	Pasco	Air Trac	Gerald Titus	509-547-5301
4/24	8a-11a	Eltopia	Wilbur Ellis	Vern Records	509-297-4291
	1p-3p	Eltopia	EA WA Spray Svc	Willis Maxon	509-297-4387
4/25	8a-10a	Pasco	Pfister Crop Care	Steve Pfister	509-297-4304
	1p-3p	Connell	B&R Crop Care	Chris Eskildsen	509-234-7791
4/26	8p-10p	Othello	Conner Flying Inc.	Mark Conner	509-488-2921
	1p-3p	Royal City	Cenex	Ted Freeman	509-346-2213
4/27	8p-10p	Bruce	Simplot	Chuck Spytex	509-488-2132
	1p-3p	Othello	B&H Chemical	Larry Hawley	509-488-6576
5/1	8a-11a	Mount Vernon	Wilbur Ellis	Marty Coble	360-466-3138
5/2	8a-11a	Conway	Cenex/Tronsdal Air Svc.	Will Cox	360-445-5015
				Kevin Belisle	360-661-0422
	12p-2p	NE Seattle	WA Tree Service	Ron Angle	206-362-9100
5/3	8a-11a	Puyallup	WSU Res Stn	Roy Jensen	253-445-4517
	8a-10a	Tacoma	Wilbur Ellis/DOT	Randy Knutsen	253-351-6591
				Dave Patterson	253-589-7255
5/4	8a-10a	Centralia	Lewis County Public Works	John Prigmore	360-740-1193
	8a-10a	Vancouver	WSU Res Stn	Martin Nicholson	360-576-6030
	1p-3p	Chehalis	Farm & Forest Helo Svc	Dan Foster	360-262-3197
	3p-4p	Morton	DOT	Craig Robbins	360-496-5516
5/14	9a-11a	George	Dependable Spray	Ceourt Rylaarsdam	509-785-2061
	1p-3p	Quincy	Cobia Spray Svc	Jim Cobia	509-750-2888
5/15	8a-10a	Quincy	Wilbur Ellis	Dale Martin	509-787-4433
	1p-3p	George		Randy Wentworth	509-878-1565
5/16	8a-10a	Quincy	Quincy Farm Chem	Ron Turner	509-787-3556
	1p-3p	Quincy	Simplot	Butch Creameans	509-787-1571
5/21	8a-10	Waverly	Wilbur Ellis	Monte Bareither	509-283-2432
	1p-3p	Tekoa	McGregor Co	Charles Wedin	509-284-5391
5/22	8a-10a	Oakesdale	Wilbur Ellis	Jerry Jeske	509-285-4511
	1p-3p	Garfield	Cascade Flying Svc	Doran Rogers	509-635-1212
5/23	8a-10a	Palouse	Dale's Flying Svc	Dale Schoeflin	509-878-1531
	1p-3p	Dusty	Dusty Farm Coop	Chris Crider	509-397-3111
5/24	8a-10a	Warden	Kilmer Crop Dusting	Terry Kilmer	509-349-2491
	1p-3p	Bruce	Cenex	Lori Anderson	509-488-5261

CONTAINERS MUST MEET THESE CRITERIA:

- Rinsed—no residue
- Clean and dry
- No apparent odor
- Majority of foil seal removed from spout (small amount remaining on rim OK)
- Half-pint, pint, quart, one and two-and-a-half gallon containers accepted whole
- Hard plastic lids and slip-on lids removed
- Five-gallon containers accepted whole if lids and bails removed
- 30 and 55-gallon containers accepted whole if above criteria is met

For information on waste *pesticide* collection through WSDA, see p. 11.

"Our industry does not want pesticide containers to become a waste issue. If we take the time to clean and recycle these products, we can save money, show that the industry is responsible in its use of pesticides, and reduce inputs to the waste stream."

Pest of the Month
Grape Mealybug

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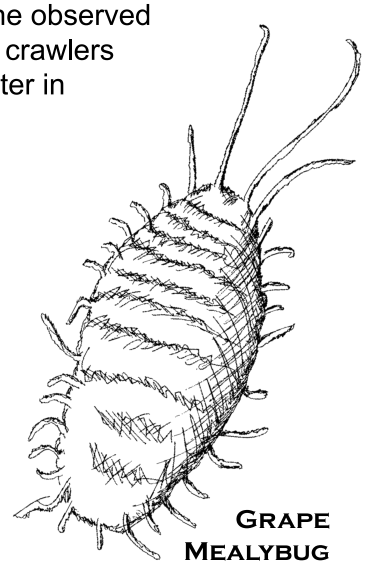
Agrichemical & Environmental News
March 2001
No. 179

Drs. Doug Walsh, Ken Eastwell, and David James, WSU; Dr. Walt Bentley, University of California

Grape mealybugs, *Pseudoccus maritimus* (Homoptera: Pseudococcidae), are an increasing concern for Washington grape growers, primarily due to the fact that they are suspected to vector grapevine leafroll disease. We speculate that the mild winters and springs we have experienced over the past several years have contributed to the recent increase in grape mealybug infestations. Mild winters decrease overwintering mortality while mild springs likely increase the insect's developmental rate.

Life Cycle

Grape mealybugs complete two generations per year. They overwinter as eggs or first instar crawlers in egg sacs under the rough bark on the trunk of grapevines. WSU Professor Emeritus Dr. Wyatt Cone observed that, if temperatures are mild in the fall, crawlers disperse from their egg sacs to overwinter in individual coverings or protective cases known as "hibernacula." The crawlers then migrate to and feed at the base of grape buds as the buds break dormancy in early spring. In late spring, immature mealybugs feed under the papery bark of two-year wood. Females in the first generation mature by early summer, then mate and move back to protected locations under bark and proceed to spin an ovisac and lay up to several hundred eggs. These eggs hatch in mid-summer and the resulting nymphs disperse to feed on shoots and grape clusters. These second-generation mealybugs are the ones that cause damage. By late summer, the mated second-generation adult females migrate to positions under the rough bark of vines, where they spin their ovisacs and lay their eggs, renewing the cycle.



Grape Mealybug

A Viral Connection?

Worldwide, grapevine leafroll disease is the most economically important virus disease of grapevines; it accounts for 62% of grape loss due to viruses. Several mealybug species are cited in the literature as confirmed vectors of grapevine leafroll virus. Two confirmed vector species, obscure mealybug *(Pseudococcus viburni)* and longtailed mealybug *(Pseudococcus longispinus)* are indigenous to grape-growing regions of the Western United States. Grape mealybug has not been confirmed to vector grapevine leafroll disease; however, there are no data indicating grape mealy bug *cannot* vector this disease. Basically, no one has ever checked. This spring, we intend to look into this possible connection.

Grapevine Leafroll in Washington

A recent survey of grape growers throughout Washington State indicated that 7.3% percent of the vines currently in the ground are infected with an agent of grapevine leafroll disease. This disease not only reduces grape yield, but also has a negative impact on fruit quality and potentially on wine quality. Management of this disease in Washington vineyards includes both ameliorating the economic impact of the disease on vines already affected and minimizing infection of grapevines currently free of the disease.

Control

Successful management of this disease depends upon accurate diagnosis and appropriate modification of vineyard management to reduce its spread to adjacent vines. In some vineyards, the number of vines affected with leafroll disease can be significant, and roguing infected plants may not be an economically viable option. Under such circumstances, modifying horticultural practices to diminish crop loss associated with this disease may be a more appropriate response. Such practices may include canopy management or nutritional management.

At this time, Washington State University's primary recommendation for control of grape mealybug infestations calls for a delayed dormant season (April) application of chlorpyrifos in a tank mix with

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Grape Mealybug, cont.

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petroleum spray oil. There is some concern regarding the long-term availability of chlorpyrifos due to regulatory actions that may be imposed by the Food Quality Protection Act of 1996. The Washington Association of Wine Grape Growers, Dow AgroSciences (the manufacturer of chlorpyrifos), and grape researchers have taken a proactive stance to retain the use of chlorpyrifos for suppression of grape mealybug populations. We are working with several candidate insecticides and petroleum spray oils to determine their efficacy against grape mealybug.

More Research Needed

A comprehensive study of the impact of grape mealybug infestations on wine grapes in Washington State is currently being proposed to the Washington Wine Advisory Commission. The proposed research includes both the direct impact of grape mealybug on grape production and the ability of grape mealybug to transmit grapevine leafroll disease. If the grape mealybug is found to be a vector of grapevine leafroll disease, then the level of control must be stringent to protect disease-free vines. Control efforts, mostly in the form of insecticide applications, have increased over the past several years. Insecticide applications for mealybug control could potentially be contributing to secondary pest outbreaks. Increased knowledge of grape mealybug biology will enable more effective use of existing chemical controls and will help us understand the most effective use of biological and cultural controls as well.

Dr. Kenneth C. Eastwell is a Virologist with Washington State University; Dr. Douglas B. Walsh and Dr. David G. James are Entomologists with Washington State University. All have offices at the WSU Irrigated Agriculture Research and Extension Center (IAREC) in Prosser, and can be reached at (509) 786-2226, or ***keastwell@tricity.wsu.edu****,* ***dwalsh@tricity.wsu.edu****, or* ***djames@tricity.wsu.edu****, respectively. Dr. Walter J. Bentley is the Area IPM Advisor at the University of California at Davis. He can be reached through the UC Davis switchboard at (530) 752-1011 or by e-mail at* ***wjbentley@ucdavis.edu****.*

PNN Update

The Pesticide Notification Network (PNN) is operated by WSU's Pesticide Information Center (PIC) for the Washington State Commission on Pesticide Registration. The system is designed to distribute pesticide registration and label change information to groups representing Washington's pesticide users.

PNN notifications can be viewed on the PNN web page at **http://www.pnn.wsu.edu** or via the Pesticide Information Center On-Line (PICOL) Main Page, **http://picol.cahe.wsu.edu/**.

Should you have questions about the PNN or anything on our PICOL page, e-mail PNN Coordinator Jane M. Thomas at **jmthomas@tricity.wsu.edu** or Pesticide Information Center Manager Catherine Daniels at **cdaniels@tricity.wsu.edu**.

PIC Offices Move

The Pesticide Information Center (PIC), part of Washington State University's Food and Environmental Laboratory, has been relocated. Formerly on the lower level of the West Building of WSU's Tri-Cities campus, PIC is now in the Cooperative Extension Annex complex on the far west side of the Tri-Cities campus, behind the book store. The mailing address remains the same.

Since most of PIC's services are provided remotely, via telephone, e-mail, Internet, and on-site presentations, the physical move should have little effect on those who use PIC's services. Telephone numbers and e-mail addresses for Dr. Catherine Daniels, Jane M. Thomas, Sally O'Neal Coates, and Charlotte Lee Parker remain the same. PIC provides agrichemical information via the PICOL web page, the PNN (see "PNN Update," to right), and *Agrichemical and Environmental News.*