I'm Dr. Al Fournier, I am an Entomologist and Associate Extension Specialist with University of Arizona Cooperative Extension. I work out of the Maricopa Ag Center. I work with our specialists and agents statewide on a variety of projects related to pest management, both in agriculture and in community environments. Today I will talk about pesticide risk and risk communication.

Ever feel like you are stuck in the middle?

There are valid concerns about a risk on both sides of the pest management equation. Whether we are talking about insects, rodents, weeds—any sort of pests—there are real concerns. But there are also genuine concerns about risks from pesticides. These risks are both real and perceived. Risks vary by chemical use pattern. Risks include acute exposure risk, people who are chemically sensitive, children and other vulnerable populations, including developmental risks in children.

Integrated Pest Management
IPM = Risk Reduction

- Least possible risk to:
  - People
  - Property
  - Resources
  - Environment
- From pests & pest management practices

Why IPM? IPM exists as a risk reduction or risk management science that permits people to reduce risks to people, property, resources and the environment. And, risks are not confined to pesticides, but to the pests themselves and all the pest management practices called upon to address our pest problems.

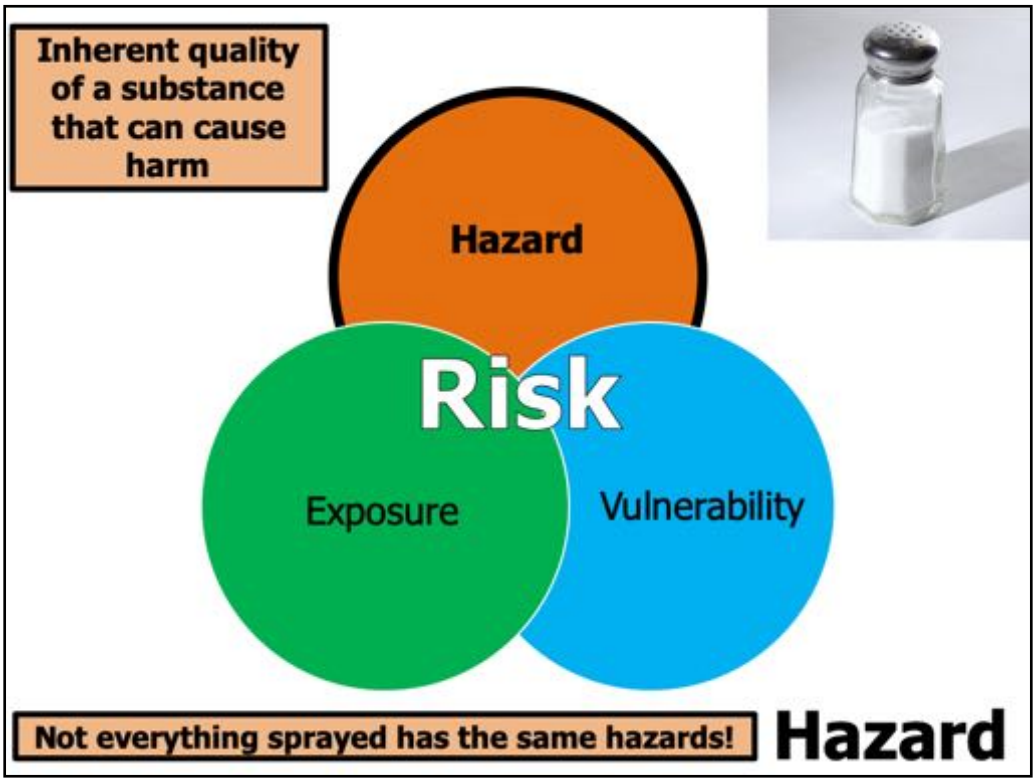
THE UNIVERSITY OF ARIZONA
Cooperative Extension

Outline

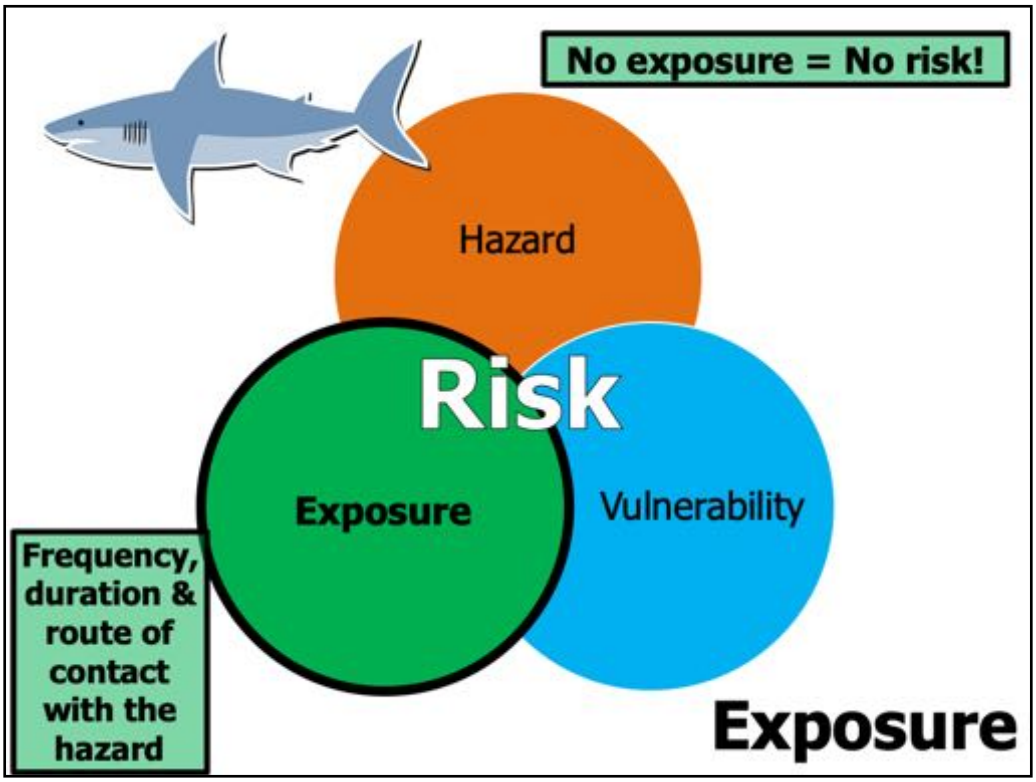
1. Pesticide Risk
   a. Components of risk
   b. EPA's role in regulating pesticides and how risks are scientifically assessed
2. Steps to Minimize Pesticide Risk
3. Communicating Pesticide Risk

What is risk? Fundamentally it is a combination of factors that have the potential to cause harm to various entities, not only human health, but the environment and the economy. Risk comes in many forms and is something we deal with every day.

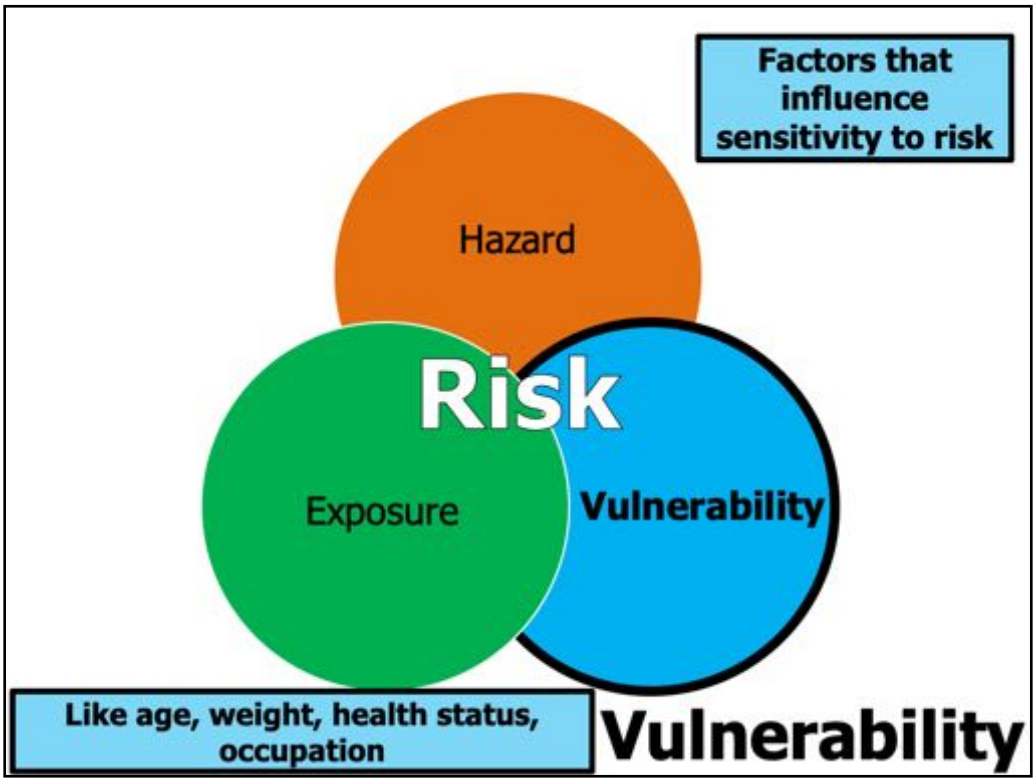
In an ecotoxicological dialogue, risk factors can be distilled down to three influences: hazard, exposure, and vulnerability. If any of these components are missing (are zero), then there will be no risk.



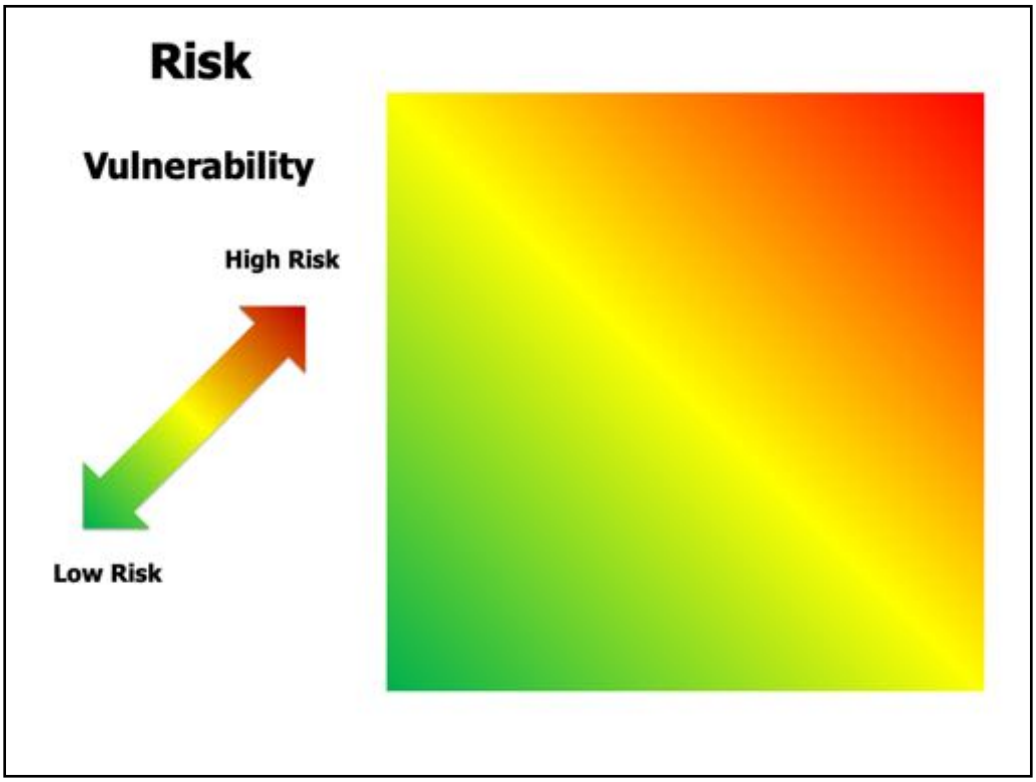
Hazard is the inherent quality of a substance that can cause harm. Something can be quite hazardous, but if it is never used in a significant dose the risk would be low. For example table salt. There is a hazard associated with salt; however, we do not commonly think of there being one. A large enough quantity of salt can be ingested to potentially kill an individual. Not everything sprayed in this industry has the same hazards. Some are considered to be "hotter" than others.



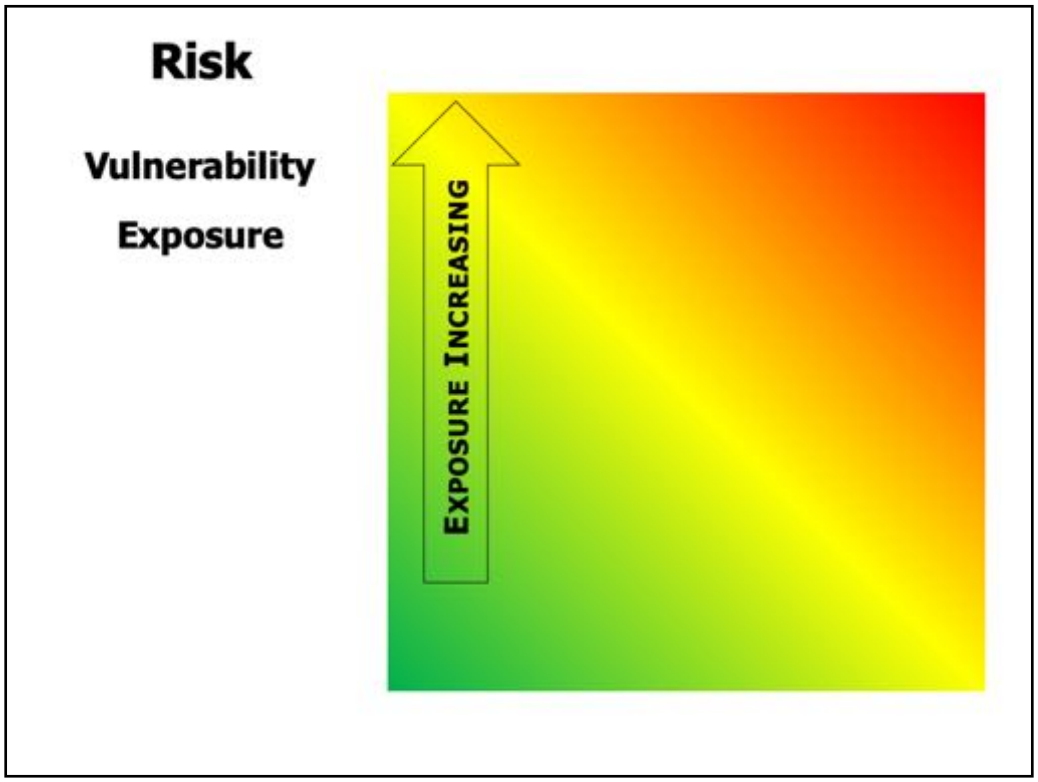
Exposure is the other component of risk. It is the frequency, duration, and route of contact with the hazard. If you have no exposure, the product of these three components will be zero and there will be no risk. If you don't swim in the ocean you are not likely to ever get killed by a shark.



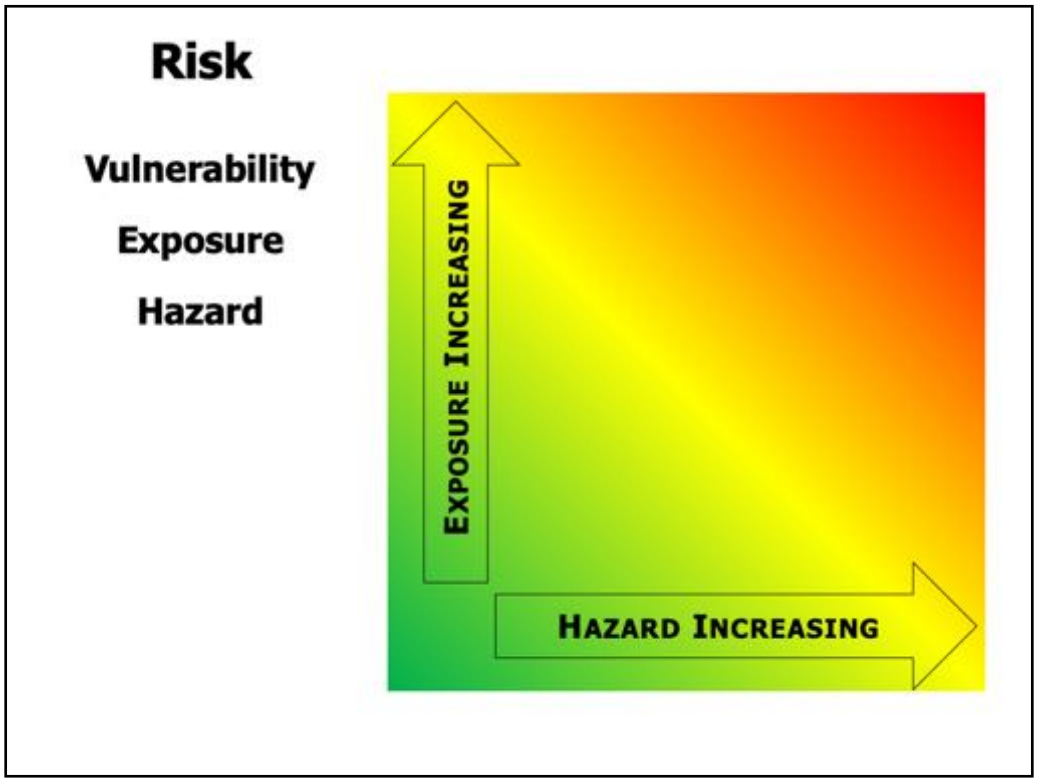
Vulnerability includes factors that affect your sensitivity to a product. When the EPA reviews pesticides they need to think of not only an average population, but the most sensitive populations. There are mitigation programs that only apply to very specific populations based on their unique vulnerabilities.



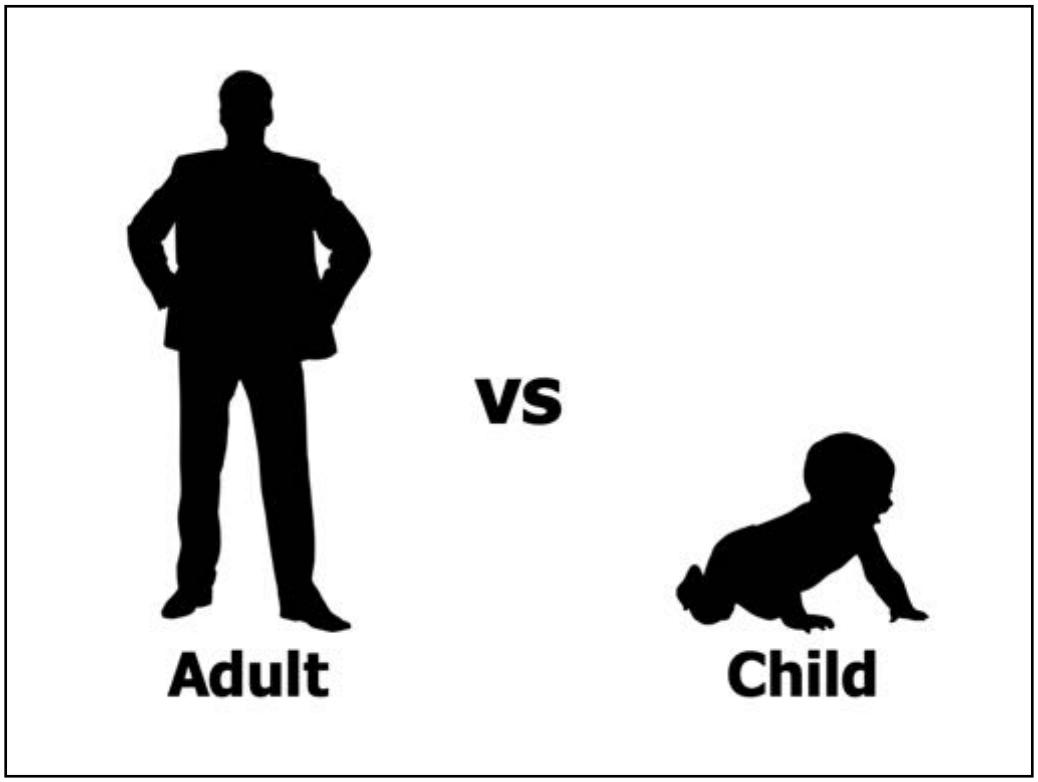
Risk is the color across the chart. High risk is the red zone, low risk is the green zone, and if you are at middle risk you are in the yellow zone. Vulnerability can slide the color across the diagonal gradient depending on the population. A more tolerant population will be depicted with more green (less risk) than a more vulnerable population.



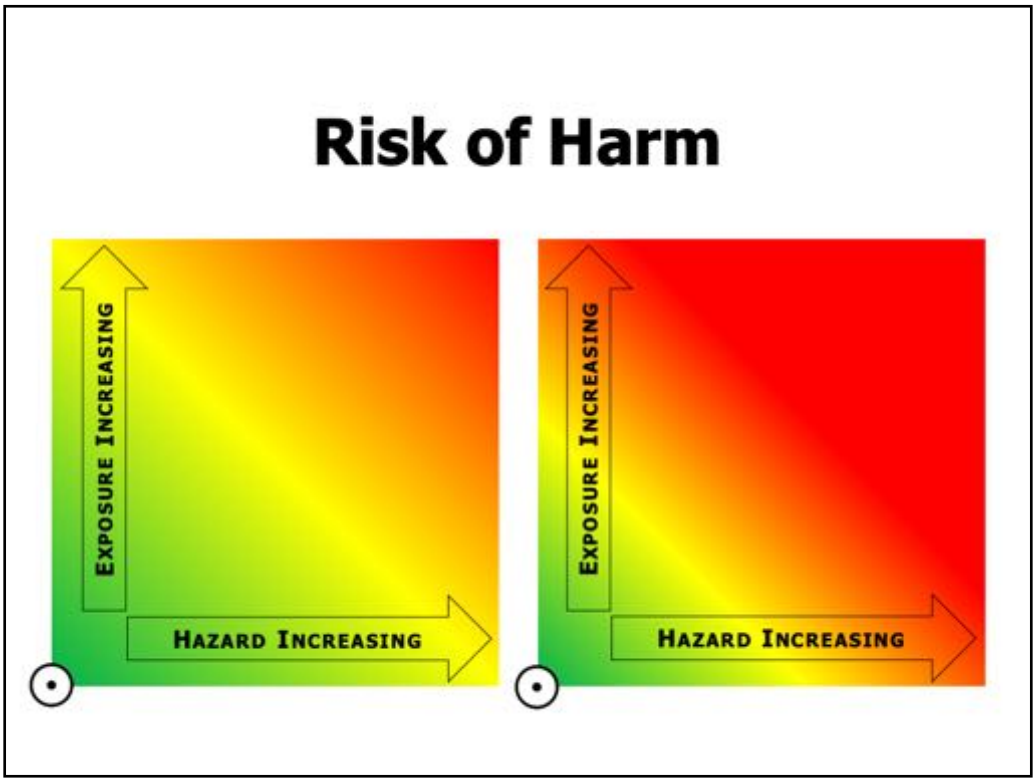
As exposure increases you are increasing the risk even with relatively safe products. A product may be more risky to a mixer and loader than a consumer because the mixer and loader is exposed to the product day after day.



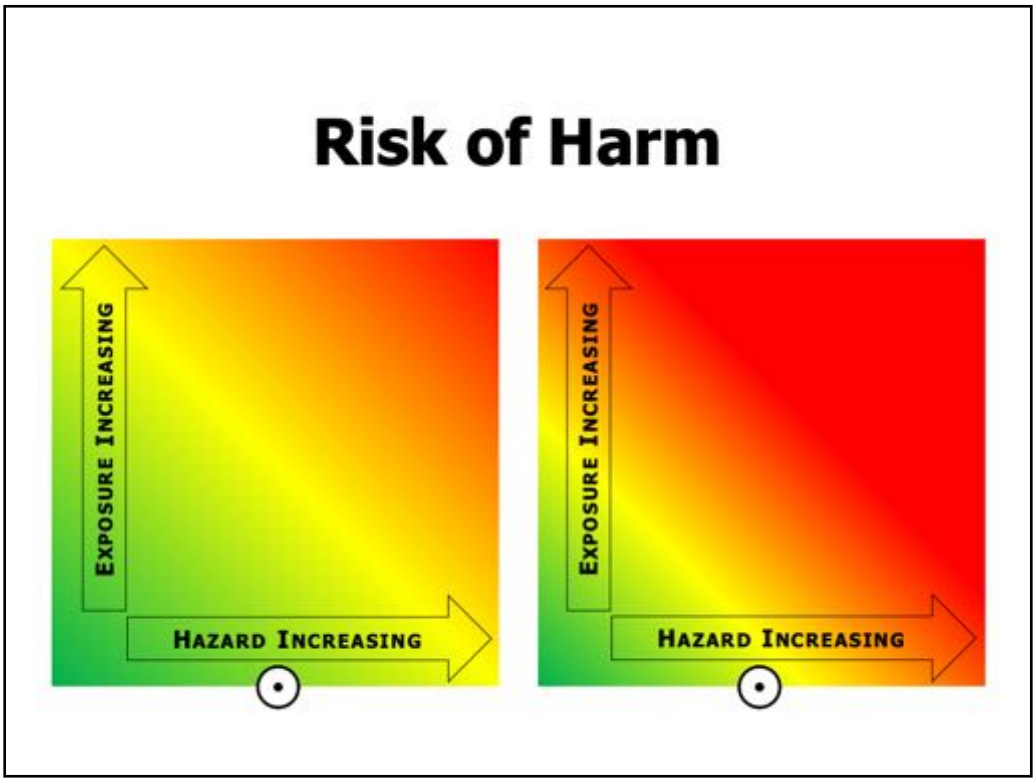
As the hazard increase, so does the risk.



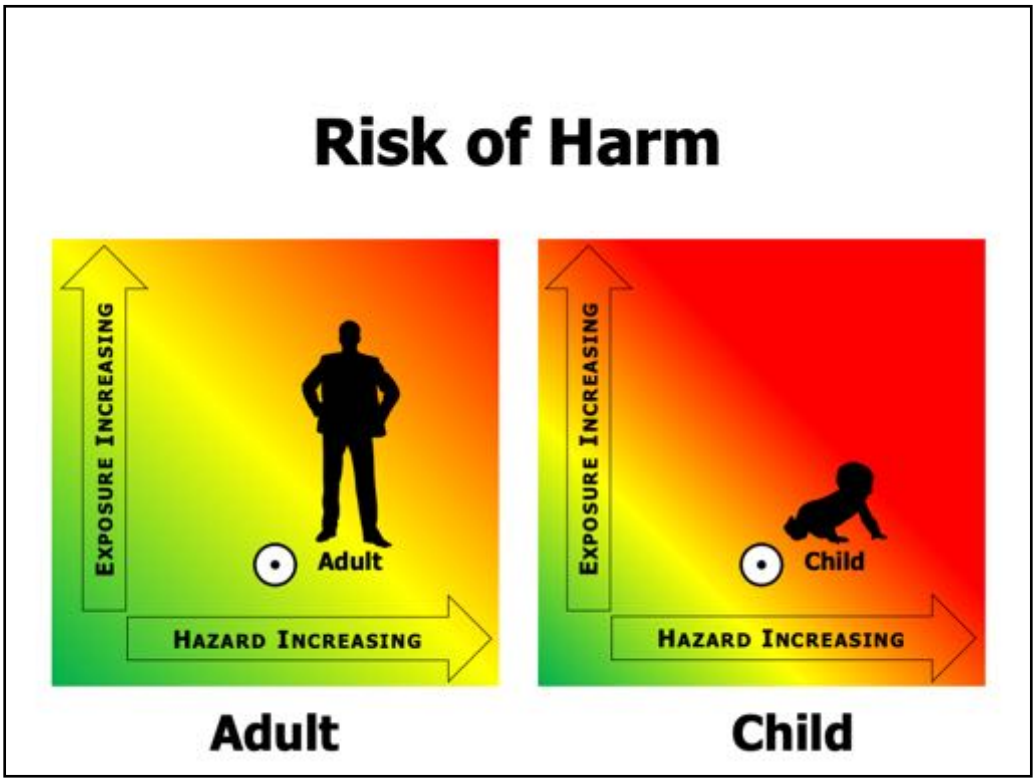
Think of an adult and a child population.



These are two very different populations with different vulnerabilities. Note how there is much more red in the right hand chart.



A chemical has a specific hazard, which is more or less toxic depending on the vulnerability of the population.



So even for the same chemical (same hazard) and same exposure, the child will be more at risk than the adult (note the underlying color for both points on the charts). The adult is much more tolerant. This factor must be kept in mind when you are treating around areas with diverse populations.

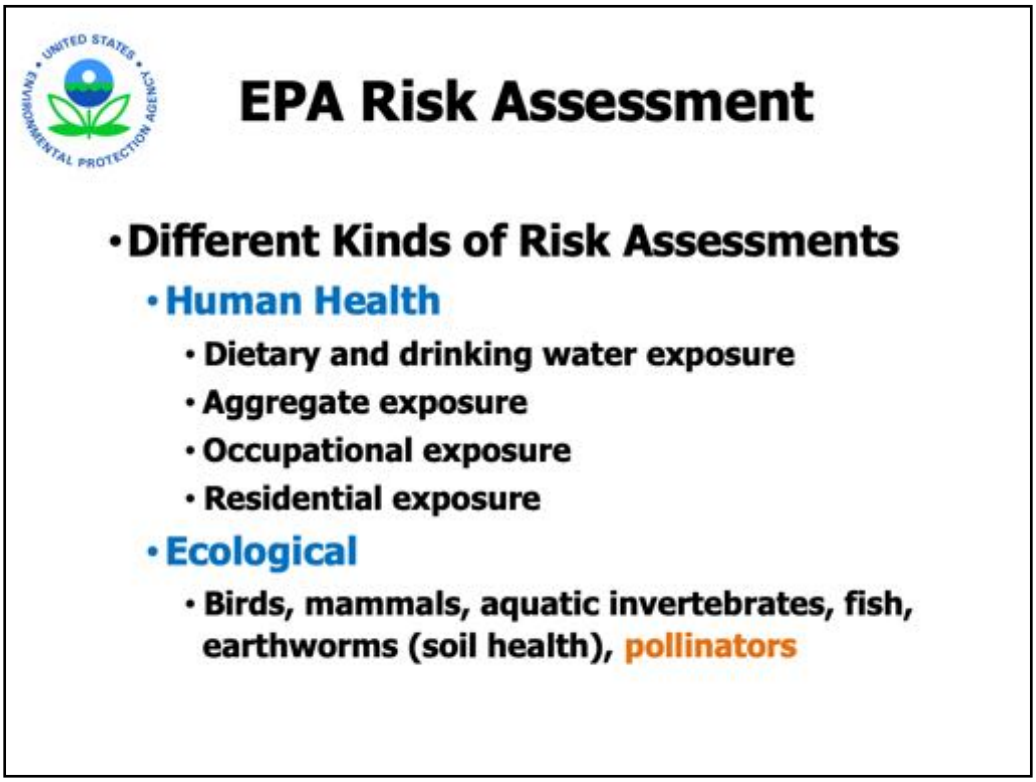
This paradigm is useful in understanding risk and some of the ways to mitigate or reduce risks in how you manage pests.

EPA Risk Assessment

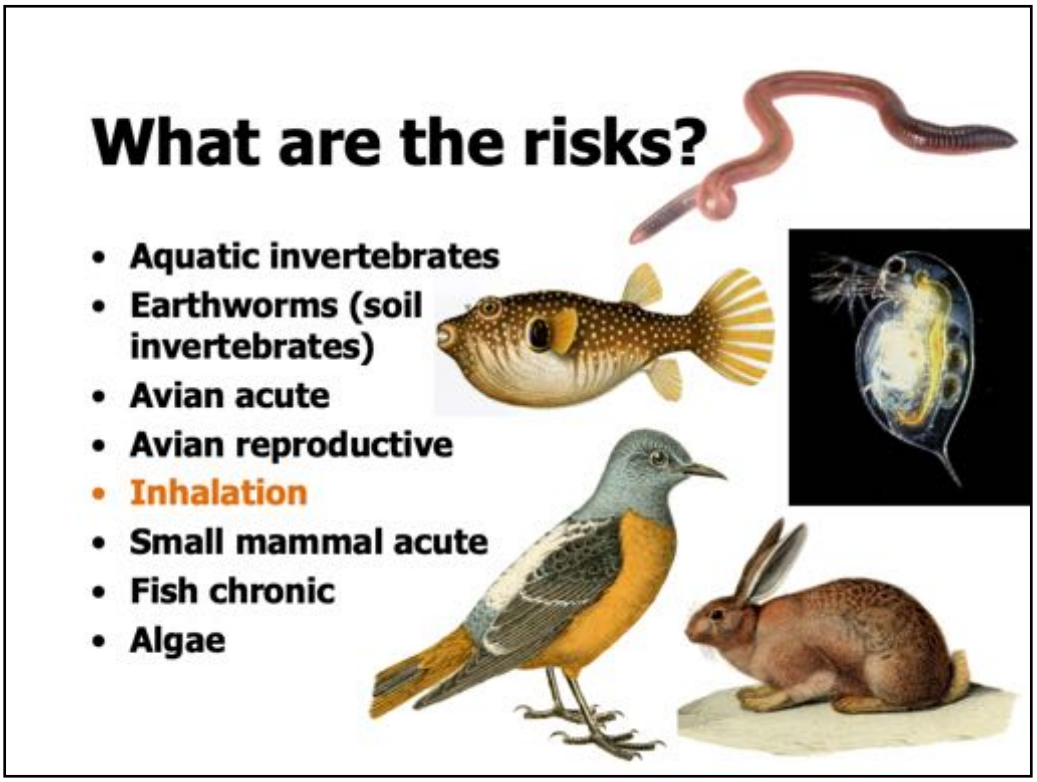
- EPA is responsible for registering and reviewing pesticides in the U.S.
- U.S. has among the most thorough & scientific review of pesticides
- EPA Considers Hazard, Exposure and Vulnerability in risk assessment
- EPA considers both Risks and Benefits of pesticide use

EPA Risk Assessment

- **Hazard.** EPA toxicologists consider innate properties of pesticides, toxicity and properties that impact movement, absorption, etc.
- **Exposure.** Dermal, inhalation, diet, frequency of exposure, aggregate, etc.
- **Vulnerability. Food Quality Protection Act**
  - Special vulnerability of children (10x factor)
  - Aggregate risk from multiple sources
  - Cumulative risk for pesticides with common mechanism of toxicity



EPA scientists develop detailed analyses based on risk models, which start from basic assumptions about pesticide use patterns, and their chemical properties. The models calculate levels of risk for different aspects of human health and different organisms in the environment. The primary categories of risk assessments are Human Health RAs and Ecological RAs.



There are several metrics in which to calculate risk, not just risk to humans. When a registrant wishes to develop a new pesticide, EPA requires that they look at all these risk factors.

Images

Earthworm:
http://blogs.discovermagazine.com/80beats/2012/12/26/highjacking-worm-guts-to-produce-tiny-semiconductors/#.W32dqs5KhEY

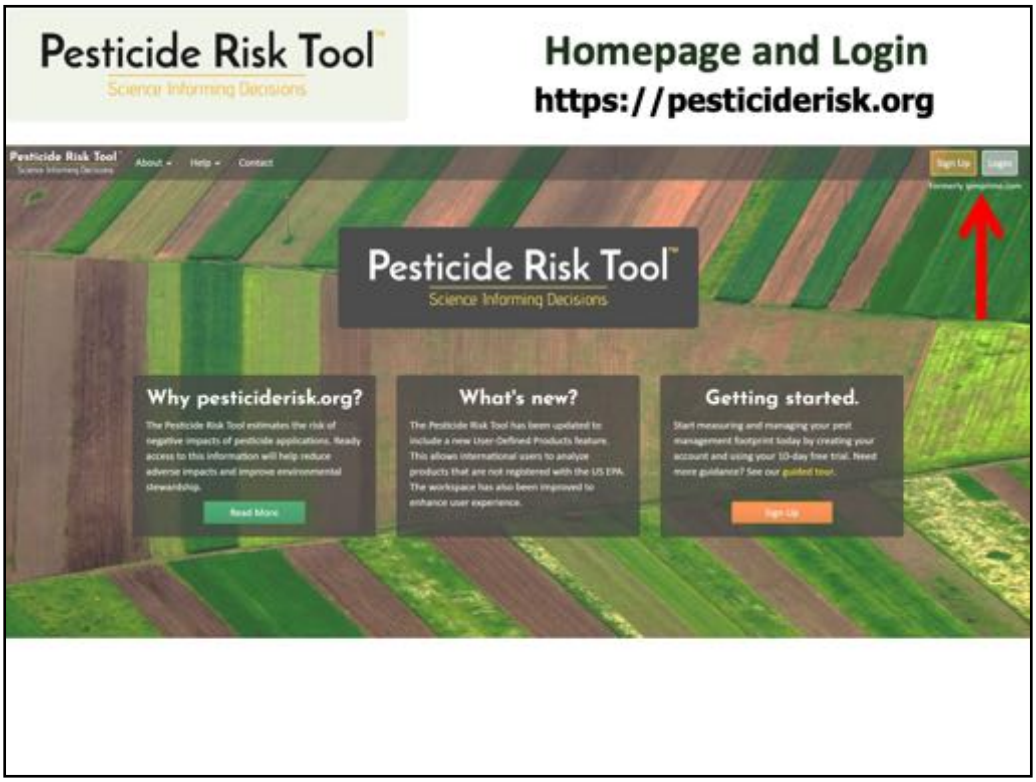
Fish: Journal des Museum Godeffroy (1873)
http://vintageprintable.swivelchairmedia.com/animal/animal-fish/animal-fish-beige-spotted-2/

Daphnia: Paul Hebert
https://commons.wikimedia.org/wiki/File:Daphnia_pulex.png

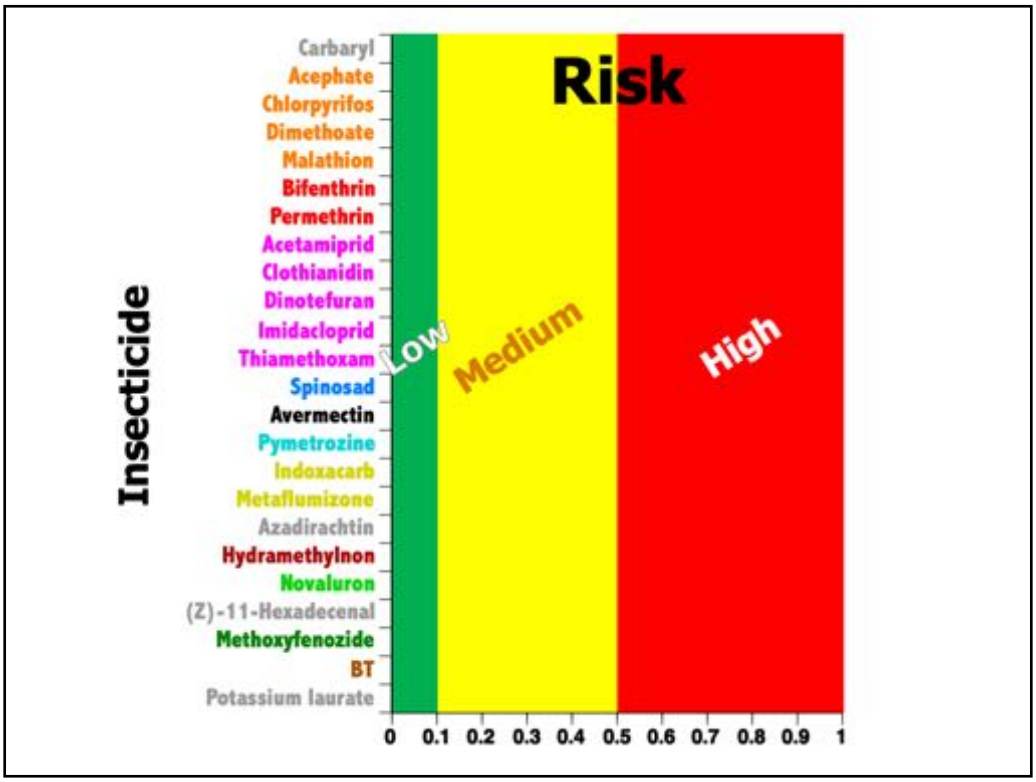
Bird: https://thegraphicsfairy.com/vintage-bird-image-great-colors/

Rabbit: https://thegraphicsfairy.com/vintage-stock-image-

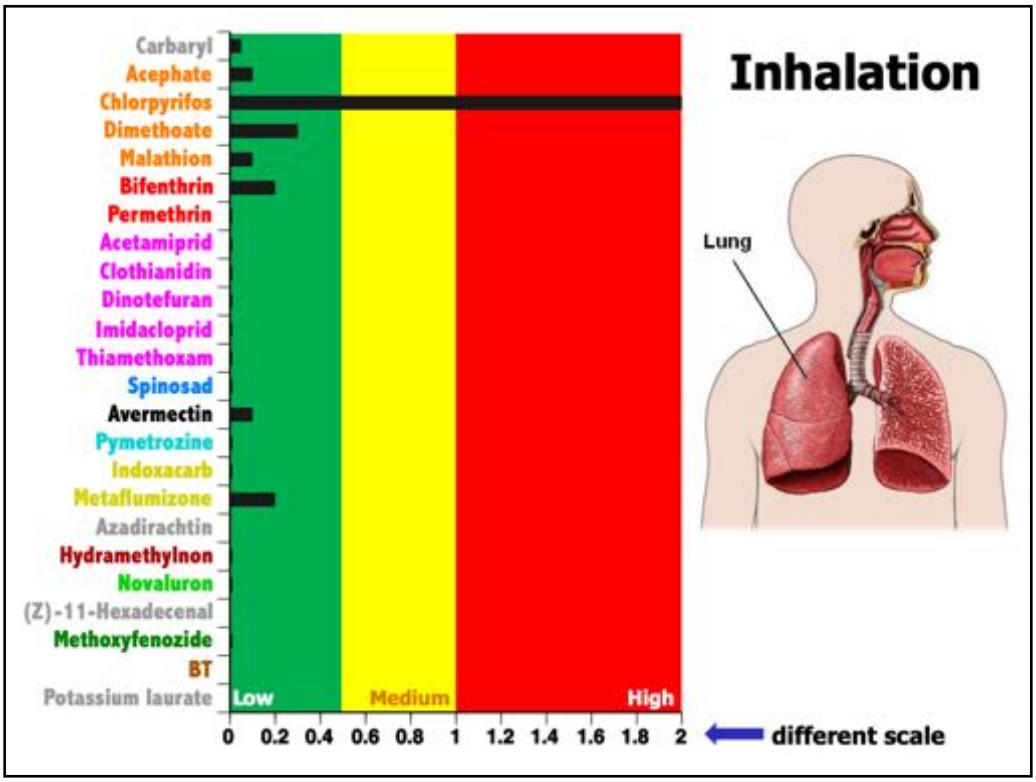
amazing-brown-rabbit/



You can explore selectivity and risk through the Pesticide Risk Tool, formerly known as IPMPRiME. This tool allows users to obtain the risk indices of certain products based on application rates and other factors.



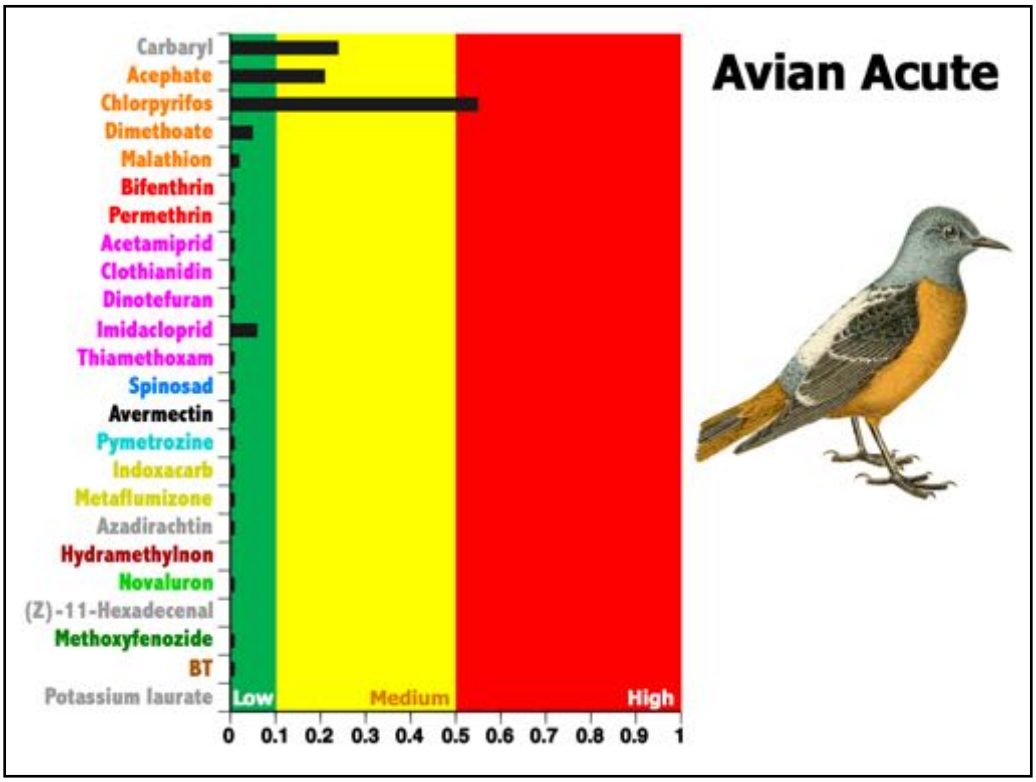
From the Pesticide Risk Tool. Scientific data is used to create a risk profile by chemistry. For each risk index, the risk of harm is organized into 3 basic levels: low (green, 0–0.1, unlikely to cause any harm), medium (yellow, 0.1–0.5, with some potential to cause harm), and high (red, 0.5–1, with a high likelihood of causing harm). Note that for inhalation 3 basic levels of risk are: low (green, 0–0.5, unlikely to cause any harm), medium (yellow, 0.5–1, with some potential to cause harm), and high (red, 1–2, with a high likelihood of causing harm).



For inhalation risk, chlorpyrifos has the highest risk index. While such risk can be mitigated using appropriate mixing and application procedures to protect mixer/loader/applicators, these risks apply to bystanders who might not be protected.

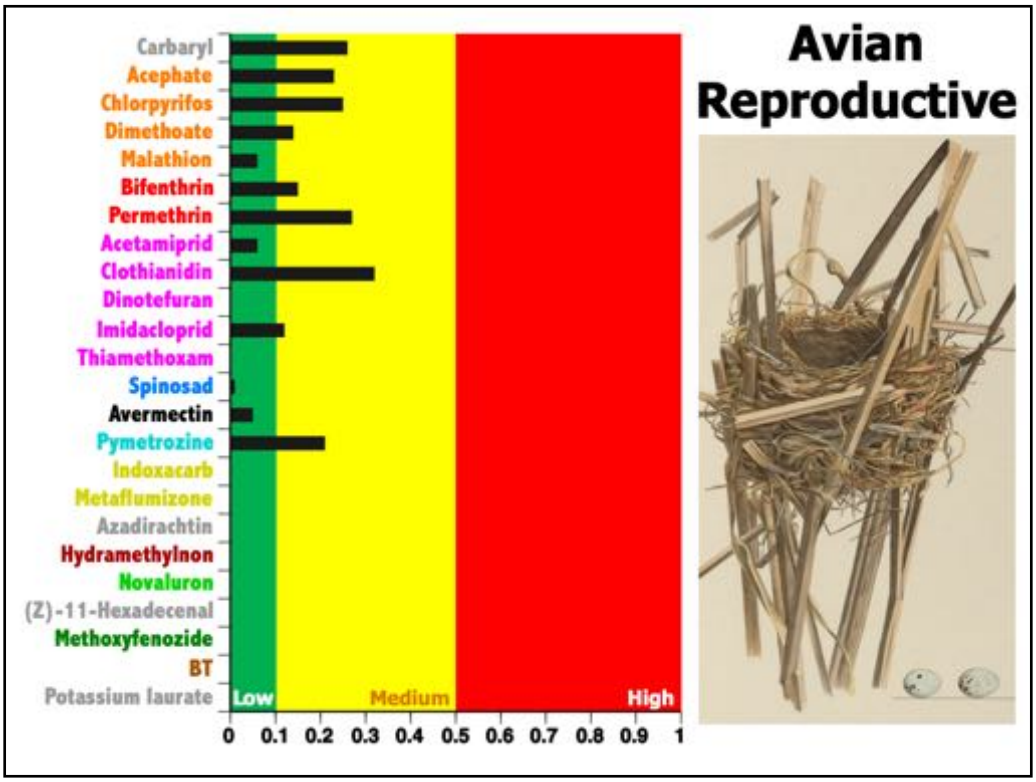
Note that for inhalation 3 basic levels of risk are: low (green, 0–0.5, unlikely to cause any harm), medium (yellow, 0.5–1, with some potential to cause harm), and high (red, 1–2, with a high likelihood of causing harm).

Image: Nucleus Medical Media, Inc.



Some of the organophosphates are quite hazardous to birds and attention needs to given when applying these chemistries in sensitive environments.

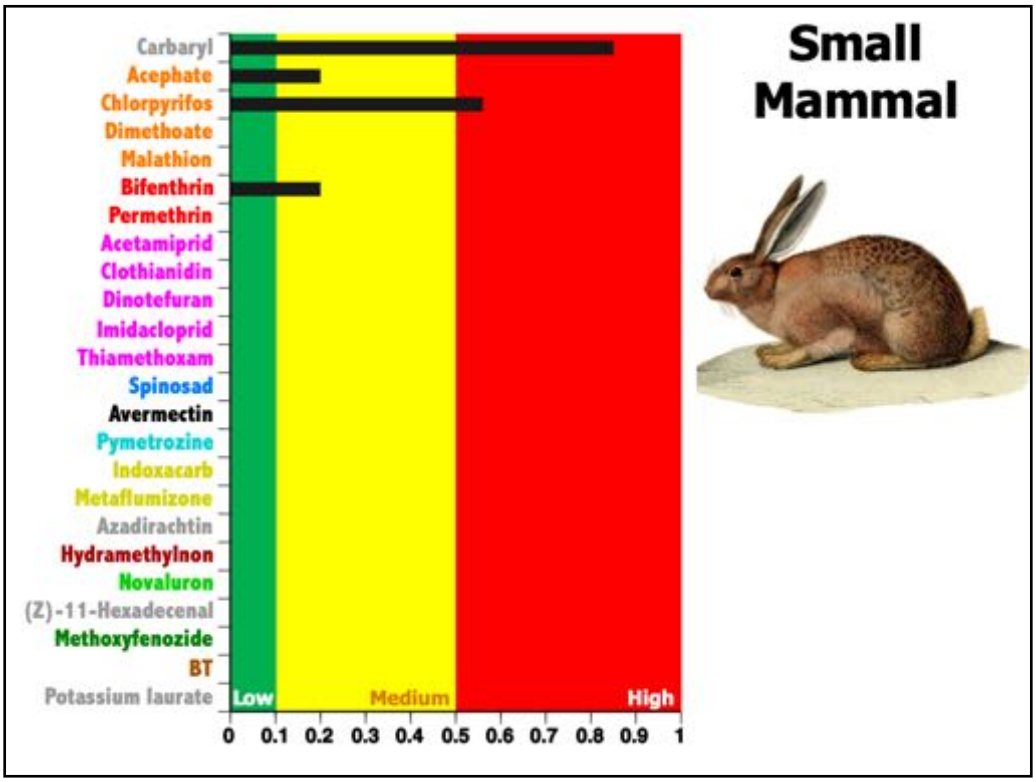
Image: https://thegraphicsfairy.com/vintage-bird-image-great-colors/



A wide range of products can potentially affect bird reproduction. Some carbamates, organophosphates, pyrethroids, and neonicotinoids have medium risks to avian reproduction.

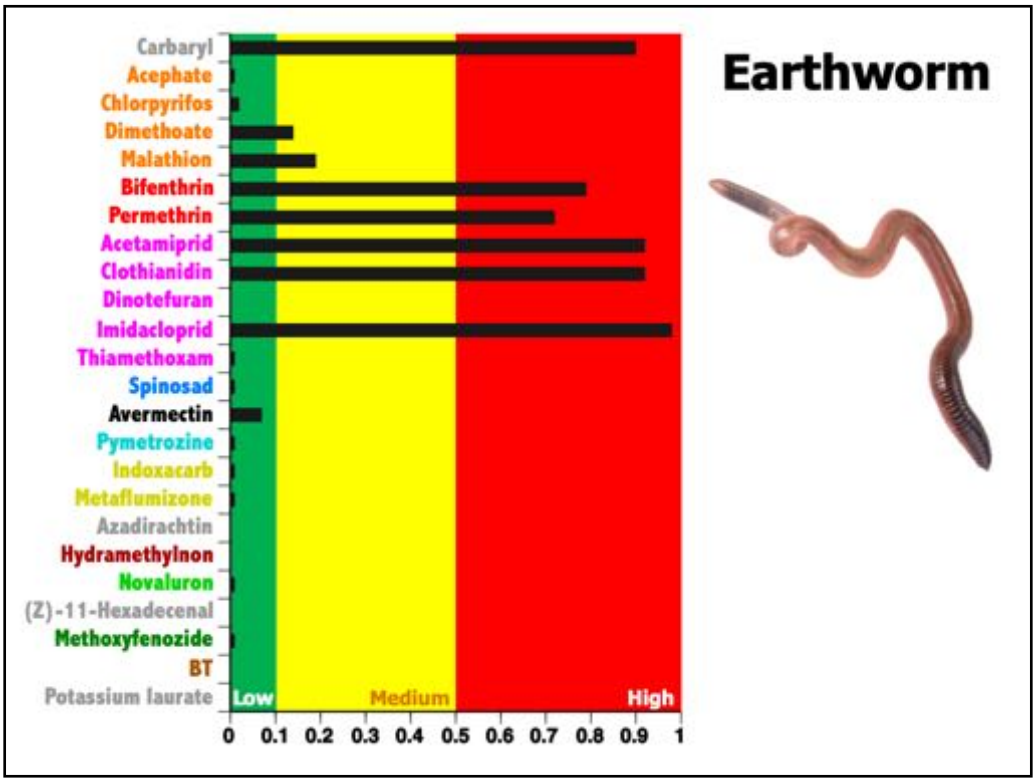
Image: Illustrations of the nests and eggs of birds of Ohio

https://www.biodiversitylibrary.org/page/34907603



Carbaryl, some of the organophosphates, and some pyrethroids are quite toxic to mammals (not just rabbits). While still available, these classes of chemistry, all nerve poisons, were in heavy usage 25 years ago, and mitigation efforts were heavily focused on vertebrate safety, including humans. Today, the diversity of chemistries available include many that are extremely safe in vertebrate systems. While mitigation efforts still place human safety at the center, a new focus has emerged over the last decade or two on invertebrate safety.

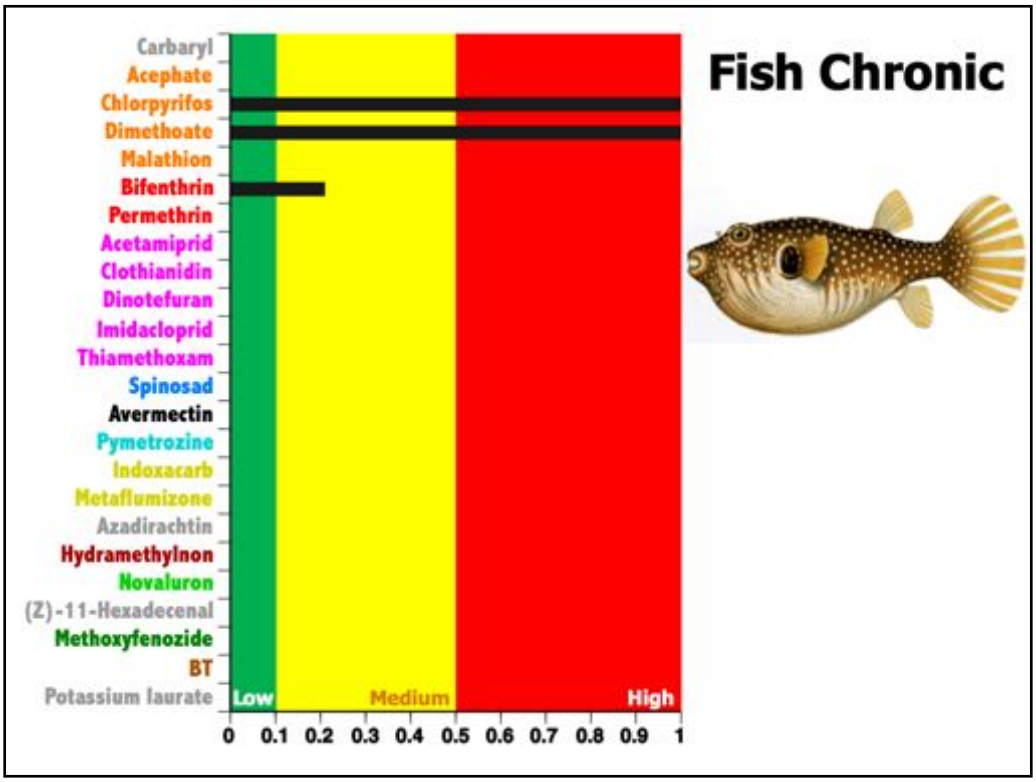
Image: https://thegraphicsfairy.com/vintage-stock-image-amazing-brown-rabbit/



Earthworms act as a model for other soil invertebrates that might be important for maintaining the tilth and health of the soil. Carbamates, pyrethroids, and some neonicotinoids are quite toxic to earthworms and some other soil organisms. Some neonicotinoids are applied to the soil as seed treatments, in furrow sprays, or soil drenches. In some cases, the targets are in fact soil pests. In all cases, the user should consider the risks involved to non-target soil invertebrates.

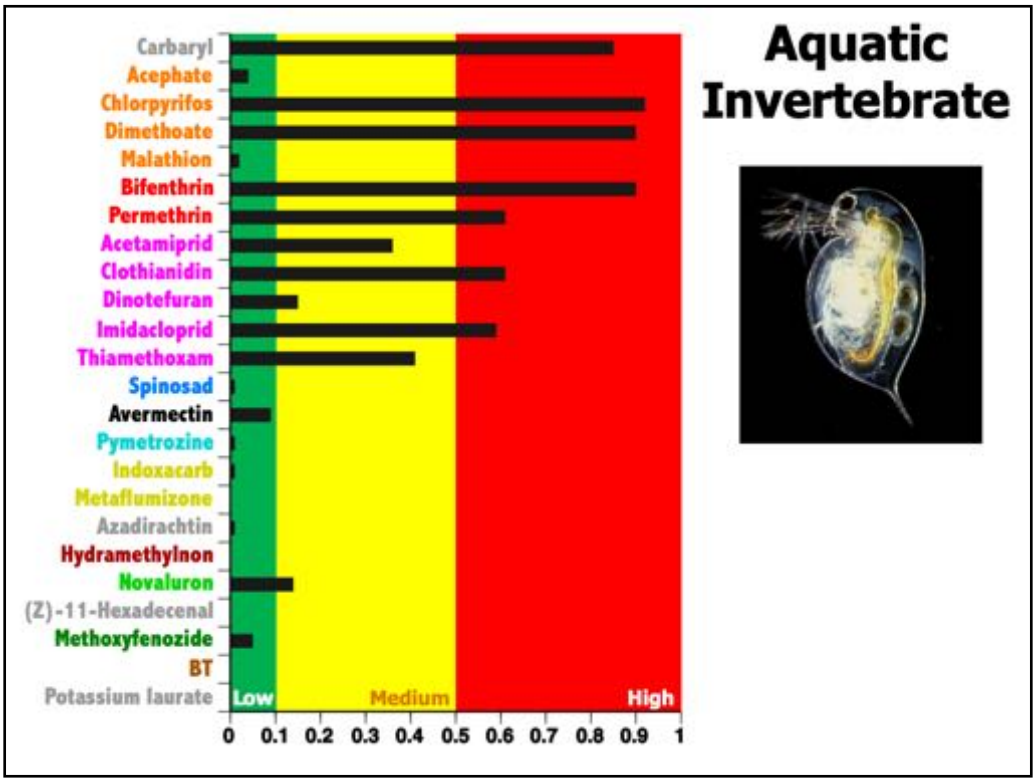
Image: http://blogs.discovermagazine.com/80beats/2012/12/26/highjacking-worm-guts-to-produce-tiny-

semiconductors/#.W32dqs5KhEY



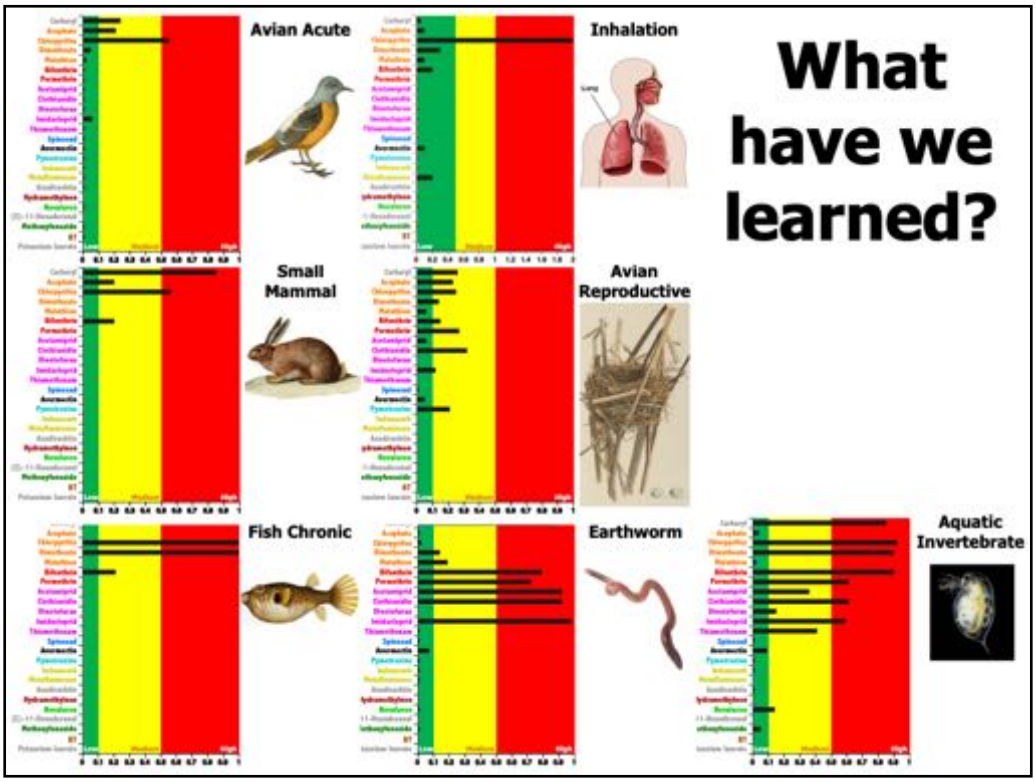
While in Arizona we may not be spraying near oceans and streams, we do have other natural and man-made water features that harbor fish. It is important to realize that many organophosphates are highly toxic to fish.

Image: Journal des Museum Godeffroy (1873) (http://vintageprintable.swivelchairmedia.com/animal/animal-fish/animal-fish-beige-spotted-2/)



Twenty-five years ago the focus was on human health, but we have made some progress collectively within the industry that we are now also concerned about aquatic invertebrates. Aquatic systems are important to ecosystem health. It's important to point out again that the carbamates, organophosphates, pyrethroids, and neonicotinoids are all nerve poisons and as humans we share some common physiology in our nervous system with insects.

Image: Paul Hebert (https://commons.wikimedia.org/wiki/File:Daphnia_pulex.png)



What have we learned?

Different chemical, different properties, different potential risks to humans, animals, environment.

Are these the only potential kinds of risks we might have to worry about with a pesticide? No. This does not account other human health risks besides inhalation, such as? Dermal exposure (through the skin), dietary exposure. EPA does address these concerns to a great extent, through label requirements for personal protective equipment (PPE).

Does following the label eliminate all risk? No. Of course not. It is important to understand that EPA is considering the benefits of pesticides along

with their risks, and that all risks may not be well understood. But the first step to protecting yourself, your family, and everyone else is to follow all the label guidelines.

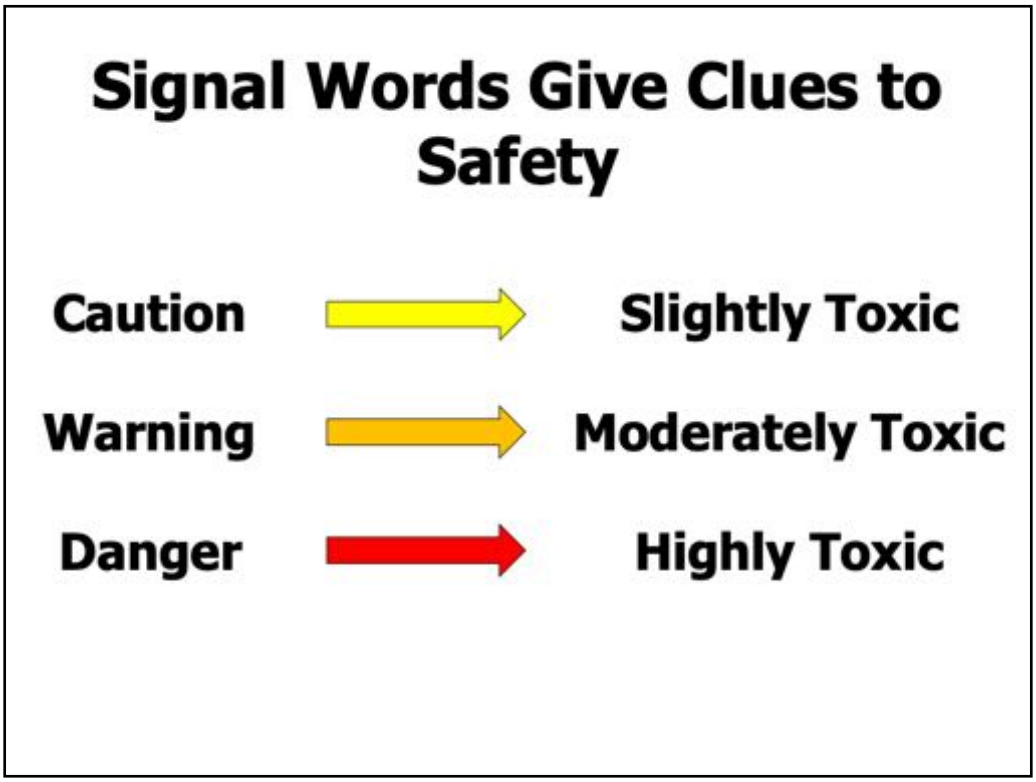
Steps to Minimize Risk

Vulnerable Populations

Be aware of more vulnerable populations: children, allergies, chemical sensitivity, etc.

Understand the Hazard

- Know the inherent risks of pesticides
  - Signal words & details provided on labels and SDS
  - Online information resources
- Eliminate use of the most hazardous materials
- Use non-chemical options first
- Select the least hazardous, effective pesticide option



How "safe" or selective a chemistry can sometimes be inferred by the signal word listed on the label. More selective chemistries are less toxic to (and safer for) non-target organisms. The words "caution", "warning", and "danger" indicate how toxic a product is (when following label instructions) to the main non-target organism, us, people.

The signal words can be found prominently listed on the product labels. It should be noted that even though a product has a signal word of "caution" (only slightly toxic) it still needs to be handled per the label instructions in order to prevent avoidable harm to human health and the environment.

Minimize Exposure

- Explore non-chemical options first
- Use baits and enclosed applications
- Time applications to minimize exposure (people, pollinators, etc.)
- Wear Personal Protective Equipment (PPE)
- Observe restricted entry intervals
- Posting and Notification (follow requirements and common sense)

Risk Communication

ARIZONA PEST MANAGEMENT CENTER

THE UNIVERSITY OF ARIZONA Cooperative Extension

Communicating Risk

- Follow legal requirements
- Practice good communication
  - Who needs to know?
  - The potentially riskier the application, the more inclusive communication should be

Adopt a Policy (school example)

- Oral notification to pupils & employees during the regular school session.
- Written, electronic or telephonic notification to parents or guardians at least 48 hours prior to application of pesticides.

Pesticides do not include:

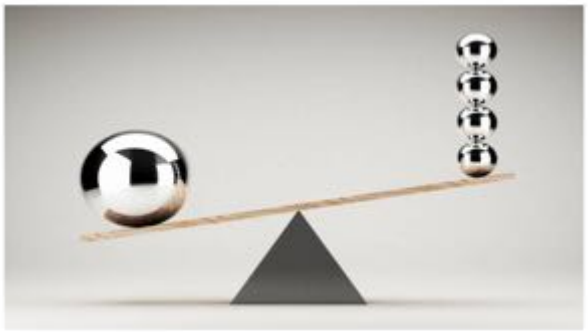
- Non-restricted use disinfectants, sanitizers or deodorizers
- Non-residual pesticide applications performed or contracted by public health agencies for vector control
- Emergency applications of a pesticide that has a toxicity category of III or IV to control harmful pests that pose an imminent threat to the public health

This example of a school pesticide communication policy spells out how and when the communication will occur.

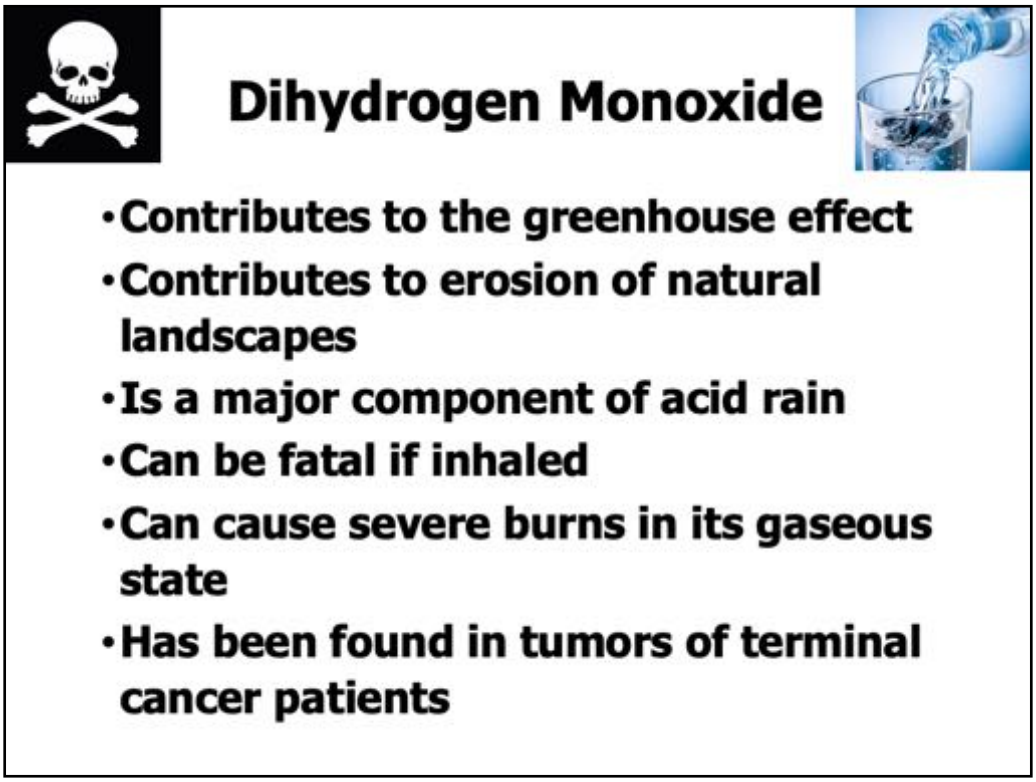
Importantly, it also addresses exceptions, or situations where we may have to act quickly to address a pest threat.

You should consider these same kinds or principles in a farm pesticide communication policy, for example.

Balancing the Risks



Risk is not limited to pesticides. We balance risk in our everyday lives all the time. Let's look at some examples of that.



Answer: Water. When something is familiar to us every day, we tend to disregard the risks. The presentation of the information about water this way also highlights the need to be aware of how information is being presented, and the source of the information. Someone with a political agenda to do away water, for example, might over-emphasize its risks without regard to its benefits and how it is essential for all life on earth.

What is it?

- Kills 40,000 people a year
- Kills millions of animals every year
- Causes fires when ignited
- Causes billions in property damage annually
- Contains a chemical that causes cancer in laboratory animals
- Produces toxic gases
- Causes air pollution

Answer: automobiles. These are real risks. But who in here is ready to give up their car?

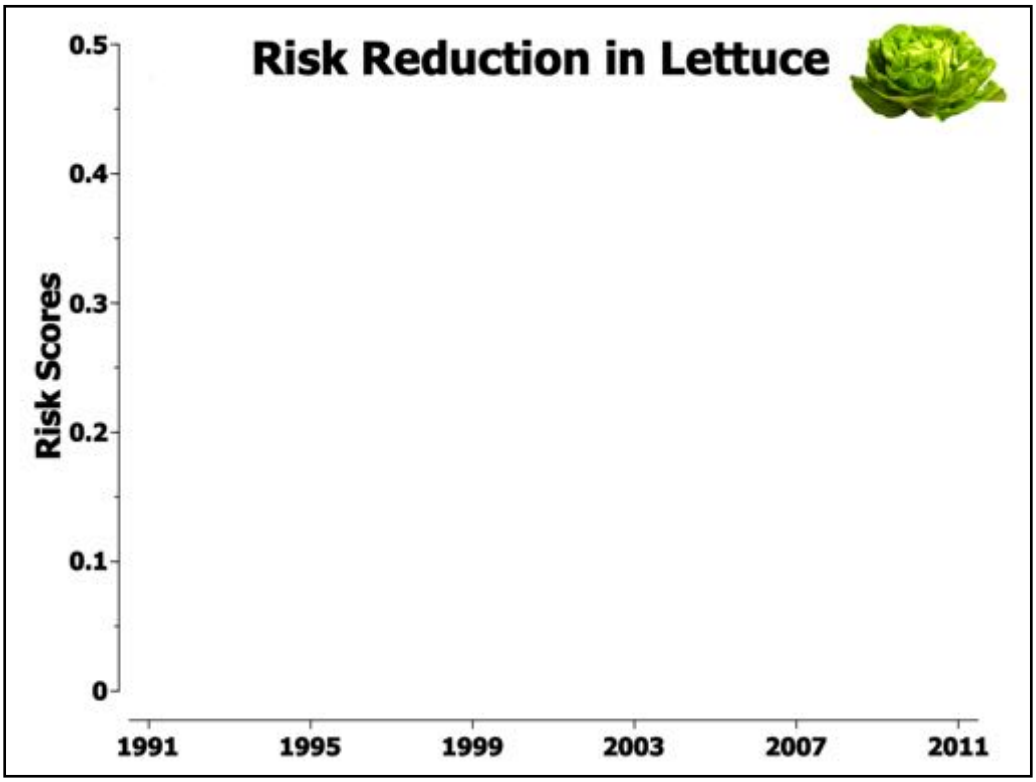
Risk Mitigation

Risks	Mitigation
• Causes air pollution	• Burn Cleaner fuel
• Produces toxic gas	• Install anti-smog devices
• People killed & injured in crashed	• Install seat belts, airbags to improve safety
• Capable of being driven dangerously	• Enforce traffic laws

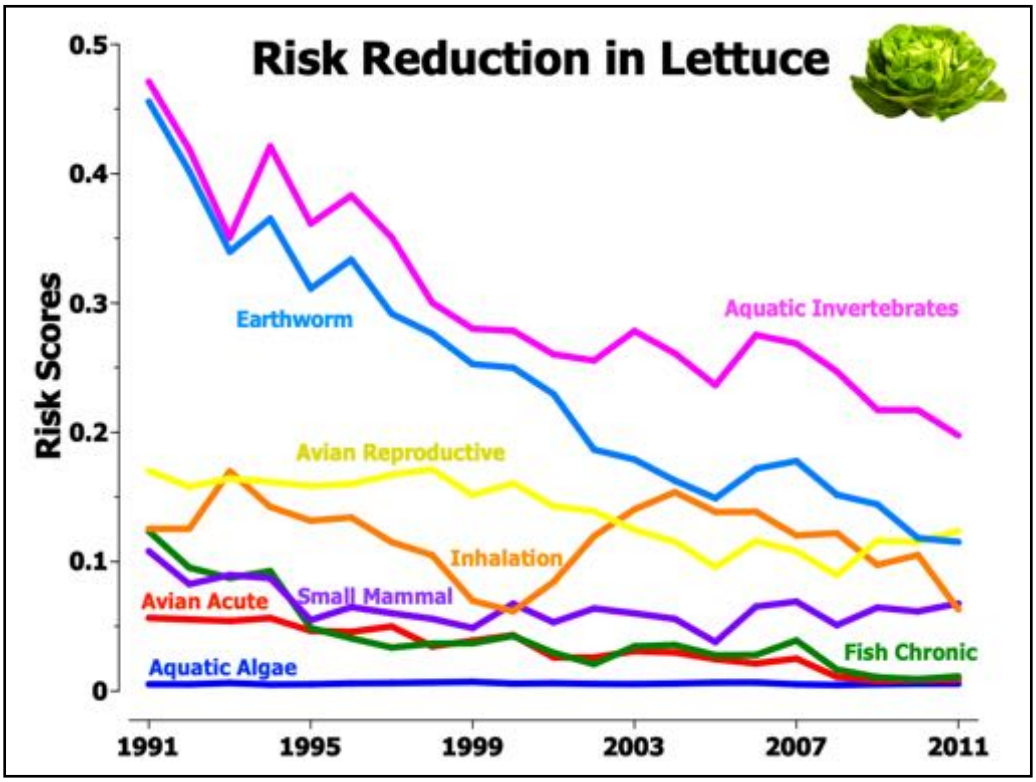
Risk mitigation

There are things we can do, and have done, to help minimize risks from automobiles. Do they still pose risks? Does that impact our willingness to drive them?

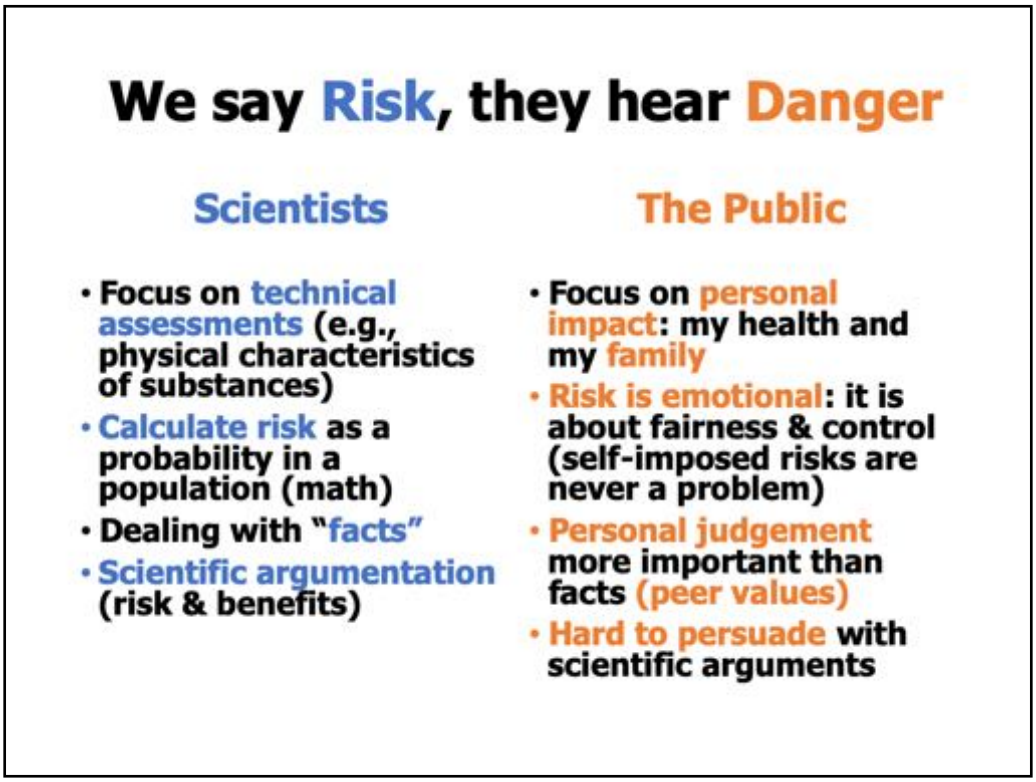
We are balance risks and benefits in almost every decision we make in daily life



We say risk, they hear danger. I was in a room full of agricultural professionals and pest managers, and I was very proud to present some astounding data in which we had analyzed over 20 years of pesticide use in Arizona lettuce production We had quantified risk of all those applications, using those risk indices we talked about earlier.



We suggested that we should publish this to toot the horn of the progressive lettuce industry that had worked so hard as stewards of the industry, to reduce pesticide risks. But we were discouraged from publishing the results because they people don't want the word "Risk" to be associated with the word "Lettuce", even a reduced risk.



Understanding these differences can be the beginning of a productive conversation.

3 broad themes for best practices in risk communication

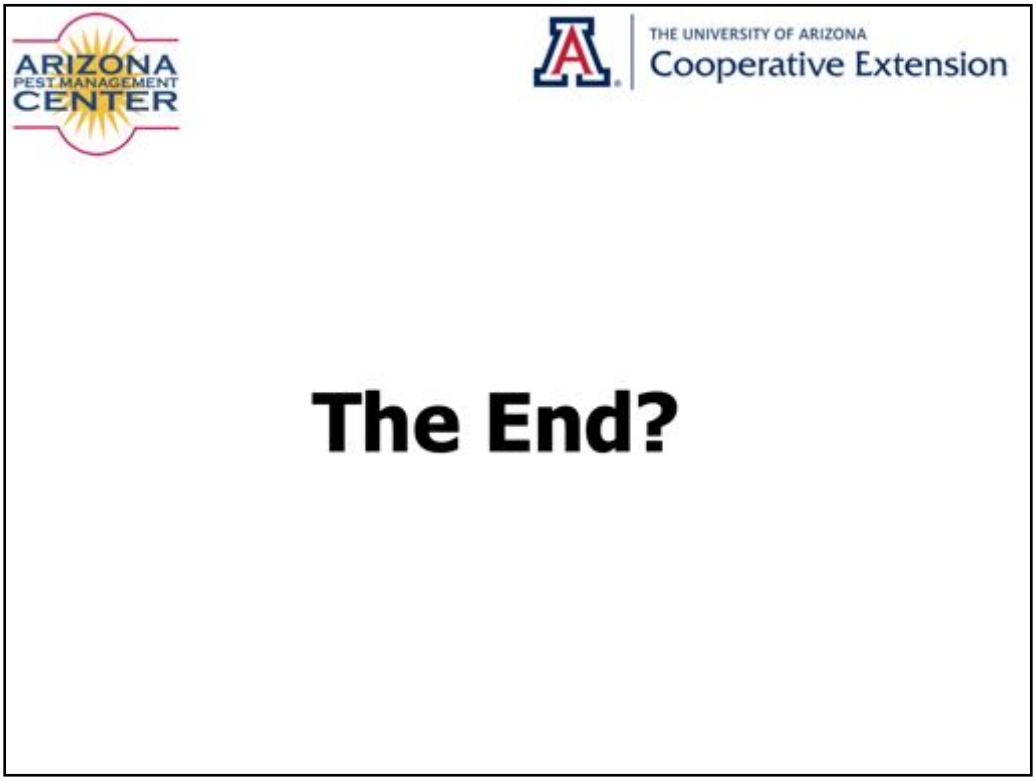
- **Characteristics of the target population**
  - Know your audience & their concerns
  - Empathize
- **Contents of the risk-benefit information**
  - Share what is most relevant
  - Make facts accessible
  - Don't evade facts, nor overwhelm with details
- **Characteristics of the information source**
  - This is about building trust
  - Is the source knowledgeable & unbiased

Source: Lynn Frewer – "Developing Effective Food Safety Risk Communication with Consumers"

Improving Risk Communication

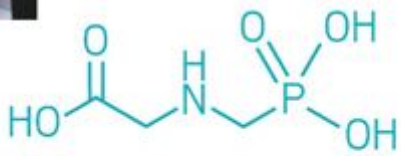
- Be informed and knowledgeable
- Be open – listen to and acknowledge feelings
- Admit what you don't know
- Build trust with your audience
  - Be honest and fair
  - Know your stuff
  - Do as you promised
- Focus on what's important to your audience

Source: Lynn Frewer – "Developing Effective Food Safety Risk Communication with Consumers"


ARIZONA
PEST MANAGEMENT
CENTER
THE UNIVERSITY OF ARIZONA
Cooperative Extension
The End?

A Challenging Example

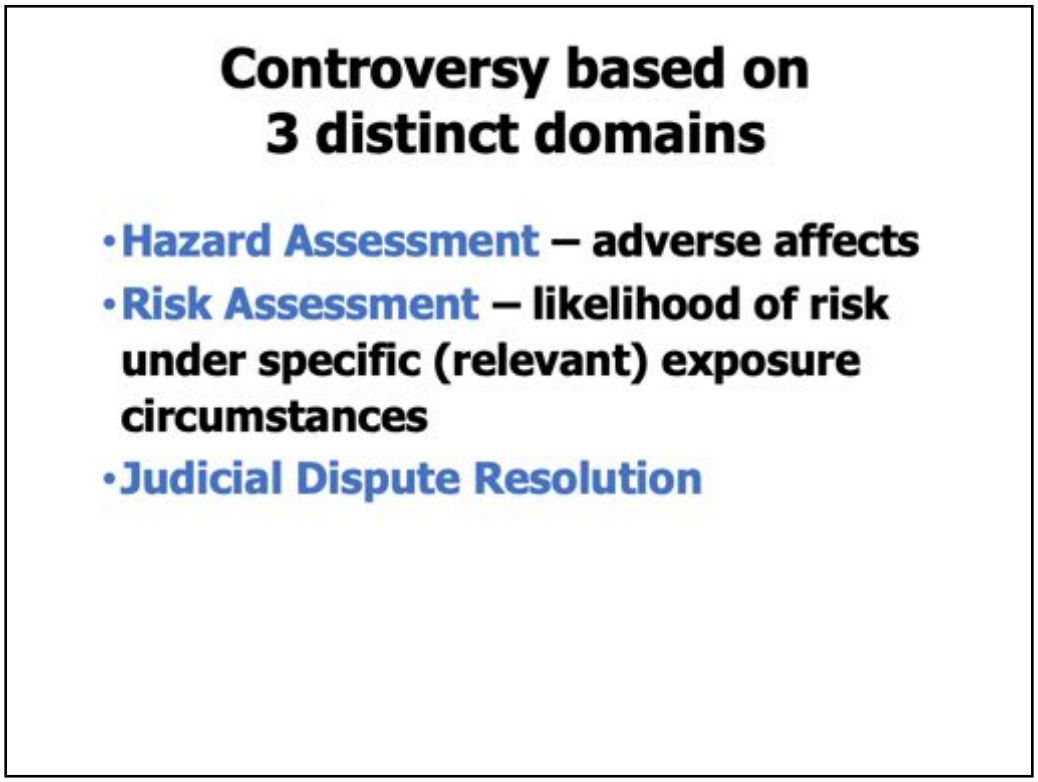
Acknowledgements:
Dr. David A. Eastman,
Professor and Toxicologist,
University of California, Riverside



Glyphosate

I would like to acknowledge Dr. David A Eastman from UC Riverside who gave an outstanding presentation on the Glyphosate hazard and risk analyses that have led to controversial court decisions.

Glyphosate is the most widely used pesticide in the world. There are about 750 glyphosate products marketed in the U.S. It is ubiquitous in agricultural, municipal and homeowner usage.



The glyphosate controversy is based in 3 distinctly different but related domains: Risk Assessment, Hazard Assessment, and Judicial & Extrajudicial Dispute Resolution (this last one easily splits also into two different domains). The first two are grounded in science but emphasize different things; the 3rd is what has ginned up so much controversy. With award settlements in the 10's of millions, some have cause to believe that all the claims must be true.

Controversy based on 3 distinct domains

- **Hazard Assessment – adverse affects**
  - Conducted by WHO Interagency for Research on Cancer (IARC, 2015)
  - "probable human carcinogen"
- **Risk Assessment – likelihood of cancer under specific (relevant) exposure circumstances**
  - WHO Joint Meeting on Pesticide Residues (JMPR, 2016)
  - In most mammalian studies, high dose oral exposure not associated with cancer
- **Judicial Dispute Resolution**
  - Awards in the tens of millions $$$
  - Assumption: Claims must be true

Comparison of Studies

JMPR (risk)

- 242 primary studies
- Included published and unpublished studies
- Gave more weight to:
- higher quality & validated studies
- mammalian studies than more distant species
- more damaging effects
- relevant routes of human exposure (oral)

IARC (hazard)

- 113 primary studies
- Included only published studies, publicly available

Both studies examined data from diverse model systems: Mammals (in vivo, in vitro cells), more distantly related species, bacteria, metabolites.

JMPR results supported IARC results in some areas.

IARC Conclusion (Hazard)

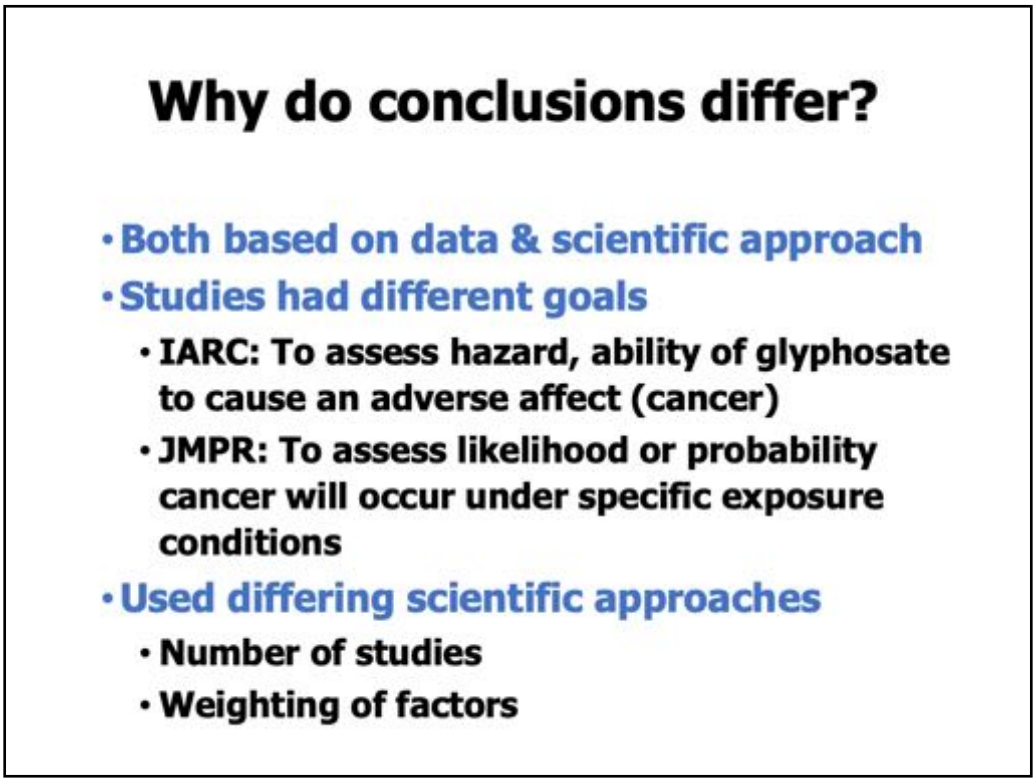
"There is strong evidence that exposure to glyphosate or glyphosate-based formulations is genotoxic based on studies in humans in vitro and studies in experimental animals. One study in several communities in individuals exposed to glyphosate-based formulations also found chromosomal damage in blood cells; in this study, markers of chromosomal damage (micronucleus formation) were significantly greater after exposure than before exposure in the same individuals."

Probable Human Carcinogen

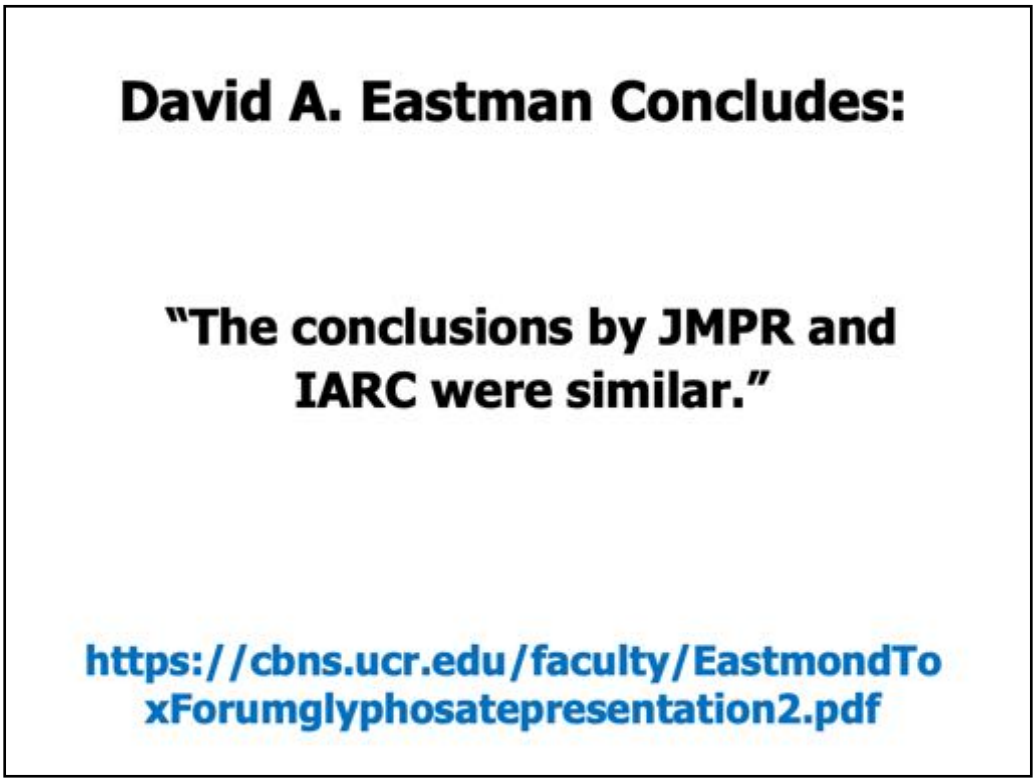
JMPR Conclusion (Risk)

"Overall, there is some evidence of a positive association between glyphosate exposure and risk of NHL from the case–control studies and the overall meta-analysis. However, it is notable that the AHS, which is the only cohort study and is large and of high quality, found no evidence of association at any exposure level."

Unlikely to cause cancer under expected exposure scenarios



When you look at the conclusions from the two studies, they seem contradictory. And they are to some extent. Why are they different? They are both based on science, but had different goals and used different scientific approaches.



Dr. Eastman's full presentation can be found online.

Questions? Comments?

Western IPM Center

Thank You!

ARIZONA PEST MANAGEMENT CENTER

Arizona Specialty Crop Block Grant Program
USDA-NIFA Extension Implementation Program

Al Fournier
fournier@cals.arizona.edu
520-374-6240

THE UNIVERSITY OF ARIZONA Cooperative Extension