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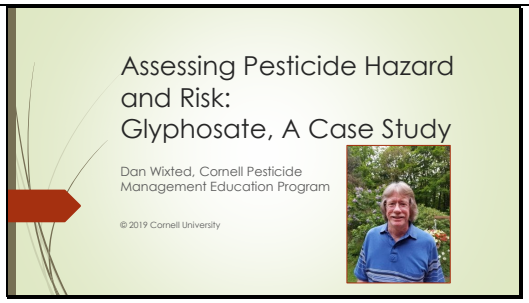
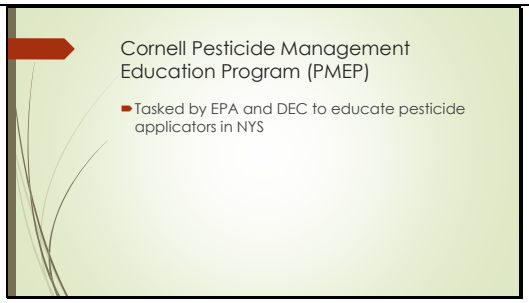
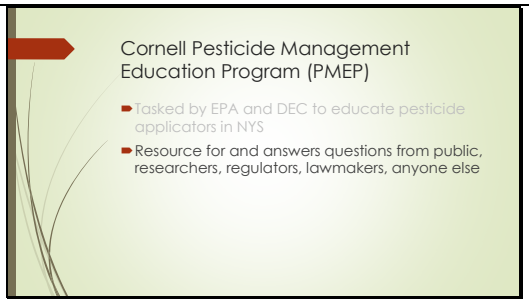
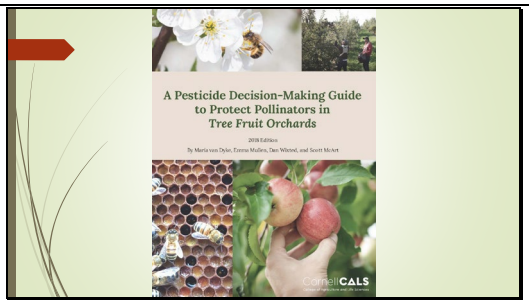
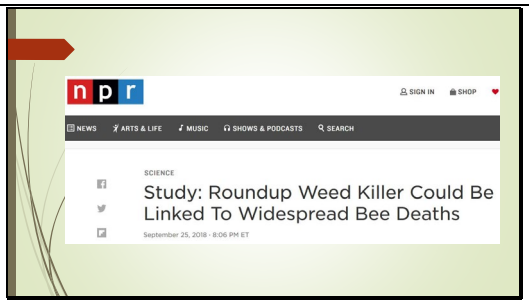
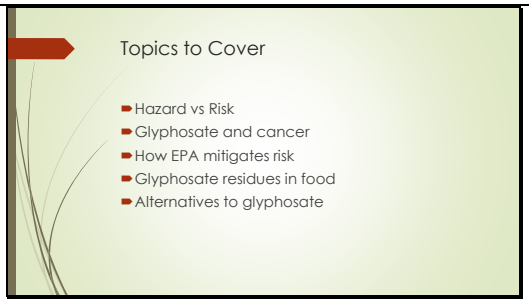
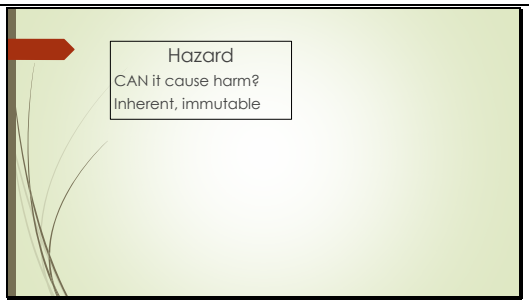
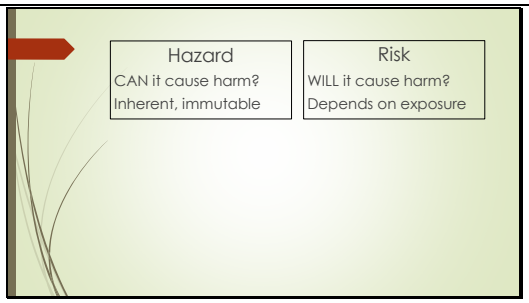
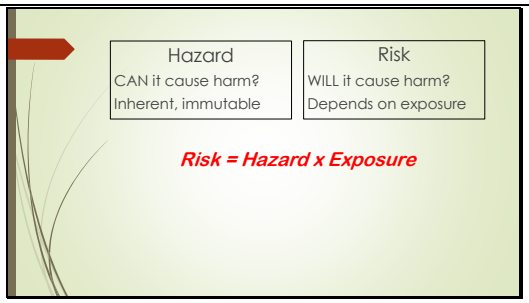
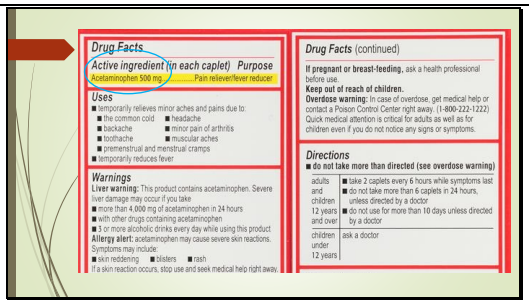
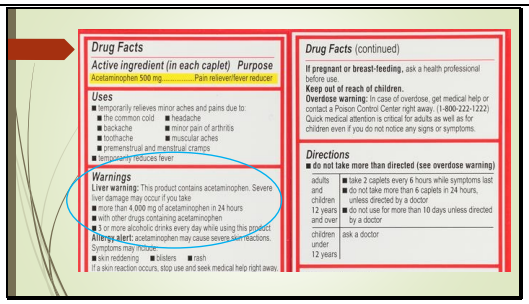
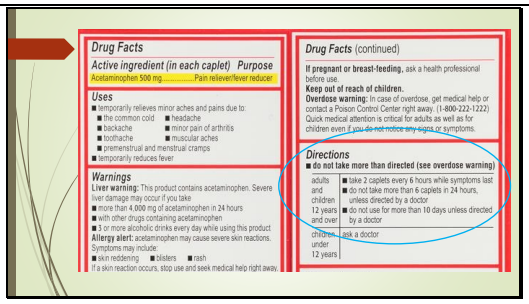
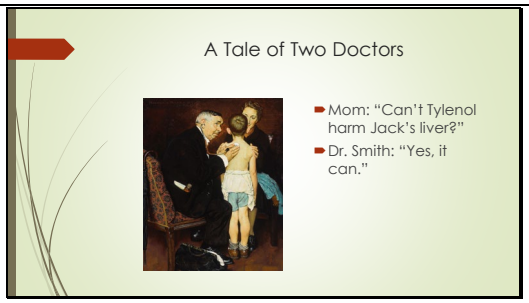
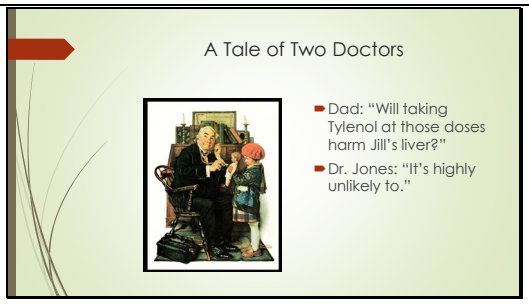
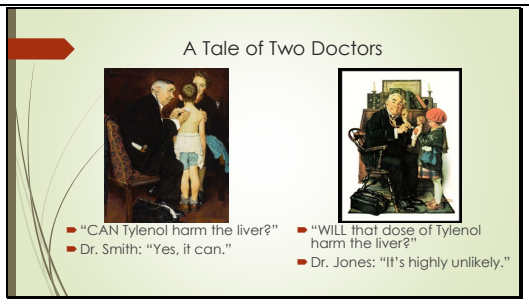
This PDF contains the slides and script from Dan Wixted's presentation to Washington's Aerial Forest Herbicide Workgroup on October 9, 2019. As indicated on the first slide, the presentation is copyrighted by Cornell University, which is sharing it for the Workgroup's purposes only. Any other use or distribution of the presentation is prohibited without express written permission from Cornell via the author, Dan Wixted (djw47@cornell.edu).

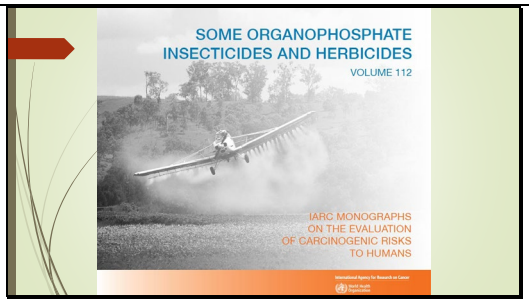
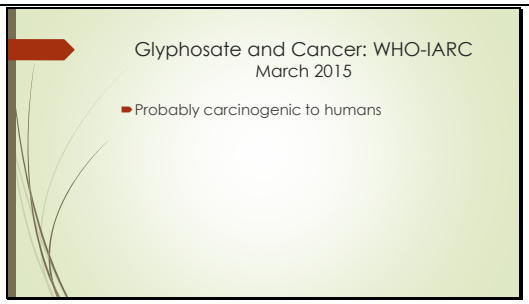
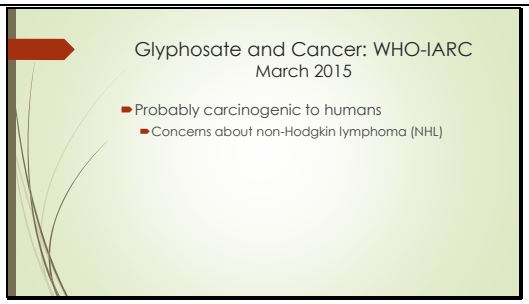
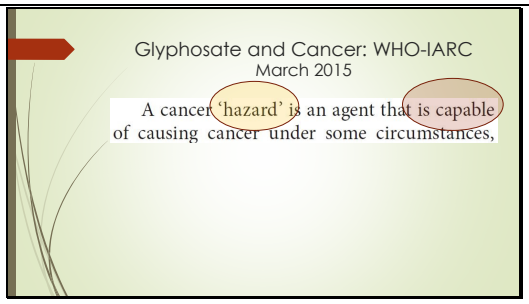
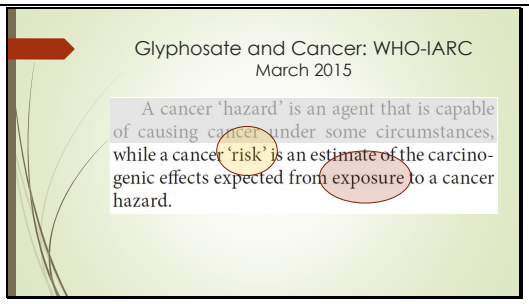
Slide 1		Glyphosate, as I'm sure you know, is the active ingredient in Roundup and many other herbicide products. It is the most widely used herbicide in the country and has been getting a lot of press and generating a lot of questions over the last few years. But before I dive into that, I always think it's good for the audience to know who the presenter is. So allow me to provide a little background on our program and how I ended up here today.
Slide 2		For the last 29 years, I've been a pesticide safety educator. Our program is mandated to provide pesticide safety education to applicators. We have sister programs in every state, and I've worked with WI's and NY's. Develop training manuals in categories ranging from ag to structural to landscape to cooling towers, provide online recert courses, produce Cornell Crop and Pest Management Guidelines, and hold workshops. And up until last year, selling these goods and services accounted for 75% of our revenue, plus we get about $10,000 from EPA and the occasional small grant. But it wasn't enough to cover costs, so CCE floated us some. But beginning with FY 2019 we are getting support from the NYS Environmental Protection fund. The state money is very helpful because a large part of what we do generates no income, and that work involves…
Slide 3		…serving as a resource to many. This takes up a huge chunk of our time, so let me expand on it. It will give you more of an idea of what we do and how I ended up here today.
Slide 4		We're serving as a resource to a neurologist at the University of Rochester who is researching the potential role of some pesticides in Parkinson's disease. We both correct some of his misconceptions about pesticides and help him obtain find useful information on the topic, such as this recent study because olfactory impairment, which is often one of the earliest indicators of Parkinson's.

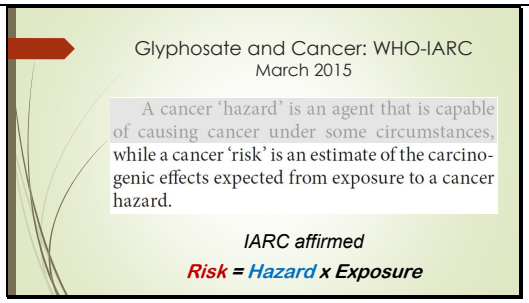
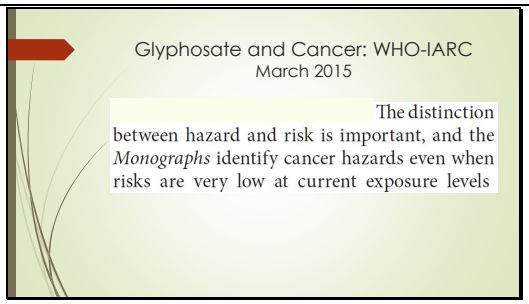
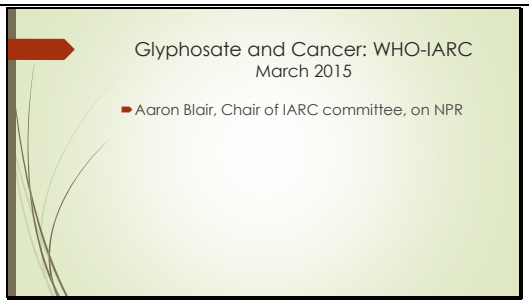
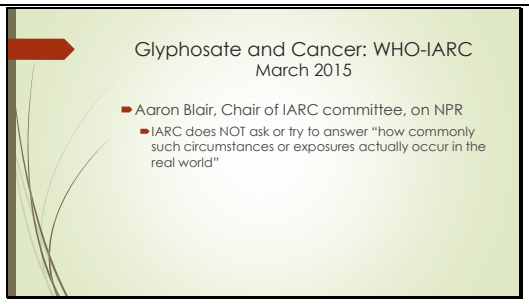
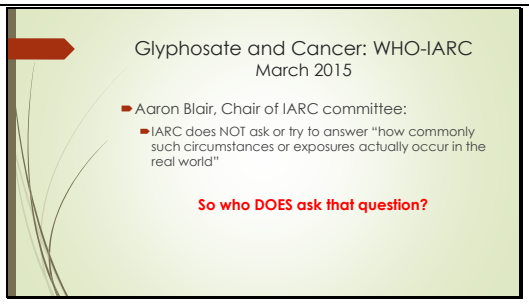
Slide 5		And notice that Aaron Blair is one of the authors. You'll hear his name again later.
Slide 6		I'm also very active with Cornell's pollinator health team. And I've co-authored the team's recent pesticide decision-making guides to help protect pollinators in sites such as orchards, landscapes, and small fruits.
Slide 7		And on the flip side, when the media recently overstated the implications of a research study involving glyphosate and bees….
Slide 8		…Scott McArt, part of the Pollinator Health Team who studies the effects of pesticides on bees, asked me to co-author a column in the January issue of American Bee Journal in which we talked about the strengths and limitations of that study. So, it's an interesting job. Depending on the audience, I can be accused of being a tree hugger or a shill for the pesticide industry even though I'm saying the same thing.
Slide 9		And speaking of glyphosate, about 2 years ago, Brian Richards at Cornell put together a spring seminar series on glyphosate. After each seminar, there'd be questions and discussion and the other speakers soon realized I had some knowledge they could tap into. Next thing I know, Brian asked if I'd fill an empty slot they had late in the semester. Of course, I realized THEY had knowledge I could tap into as well, so I again got speakers on our annual In-Service agenda to talk about potential risks to soil bacteria, movement of glyphosate in soil water, and health effects of glyphosate.

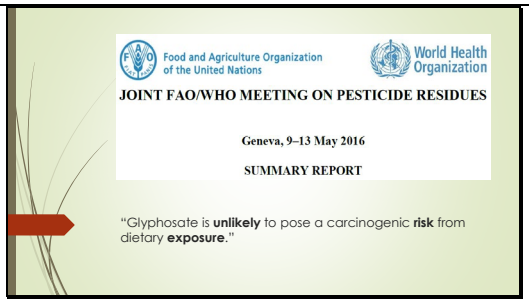
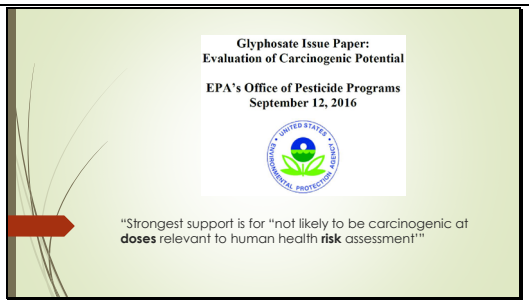
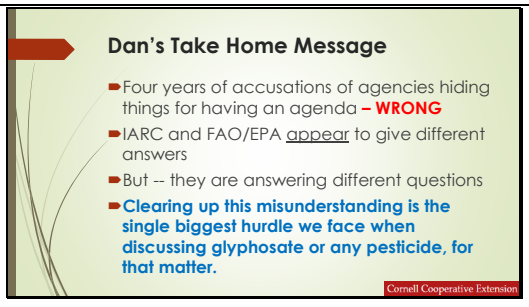
Slide 10		So today, I'm going to address the difference between a hazard and a risk because that difference is the source of much confusion regarding reports on glyphosate, especially with regard to cancer. I'll give a brief overview of the regulatory framework and how that process is used to mitigate risk. That will help you understand the next topic: glyphosate residues in food. Then if we have time, I'll close with a brief look at herbicides that can be used in place of glyphosate.
Slide 11		OK, so let's start with some basic but very important definitions.
Slide 12		Hazard, also called "toxicity," is a measure of a substance's ability to cause harm. It's an inherent property of the substance itself. It is immutable.
Slide 13		Risk, on the other hand, is an estimate of how likely it is that a substance WILL cause harm. That estimate depends on both the substance's hazard AND your level of exposure to the substance.
Slide 14		This yields the risk equation. In most cases, we can't rule out at least some exposure to something, so we tend to say there is always risk, but it can be very low or very high depending on the level of hazard and exposure. So unlike hazard, risk IS mutable; we can manage it.

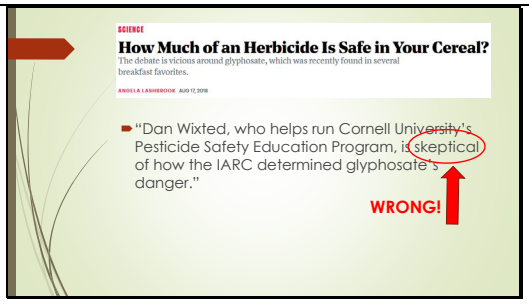
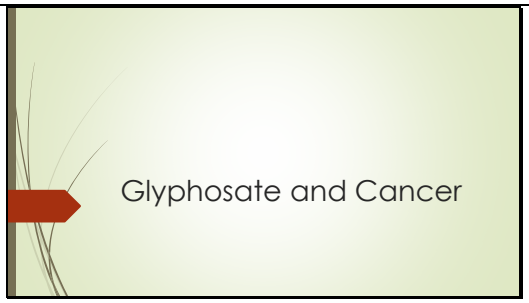
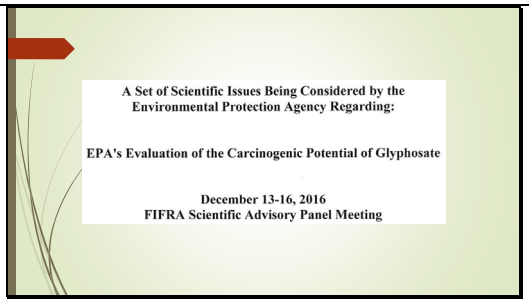
Slide 15		For a common, real-life example of hazard vs risk, consider what's on the label of every bottle of Tylenol.
Slide 16		The active ingredient in Tylenol is acetaminophen.
Slide 17		Great stuff, but toxicology studies show that at high doses it can be toxic to your liver and cause liver failure and even death. That is a hazard associated with acetaminophen. Notice it says the damage may occur if you take over a certain amount of acetaminophen…so it tells you not to take other drugs containing acetaminophen at the same time.
Slide 18		So the use directions right on the bottle show you how to avoid overexposure. Medical studies show that the doses indicated are high enough to relieve headache or fever, but too low to cause liver damage.
Slide 19		The warning to not use Tylenol with other medicines containing acetaminophen is even repeated on the front panel of the label.
Slide 20		And it comes in a bottle with a child-resistant cap.

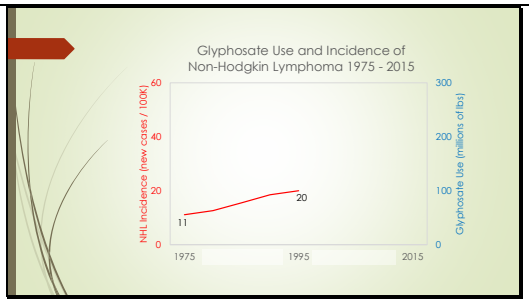
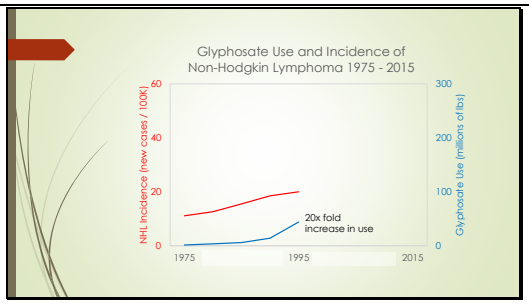
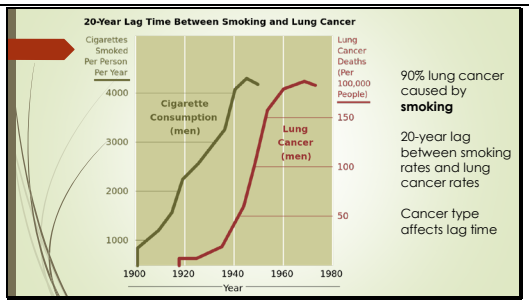
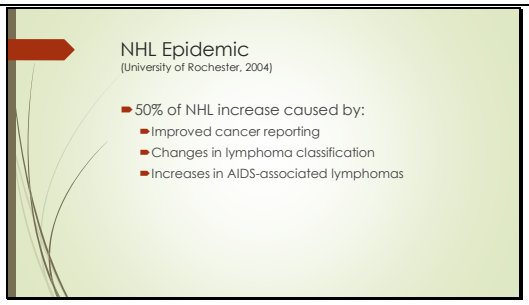
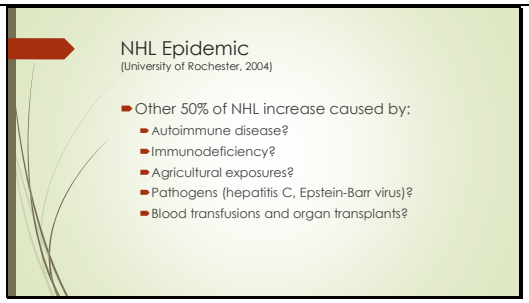
Slide 21		And with Infant's or Children's Tylenol, the dose is reduced because, since children are smaller than adults, it would take a smaller dose not only to be effective, but to harm the liver. So, do these features such as the childproof cap and maximum daily dose do anything to reduce the hazard of acetaminophen -- it's inherent ability to cause liver damage? No…the same overdose will still hurt your liver. But all these features are steps taken to reduce your exposure to the chemical and therefore reduce your risk of liver damage. Now imagine two kindergarteners who come down with a fever. Their family doctors both prescribe children's Tylenol.
Slide 22		Dr. Smith says READ SLIDE Jack's mom is concerned and asks Dr Smith (read rest of conversation on slide)
Slide 23		Dr Jones gives the same prescription to Jill's dad. Like Jack's mom, Jill's dad is concerned and asks READ REST OF SLIDE.
Slide 24		OK, so one doctor says Tylenol can harm the child's liver, and another doctor says it's unlikely to. Sounds like they disagree, so which doctor is wrong or, worse, lying about the dangers of Tylenol? Right, neither. Jack's mom asked about the hazard associated with Tylenol and the doctor answered honestly because science shows that acetaminophen CAN cause liver damage. Jill's dad, on the other hand, asked about the risk associated with taking Tylenol and the doctor answered honestly because science shows that liver damage is highly unlikely when Tylenol is used as directed. So, what's this have to do with glyphosate?

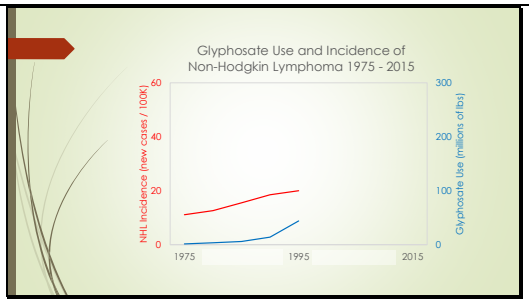
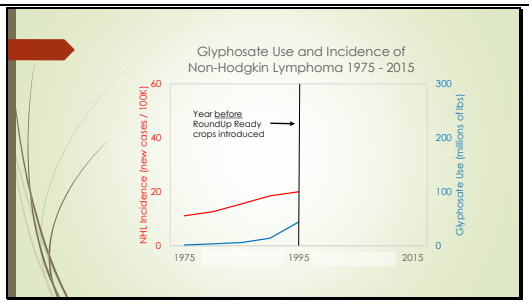
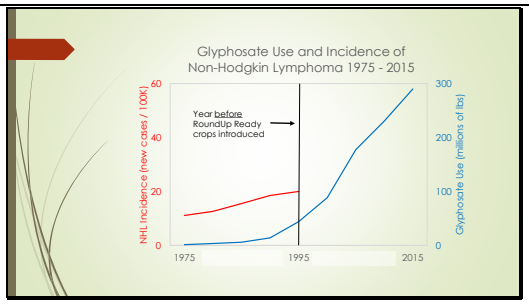
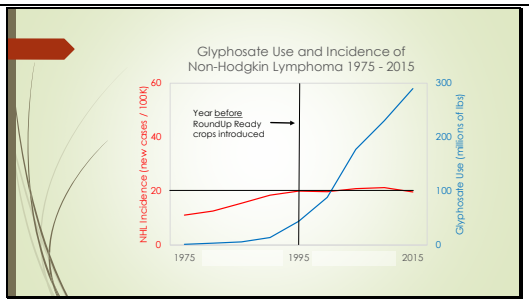
Slide 25		The International Agency for Research on Cancer, or IARC, is under the UN's World Health Organization. In March 2015, IARC issued this monograph…
Slide 26		…in which they listed glyphosate as a probable human carcinogen. Raise your hand if you were aware of this.
Slide 27		IARC's committee was made up of qualified scientists who looked at a boatload of scientific studies on the subject to come up with a science-based consensus, largely based on concerns about non-Hodgkin lymphoma, or NHL. So then why is glyphosate still being used worldwide? Why hasn't EPA banned it?
Slide 28		You'll found part of the answer in a passage from the preamble of that same IARC Monograph. It starts with READ SLIDE.
Slide 29		Read slide

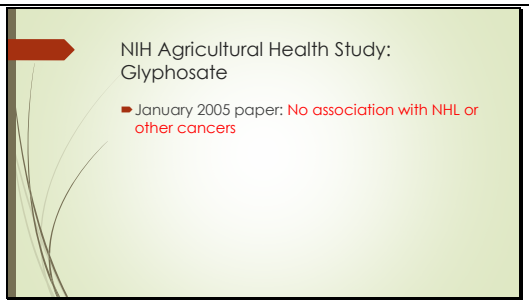
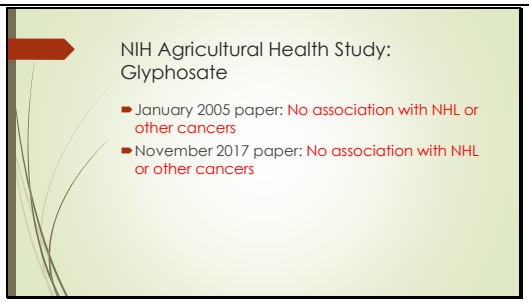
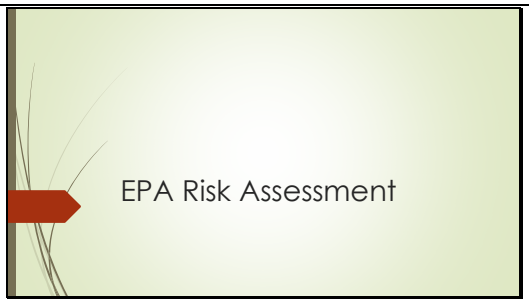
Slide 30		Here, IARC is affirming that risk is based on hazard and exposure. The passage continues…
Slide 31		Read slide. Raise your hand if you were aware of THIS. Didn't hear it in the news? Mostly because it didn't make the news.
Slide 32		Except on NPR, where they interviewed Aaron Blair, the chair of the IARC committee. Dr. Blair is with the National Cancer Institute and has been studying pesticides and cancer for over 40 years. In that interview, Dr. Blair said the agency asks: can it cause cancer in some circumstances at some level of exposure?
Slide 33		But he reaffirmed that IARC does NOT ask how commonly such circumstances or exposures occur in the real world; that is, what is the risk?
Slide 34		So if IARC doesn't ask that question, who does?

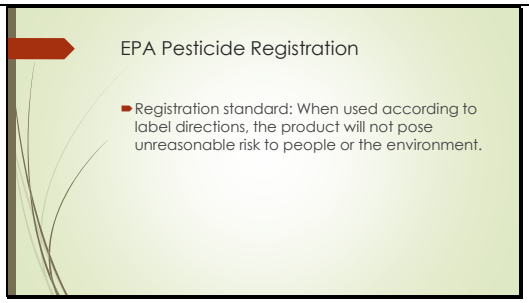
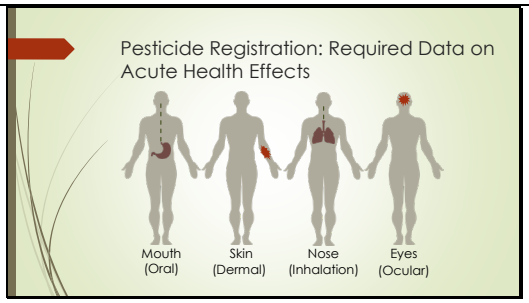
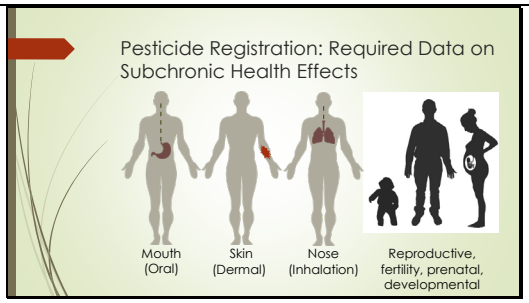
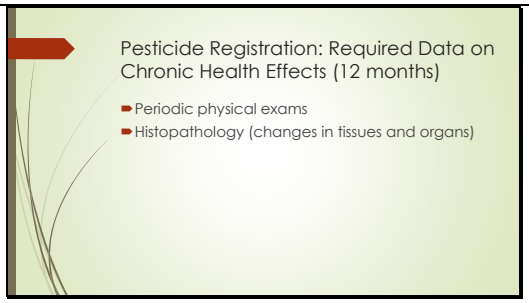
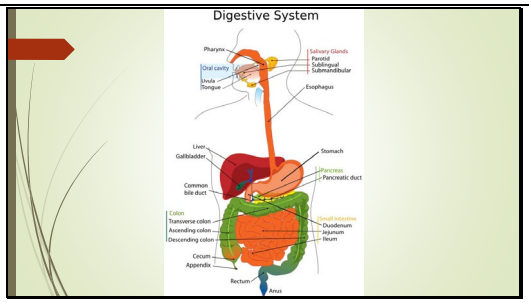
Slide 35		Well, IARC's parent agency (WHO) and the UN's Food and Agriculture Organization do. And they claimed glyphosate is unlikely to pose a carcinogenic risk from dietary exposure.
Slide 36		And the EPA does, finding in its draft evaluation of glyphosate's carcinogenic potential that the strongest support is for not likely to be carcinogenic at doses relevant to human health risk assessment. These determinations came after the IARC report. They were performed by qualified scientists who looked at a boatload of scientific studies on the subject to come up with a science-based consensus. So why are they saying glyphosate is not likely to be carcinogenic when IARC said it is a probable human carcinogen? The key is that FAO and EPA were asking an entirely different question from what IARC was asking; that is, risk based on real-world exposure vs hazard.
Slide 37		So, in our Tylenol analogy, IARC is Dr. Smith, answering the question CAN a chemical do harm, while FAO and EPA act as Dr. Jones, answering the question what is the likelihood that a chemical WILL do harm at the expected levels of exposure. And just as the two doctors were being honest and open and answered their respective questions based on the best science available, so were IARC, FAO, and the EPA.
Slide 38		Because for nearly 4 years I've been hearing accusations that one agency or the other had an agenda or was hiding something, all because they APPEARED to give different answers. When all along, they were only answering different questions. Clearing up this misunderstanding is the single biggest hurdle we face when discussing glyphosate or any pesticide, for that matter.

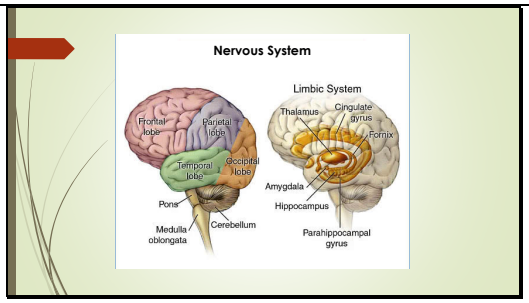
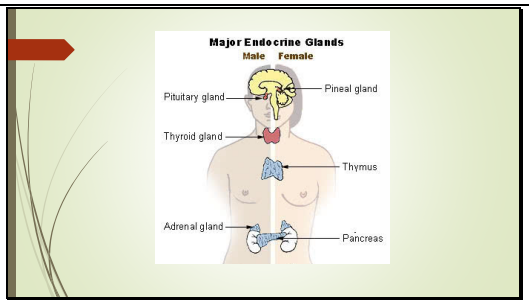
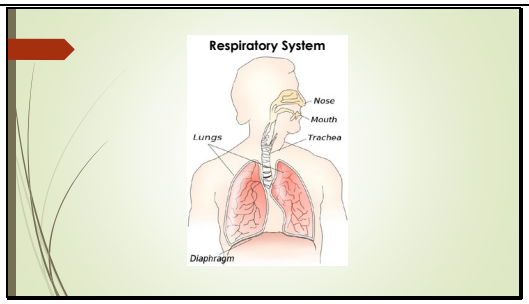
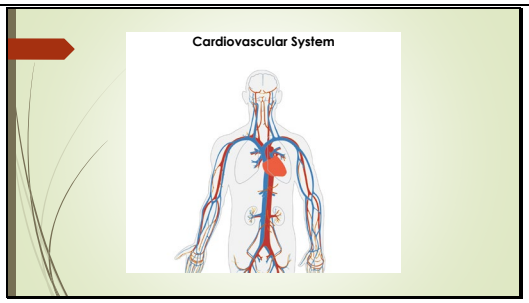
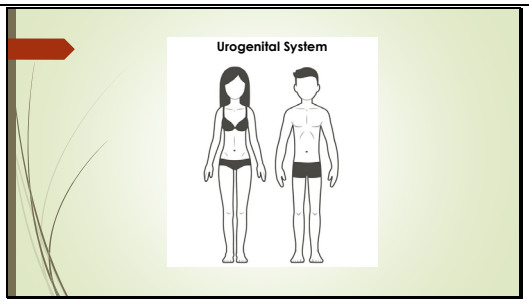
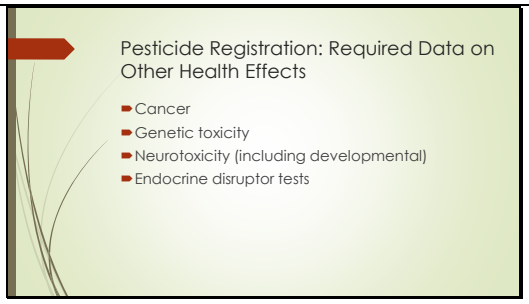
Slide 39		NOTE: THIS SLIDE IS AN INTERACTIVE PORTION OF THE TALK. SOMETIMES, I JUST GIVE THE INFO WITHOUT HAVING PEOPLE DO THE EXERCISE. OK, so this past August, The Atlantic reached out to me about the glyphosate issue and I told the author pretty much what I've told you. But she got it wrong in the original article and I asked her to correct it, which she did. You have this handout, and either the name of the magazine at the top is in orange or blue, depending on which way you hold it. So hold yours with one color on top, and ask your neighbor to hold it with the other color on top. Take a minute to read each version of the article and choose which is the original and which is the corrected. And also discuss with your neighbor why the difference matters.
Slide 40		But she got it wrong in the original article and I asked her to correct it, which she did.
Slide 41		So, let me briefly talk about the cancer issue. And to make sure what I tell you is accurate I sent the slides and script to Aaron Blair and during a phone conversation he mentioned some ways I could improve my accuracy. I don't skimp when I do my fact checking, especially when I'm fact checking myself.
Slide 42		Remember I said that EPA's draft assessment said glyphosate was not likely to be carcinogenic at doses relevant to human health risk assessment. The draft was by the Agency itself. Its independent Scientific Advisory Panel reviewed it and some members disagreed with EPA's analysis. Mostly because of a concern over non-Hodgkin lymphoma, which also was a big factor in the IARC report. And one claim I've read over and over is that the incidence of NHL has doubled since glyphosate came on the market. So, all this led me to investigate the issue of glyphosate and NHL.

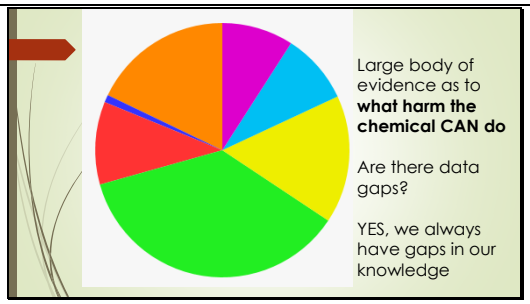
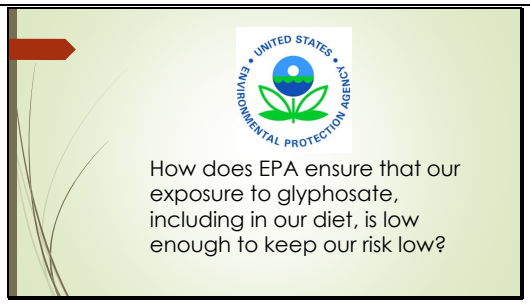
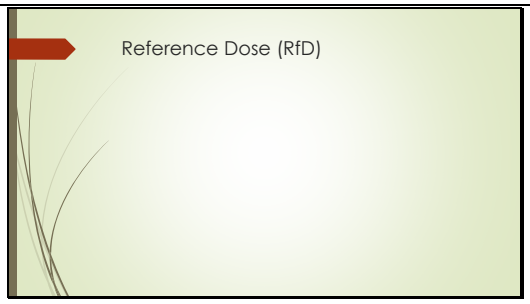
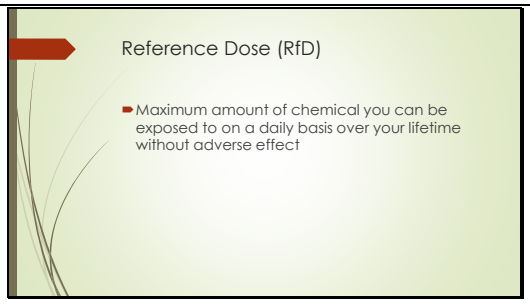
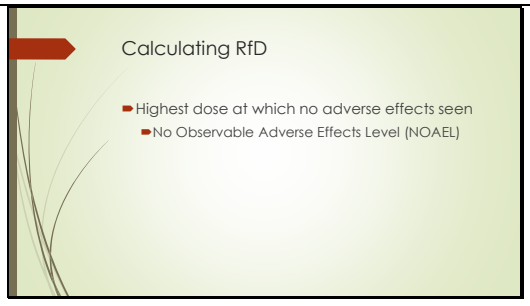
Slide 43		According to data from the National Cancer Institute, the incidence of NHL had indeed nearly doubled from 1975 to 1995, from 11 new cases/100K/year to 20.
Slide 44		And according to EPA data from that time period, glyphosate use increased about 20-fold. So, we definitely see the two graphs tracking in parallel, which had a lot of people thinking this showed a causal relationship. But is that the way cancer works? Well, that's complicated.
Slide 45		Let's look at smoking. There is generally about a 20-year lag between smoking rates and lung cancer rates, as shown here. Note the graphs follow a similar track, but 20 years apart. But the lag can vary depending on the factor and the type of cancer, and I'll touch on that more later. One thing to notice is how strongly these curves track. That's because smoking causes about 90% of lung cancers. So other factors, such as air pollution, won't affect this graph much. Smoking is the major driver.
Slide 46		But in the case of NHL, these 3 factors were found to account for 50% of that increase we saw. The last one here is the most interesting, because there is a very short lag with AIDS. Remember, the AIDS epidemic was during those years from the late 70s to the mid-90s, and it clearly contributed to the NHL rate. And Dr. Blair confirmed the lag can be much shorter with NHL than with lung cancer. Source: http://www.nature.com/onc/journal/v23/n38/full/1207843a.html
Slide 47		The other half is unclear, but exposure to environmental toxins such as pesticides might be a contributor…the authors couldn't say for sure.

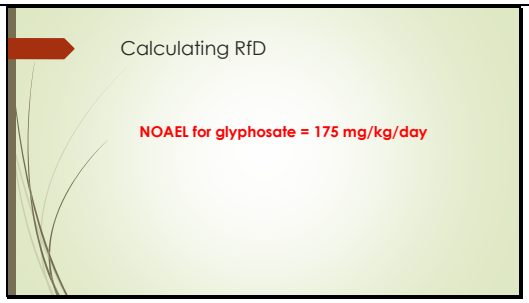
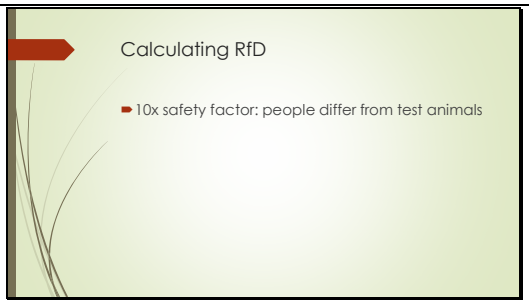
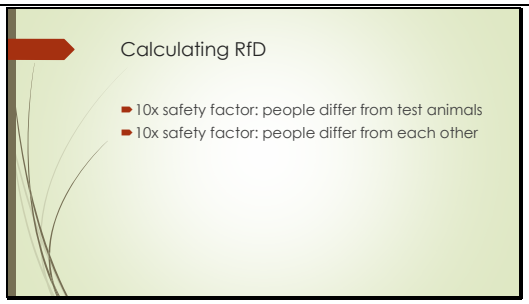
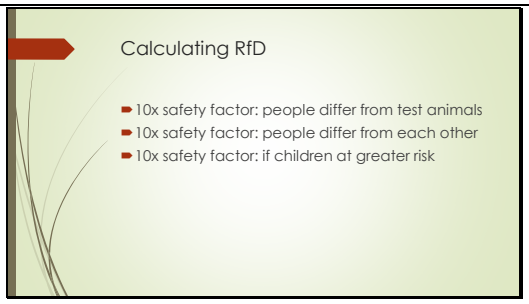
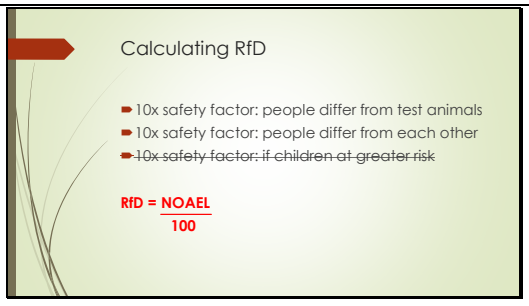
Slide 48		Going back to the NCI and EPA data, we see a correlation between cancer and a factor that shows some suggestion of being carcinogenic, and it's for a cancer that can have short lag times.
Slide 49		So, what happened in the next 20 years? I added the vertical line here because 1995 was the year BEFORE RoundUp® Ready crops first came on the market.
Slide 50		To no one's surprise, annual glyphosate use skyrocketed once those crops came on the market, from less than 50 million pounds to nearly 300 million.
Slide 51		Meanwhile, the NHL rate has leveled off at about 20 new cases / 100K. Does this mean glyphosate is not contributing to NHL incidence in the general population? Not necessarily. All we can say for sure is that even if glyphosate exposure can cause NHL in some people under some circumstances, it is not a major driver in the rate of NHL in the general population; think of the smoking and AIDS examples we've already discussed; THOSE are major drivers. And this graph is consistent with targeted studies that look for connections between glyphosate exposure and NHL. As Dr. Blair mentioned to me, human studies show much inconsistency, and even in those that show there might be an association, the elevated risk of contracting NHL is very small. And those studies focus on applicators, who experience the greatest exposure, not the general public. And that's a key point for you farmers and commercial applicators out there: IF anyone is at risk of getting cancer from glyphosate exposure, it's you. So please, use glyphosate and all pesticides wisely to reduce your exposure.

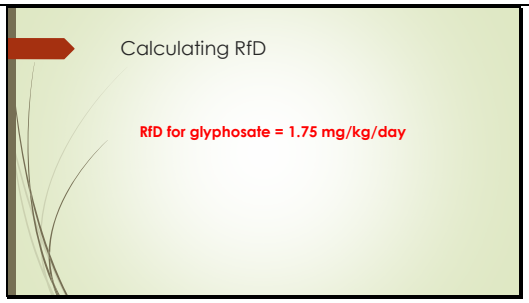
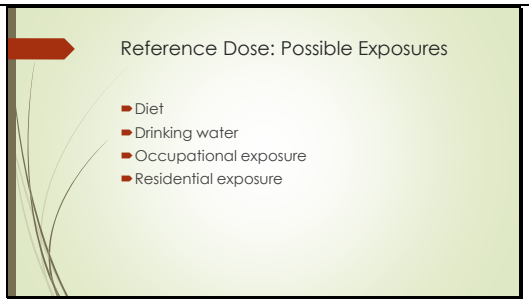
Slide 52		So, one thing EPA looked at is the National Institute of Health's Ag Health Study. I believe this is the largest and longest epidemiological study involving pesticide applicators and their spouses, which gives its findings a lot of weight. The study has been tracking participants' pesticide use and health history for over 20 years now.
Slide 53		And in 2005, a peer-reviewed paper found no statistically significant association with glyphosate use or exposure and any cancer, including NHL. That was good news for applicators, but the data was up to only a few years after glyphosate use started skyrocketing. The authors promised a follow-up study, so I kept my eyes open for it.
Slide 54		And in late 2017, it came out and came to the same conclusion, which helped lead EPA to reaffirm its conclusion that glyphosate is unlikely to pose a carcinogenic risk at expected levels of exposure.
Slide 55		I mentioned before that we always assume there is some risk associated with chemicals, including pesticides. Let's look at how EPA assesses risk to determine what level of exposure yields an acceptable level of risk.

Slide 56		The standard that must be met for a pesticide product to be registered is that when used according to label directions, the product will not pose unreasonable risk to people or the environment. That's a pretty high standard. And, notice the emphasis on risk as opposed to hazard. And as a reminder, after a pesticide is registered by EPA, it has to undergo further review by the DEC before it can be registered for use in NY. OK, so meeting EPA's registration standard requires the review of a huge amount of data regarding the product's efficacy and the potential health and environmental effects of the product's ingredients, both active and inert. That is, what hazards do the ingredients pose? Note that health effects studies are performed on animals, not people.
Slide 57		EPA looks at acute toxicity studies involving the 4 main routes of pesticide exposure. Studies on acute dermal effects also include dermal irritation and skin sensitization.
Slide 58		Subchronic toxicity studies look at oral, dermal, and inhalation exposure as well as reproductive, fertility, prenatal and developmental effects.
Slide 59		Chronic health effects studies require periodic physicals, including such things as bloodwork, urinalysis, and response to stimuli. And they finish by looking for effects in tissues an organs, including…
Slide 60		Digestive system (salivary glands to rectum, liver, pancreas, gallbladder)

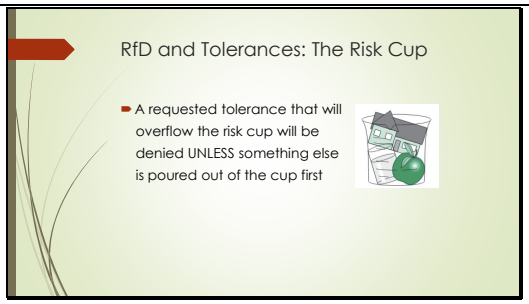
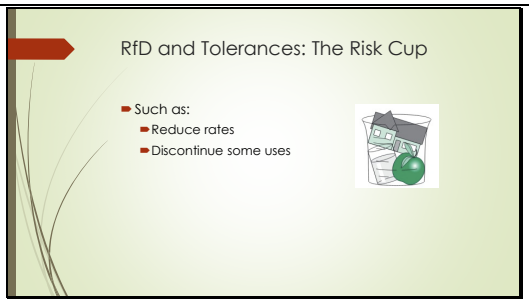
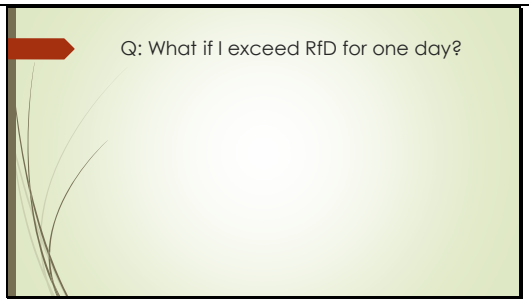
Slide 61		Nervous system (brain sections; pituitary; lumbar, mid-thoracic, and cervical regions of spinal cord; retina; optic nerve)
Slide 62		Glandular system
Slide 63		Respiratory system (lungs, trachea, pharynx, larynx, nose)
Slide 64		Cardiovascular system (aorta, heart, bone marrow, lymph nodes, spleen)
Slide 65		Urogenital system including the mammary glands (kidneys, bladder, prostate, testes, seminal vesicles, uterus, ovaries, mammary glands)
Slide 66		And testing is done to look for these very important health effects.

Slide 67		EPA also looked to see if glyphosate gets in breast milk or bioaccumulates in the body and found it does neither. And because they're doing a risk assessment, they need to determine how and to what extent people can be exposed to glyphosate given its current use patterns.
Slide 68		At the end of all this, there's a huge body of evidence as to what harm the chemical CAN do. Pretty extensive. Are there data gaps? YES. For example, testing is done on glyphosate rather than on formulated products because there are endless combinations and possible concentrations of active and inert ingredients. So we always have gaps in our knowledge. And I'll touch on that more later.
Slide 69		Now that EPA has a handle on the hazards that glyphosate can pose…how does it ensure that our exposure to glyphosate, including in our diet, is low enough to keep our risk low?
Slide 70		EPA uses the health effects data to calculate a Reference Dose, or RfD, for the active ingredient.
Slide 71		The Reference Dose is the maximum amount of the chemical you can be exposed to on a daily basis for 70 years without experiencing adverse effects.
Slide 72		To calculate the RfD, EPA starts with the highest dose that posed no harm to the test animals. This is the No Observable Adverse Effect Level...

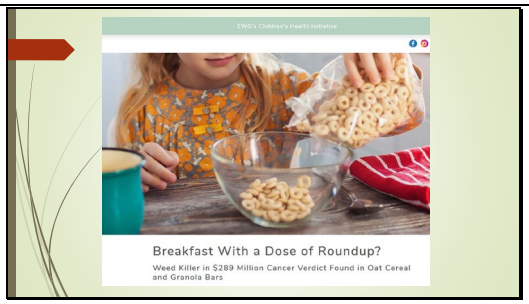
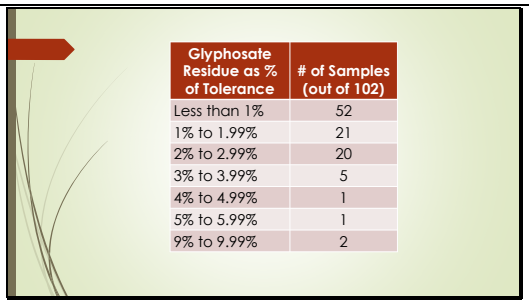
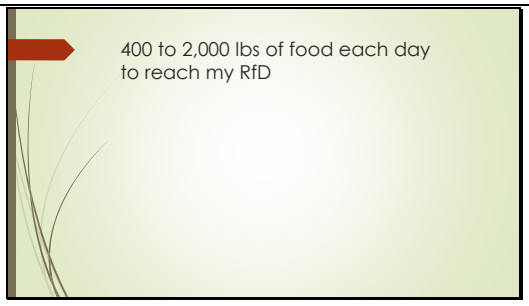
Slide 73		…which for glyphosate is 175 mg/kg of body weight/day.
Slide 74		Next, they reduce it 10-fold. This safety factor allows for the possibility that people will be more susceptible than the test animals to the pesticide.
Slide 75		Then, it's reduced another 10-fold because we know that within the human population, there is variability in our susceptibility and reaction to toxins due to differences in traits such as gender, age, medical conditions, etc.
Slide 76		Finally, if data indicate that there are unique hazards to children, another 10-fold safety factor is used. This is not the case with glyphosate ….
Slide 77		So, from the NOAEL we start by adding a combined safety factor of 100.

Slide 78		So, glyphosate's NOAEL of 175 mg/kg/day is reduced 100 fold, giving a reference dose of 1.75 mg/kg of body weight/day. Note that the reference dose isn't simply 1.75 mg; it's 1.75 mg per kg of body weight. The more you weigh, the more glyphosate you can be exposed to. For me, it's about 131 mg per day. For someone who weighs about 125 pounds, it would be about 93 mg per day. And remember that the Reference Dose = Maximum amount of chemical you can be exposed to on a daily basis over your lifetime without adverse effect.
Slide 79		This includes all potential sources of exposure, including in your diet, drinking water, and occupational and residential exposure…both from using glyphosate yourself and from being where others have used it. So to help visualize how EPA uses this information to determine how much can be in our food….
Slide 80		Consider a cup that holds all these potential exposures. We call this the risk cup, and for glyphosate this cup is just barely big enough…
Slide 81		…to hold exposures totaling 1.75 mg/kg/day. Because if risk cup overflows, RfD is exceeded and that is against the law. So EPA has to limit how much glyphosate we can be exposed to, including how much can be in our food, to make sure the risk cup does not overflow.
Slide 82		Now, let's focus on one of those exposures: food.

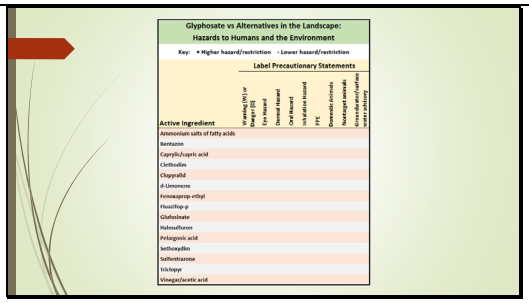
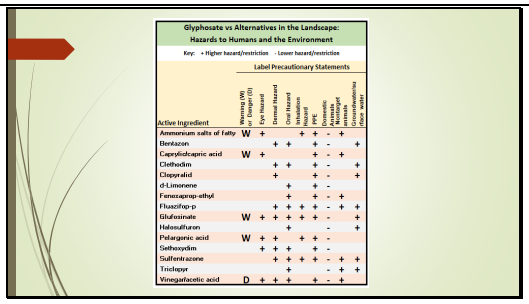
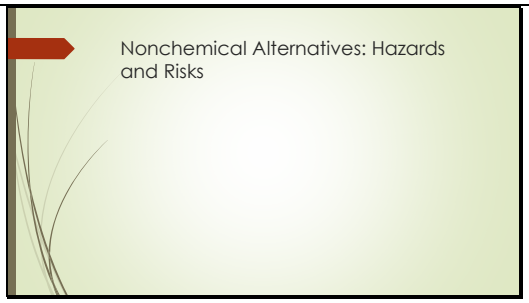
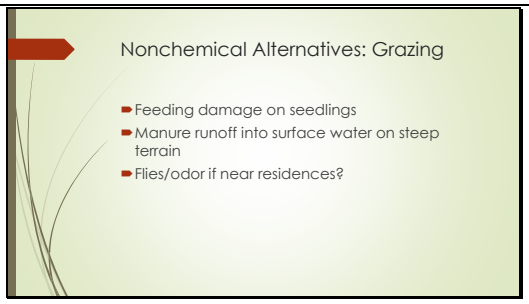
Slide 83	Pesticide Registration: Tolerances	If the pesticide manufacturer is requesting to use the product on food or feed crops or livestock, there's yet another step involved in the registration process. EPA sets tolerances for the active ingredient, inert ingredients, and relevant breakdown products, such as AMPA in the case of glyphosate.
Slide 84	Pesticide Registration: Tolerances - Maximum chemical residue allowed on or in crop/animal at harvest/slaughter - mg / kg (parts per million or ppm)	A tolerance is READ SLIDE.
Slide 85	Pesticide Registration: Product Label 	When EPA registers a product, they are allowing its use ONLY as stated on the label…that's the law. And they won't allow a crop use unless a tolerance has been set. By following label directions, a grower can ensure that tolerances will not be exceeded because label rates and application timing are set with that in mind. And note that a crop will be seized if tolerance is exceeded. So, it is very much in the farmer's self-interest to use pesticides according to label directions. But glyphosate is used on a lot of crops, each of which has a tolerance. How do we ensure that the tolerances are kept low enough to protect us?
Slide 86	Food Quality Protection Act of 1996 (FQPA)	This is where the Food Quality Protection Act kicks in. Remember I told you that the registration standard is that, when used according to label directions, a pesticide will not pose unreasonable risks to human health or the environment. But when pesticide residues could be found in food, FQPA ups the ante….

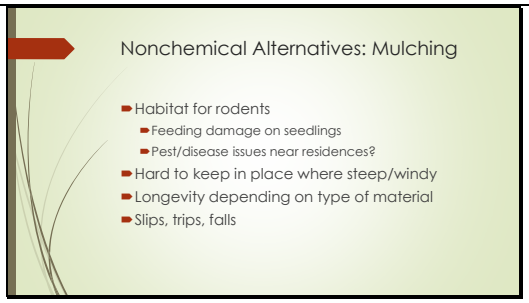
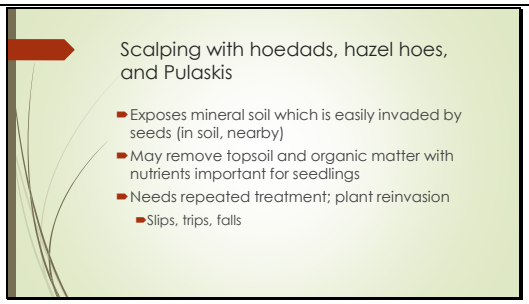
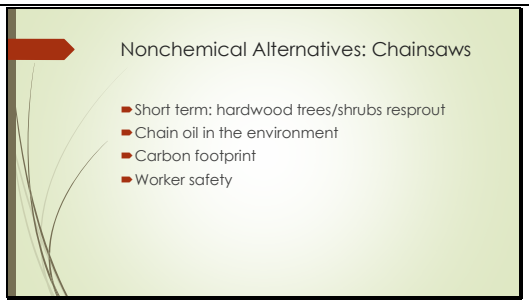
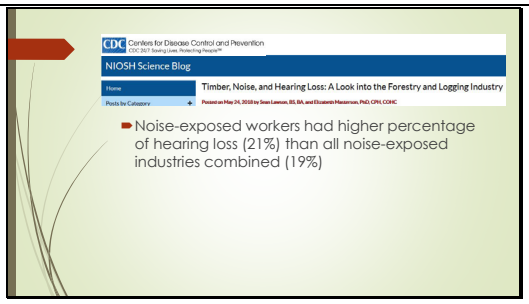
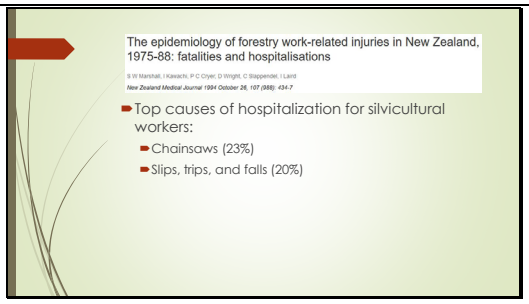
Slide 87		…and requires there to be a reasonable certainty of no harm from dietary exposure to such residues.
Slide 88		It also requires registration review every 15 years to ensure that risk mitigation measures still meet the FIFRA and FQPA standards in light of new science and use patterns. Glyphosate is undergoing its registration review as we speak.
Slide 89		Going back to the risk cup, if a requested tolerance WOULD cause the cup to overflow, the tolerance is rejected unless some other risk is drained from the cup.
Slide 90		For example, application rates could be reduced, which would lower the potential exposure and allow EPA to set a lower tolerance. Or some uses of the pesticide could be discontinued. Does everyone understand that tolerances and pesticide use rates are set so that your reference dose will not be exceeded? That is, so that it meets the standard of reasonable certainty of no harm from dietary exposure to glyphosate. OK, but if glyphosate residues are allowed in our food, isn't it possible we'll consume more than the reference dose each day?
Slide 91		The first time I gave this talk, someone asked that very question and I gave the good old "Uh, I don't think so" answer that I hate.

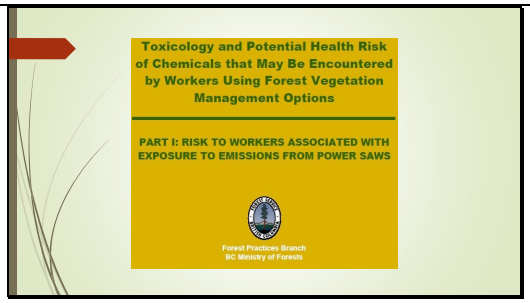
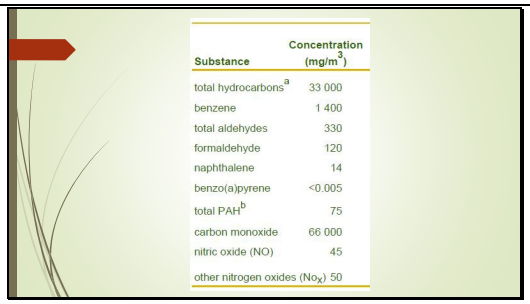
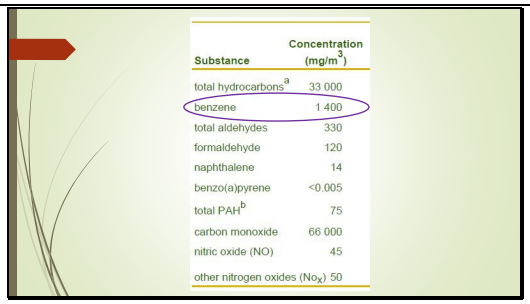
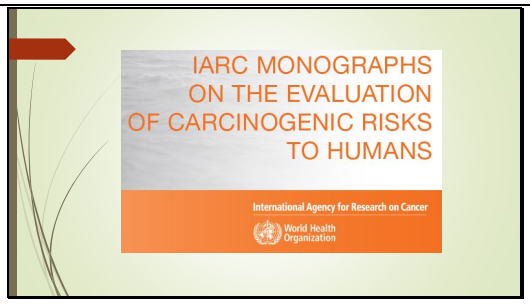
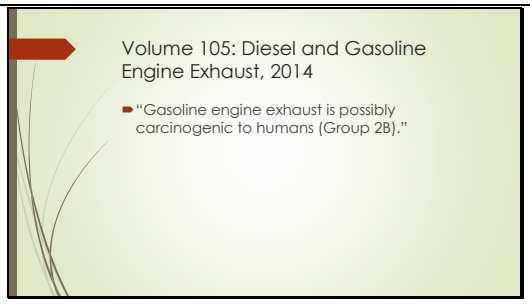
Slide 92	Q: What if I exceed RfD for one day? • My personal RfD = 131 mg/day	So, I decided to see if I CAN I exceed my RfD of 131 mg via dietary exposure. Due to time constraints, I'll skip the process and cut to the chase…if I consumed the recommended USDA diet for a man of my age and activity level, and everything I ate and drank…including the proper daily amount of water…contained glyphosate residues at 100% of tolerance…
Slide 93	Q: What if I exceed RfD for one day? • My personal RfD = 131 mg/day • My glyphosate-rich diet: 11 mg (8% of RfD)	…I'd consume about 11 mg, or 8% of my personal RfD. OK, that sounds good. But don't rest easy yet.
Slide 94	Two Conditions • Residues are at or below tolerance • Calculated RfD is accurate measure of risk	Because the fact is, the idea that I won't my RfD through my diet is based on two conditions: 1. The amount of glyphosate in foods I eat really is below tolerance 2. The calculated RfD is an accurate measurement of how much glyphosate it would take to put me at risk. Regarding this first assumption…
Slide 95	2016 FDA Pesticide Residue Monitoring Commodity / % of Samples with Glyphosate Residues / % of Samples Exceeding Glyphosate Tolerance Corn Soybeans Milk Eggs	In 2016, FDA sampled these 4 commodities; they focused on corn and soy due to RoundUp Ready crops, and milk and eggs because feed for cows and chickens often contains corn and/or soybeans. So, what did they find?
Slide 96	2016 FDA Pesticide Residue Monitoring Commodity / % of Samples with Glyphosate Residues / % of Samples Exceeding Glyphosate Tolerance Corn 63 Soybeans 67 Milk 0 Eggs 0	They found glyphosate residues in over 60% of both corn and soybean samples, but none in milk or eggs. And of the positive samples they did find,…
Slide 97	2016 FDA Pesticide Residue Monitoring Commodity / % of Samples with Glyphosate Residues / % of Samples Exceeding Glyphosate Tolerance Corn 63 0 Soybeans 67 0 Milk 0 0 Eggs 0 0	All were below tolerance. Unfortunately, the report I saw stopped here without providing actual residue levels found. But here are some other reasons why I'm confident that glyphosate residues are below tolerance.

Slide 98		Food Democracy Now! put out a report a couple of years ago about glyphosate in common grain-based foods.
Slide 99		And just this past August and October, the Environmental Working Group issued similar reports about glyphosate residues in oat-based cereals and granola bars. Both studies warned of extremely high residues. So, what did they find?
Slide 100		Out of 102 samples, over half had residues less than 1% of tolerance, and less than 1 in 10 exceeded 3% of tolerance. But the groups claimed the levels were extremely high because they believe the tolerances are set too high. Keep in mind that I only consumed 8% of my reference dose with a diet that contained 100% tolerance. These groups were finding at most an average of maybe 2% of tolerance. And I've seen some reports of residues in soybeans nearing 10%, and that's the highest I've seen. So, if my food actually averages anywhere from 2% to 10% of tolerance, that means I'd consume about 0.16% to 0.8% of my RfD each day. So, for a person like me who is supposed to consume roughly 3 pounds of food a day, this means I'd have to eat about…
Slide 101		And remember the RfD is 100 times lower than an exposure level that produced NOAEL. So, that sounds like a sales line for glyphosate, right? But…

Slide 102		…what do you think this really tells you? The correct answer is that the **known risk is low.** Here's my take on this is: while **there are data gaps,** what I've shown is **how incredibly conservative the regulatory process already is.** EPA knows there are things we don't know, so they base their risk assessments on worst case scenarios, such as all food having 100% of tolerance, applicators not wearing any PPE, assuming we are more sensitive to chemicals than test animals, etc. And as a result, large safety factors are built into the process. So even if we discover hazards we hadn't been aware of, there's a good chance our risk is still low because our exposure is so low. Does that make sense? And note the safety margin, or margin for error if you prefer, won't be the same for every pesticide. It's much slimmer for some. I'm just talking about glyphosate today. And in all cases, I support continued research and will help get the resulting information out to applicators and the general public.
Slide 103		With all these reports from IARC and Environmental Working Group and Food Democracy Now, and with the media largely unaware of the what I've shared with you today, people, even farmers, are asking about alternatives to glyphosate because of concerns about health and environmental effects. So, Andy Senesac, an Extension Weed Scientist with Cornell, helped put together a piece on alternatives to glyphosate for weed control in landscapes. I decided to compare them with respect to hazards to people and the environment, because that's what a pesticide safety educator should do, especially when concern about health and environmental safety is the reason people are looking for alternatives in the first place. I did this by looking at the labels of the sample products listed for each active ingredient discussed in the piece. For glyphosate, the sample product was RoundUp Pro®.

Slide 104		And here are the other active ingredients discussed by Andy and his co-author. For each, I looked at the product label to find the signal word (which indicates the level of acute toxicity), hazards by route of exposure, personal protective equipment needed, hazards to domestic and nontarget animals, and, when present, statements claiming the product is prone to contaminating ground- or surface water. In the next slide, a plus sign means the product label indicates there is a greater hazard or restriction than what's indicated on the glyphosate label, a minus sign indicates a lower hazard. A blank just means the labels indicate no difference between the active ingredient and glyphosate. And here's what the table looks like when it's filled in:
Slide 105		In every case, the alternative's label indicates more hazard than the Roundup label. Now, all these pesticides have their uses and every one of them meets the standard of posing no unreasonable risk to people and the environment when used according to label directions. But accidents happen. A hose can burst and spray you in the face. A farmer might make a turn to close to the edge of a field and have the spray tank tip over and spill into a drainage ditch. When things like that happen, which chemical would you want in the tank? Applicators think about these things, so when they choose a pesticide and if all other things are equal, they'll pick the one with the lowest hazard.
Slide 106		As a pesticide safety educator, my focus is on teaching people about pesticide hazards and how to mitigate risk when using pesticides. But I've noticed that hazard and risk are rarely discussed when it comes to nonchemical means of pest management. I assume you will be talking about about effectiveness, potential benefits, and cost of nonchemical alternatives, so I'd like to take a moment to talk just about hazard and risk in the forest setting because these are also important factors necessary for making informed decisions. I'm not making any qualitative judgments; rather, I just want to make you aware of factors you need to consider when weighing pest management options.
Slide 107		Grazing by domesticated livestock can be an option, but not a trouble-free one.

Slide 108		As with grazing, mulching could result in increased feeding damage on seedlings. The displacement and reduced longevity mean more worker entry into the terrain, increasing the risk of slips, trips, and falls.
Slide 109		Using brush rakes, hoes, or tillage exposes mineral soil…(continue reading slide)
Slide 110		Chainsaws can be used to control trees and shrubs, but they involve a lot of labor and repeat visits, since woody plants can resprout after being cut back. And chain oil and exhaust can be environmental hazards; back in the 90s, EPA concluded that annual use of a single chainsaw produced the sae amount of exhaust as driving a passenger car 9,000 miles. But the big issue is worker safety.
Slide 111		Hearing loss is a huge issue for forestry workers, with chainsaws being a leading factor.
Slide 112		And a study in NZ showed that chainsaws and slips, trips, and falls accounted for nearly half of all hospitalizations among forestry workers. And given the terrain in the Pacific Northwest, slips, trips, and falls while operating a chainsaw pose a risk that cannot be ignored.

Slide 113		I mentioned chainsaw exhaust before in terms of carbon footprint, being comparable to exhaust from a car driven 9,000 miles. What's not comparable is exposure to the exhaust: unlike the chainsaw operator, the person driving the car does not have their face 2 feet away from the tailpipe for 9,000 miles.
Slide 114		Here are some of the components in the chainsaw exhaust, given in mg/cubic meter at the saw. a Total hydrocarbons include benzene, PAH, and numerous other straight and branched chain compounds. b Polyaromatic hydrocarbons, including naphthalene and benzo(a)pyrene.
Slide 115		And note the level of benzene.
Slide 116		And IARC, the agency that listed glyphosate as a probably carcinogenic to humans, has also looked at gasoline engine exhaust and its components.
Slide 117		Read slide

Slide 118	Volume 120: Benzene, 2018 - "Benzene is carcinogenic to humans (Group 1)." - "Benzene causes acute myeloid leukemia in adults." - "Positive association has been found for NHL and a small minority of the Working Group considered that benzene causes NHL."	Read slide. So, going back to that report on chainsaw emissions from British Columbia, they said more research was needed on exposure to exhaust and that respirators were not a viable solution given the work conditions. Importantly, they expressed concern about policies that endorsed using manual brush control as a means of providing entry into the forestry labor pool, but their words are pertinent to policies about herbicide use as well. They said…
Slide 119	If manual brush control with power tools is to be used… the ethical and policy implications of the potential accompanying health risks must be given close attention. Such policy decisions are beyond the realm of scientific analysis, but must include an objective and thorough examination of the risks for each option.	Read slide.
Slide 120	Questions or Comments? Dan Wixted 607-255-7525 djw47@cornell.edu   **Fellow** American Association of Pesticide Safety Educators	

Sources for Wixted WSDA Aerial Herbicide Workgroup Presentation, 10/09/19

Slide 4: Parkinson's paper
https://ehp.niehs.nih.gov/doi/10.1289/ehp3713

Slide 6: Pollinator pesticide decision-making guides
https://pollinator.cals.cornell.edu/resources/grower-resources/

Slide 7: NPR on Roundup and bee deaths
https://www.npr.org/2018/09/25/651618685/study-roundup-weed-killer-could-be-linked-to-widespread-bee-deaths
https://www.pnas.org/content/115/41/10305

Slide 8: Notes from the Lab
http://blogs.cornell.edu/mcartlab/notes-from-the-lab/ (use link for January 2019 article)

Slides 25 – 31: IARC Monograph on Glyphosate
https://monographs.iarc.fr/wp-content/uploads/2018/07/mono112.pdf (language excerpts on slides 28-31 come from page number 10 [page 20 of 464 in the pdf])

Slides 32-34: NPR article featuring Aaron Blair
https://www.npr.org/sections/thesalt/2015/03/24/394912399/a-top-weedkiiller-probably-causes-cancer-should-we-be-scared

Slide 35: FAO/WHO on dietary risk
https://www.who.int/foodsafety/jmprsummary2016.pdf page 2

Slide 36: EPA 2016 Evaluation of Carcinogenic Potential
https://www.epa.gov/sites/production/files/2016-09/documents/glyphosate_issue_paper_evaluation_of_carcincogenic_potential.pdf (see top of page 140)

Slides 39-40: Corrected *Atlantic* article
https://www.theatlantic.com/science/archive/2018/08/glyphosate-breakfast-controversy/567784/

Slide 42: FIFRA Scientific Advisory Panel
https://www.epa.gov/sites/production/files/2017-03/documents/december_13-16_2016_final_report_03162017.pdf

Slides 43, 44, 48-51: NHL and glyphosate graphs
NHL incidence: https://seer.cancer.gov/statfacts/html/nhl.html (scroll down and click on "Trends in Rates)
Glyphosate use:
https://enveurope.springeropen.com/articles/10.1186/s12302-016-0070-0 then follow links to supplementary tables at https://enveurope.springeropen.com/articles/10.1186/s12302-016-0070-0#MOESM1 and click on the link for the xlsx document at the top of the page; usage data from 1974-2014 is in worksheet S18.
https://www.epa.gov/sites/production/files/2019-04/documents/glyphosate-response-comments-usage-benefits-final.pdf (start at page 13 of 31 for 2012-2016 estimates)

Slide 45: Smoking and lung cancer
I was given this slide by a colleague and cannot find the original source. Searched the terms "cancer smoking lag" in google and selected the images option. The picture comes up in numerous places including wikipedia https://en.wikipedia.org/wiki/Health_effects_of_tobacco.

Slide 46-47: NHL Epidemic and main drivers
https://www.nature.com/articles/1207843

Slide 52: NIH Ag Health Study
https://aghealth.nih.gov/

Slide 53: 2005 Ag Health Study paper
De Roos, A.J., Blair, A., Rusiecki, J.A., Hoppin, J.A., Svec, M., Dosemeci, M., Sandler, D.P., and Alavanja, M.C. (2005). Cancer Incidence among Glyphosate-Exposed Pesticide Applicators in the Agricultural Health Study. Environmental Health Perspectives, 113(1):49-54. At https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1253709/

Slide 54: 2017 Ag Health Study paper (published in 2018, but accepted in 2017)
Andreotti, G., Koutros, S., Hofmann, J.N., Sandler, D.P., Lubin, J.H., Lynch, C.F., Lerro, C.C., De Roos, A.J., Parks, C.G., Alavanja, M.C., Silverman, D.T., Beane Freeman, L.E. (2018). Glyphosate Use and Cancer Incidence in the Agricultural Health Study. JNCI, 110(5):509-516. Epub 2017 Nov 9. At https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6279255/
Statement that EPA referenced the second Ag Health Study and reaffirmed its conclusion that glyphosate is "not likely to be carcinogenic at doses relevant to human health risk assessment" are seen on pages 141 and pages 142-143, respectively, at https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=OPP&dirEntryId=337935 (click on link for "Revised Glyphosate Issue Paper: Evaluation of Carcinogenic Potential)

Slides 57-67: Health effects testing
https://www.epa.gov/test-guidelines-pesticides-and-toxic-substances/final-test-guidelines-pesticides-and-toxic provides links to all studies mentioned except breast milk

Slide 67: For breast milk study, go to https://regulations.gov and search for EPA-HQ-OPP-2009-0361-0085 to get a link for the pdf.

Slide 73-78: Reference dose
Page 22 in "Glyphosate: Human Health Assessment Scoping Document in Support of Registration Review" at https://www.regulations.gov/document?D=EPA-HQ-OPP-2009-0361-0006

Slides 92-93: Dan's glyphosate intake at 100% tolerance
To determine calorie needs: https://health.gov/dietaryguidelines/2015/guidelines/appendix-2/
Dietary guidelines: https://health.gov/dietaryguidelines/2015/guidelines/appendix-3/
Convert cups/ounces/grams of each food group to grams per cup/oz/g: http://nutritiondata.self.com
Divide by 1000 to get kg per cup/oz/g, then multiply by the number of cups etc to determine kg consumed of each food
Get glyphosate tolerance in mg/kg of each food at https://www.law.cornell.edu/cfr/text/40/180.364
(sometimes had to see what food group a particular food fell into, so went to https://www.law.cornell.edu/cfr/text/40/180.41 for that)
kg of a food consumed x mg/kg tolerance for that food = mg glyphosate consumed

Slides 95-97: FDA pesticide monitoring
https://www.fda.gov/food/pesticides/pesticide-residue-monitoring-2016-report-and-data

Slide 98: Food Democracy Now report
https://s3.amazonaws.com/media.fooddemocracynow.org/images/FDN_Glyphosate_FoodTesting_Report_p2016.pdf

Slide 99: Environmental Group, Breakfast with a dose of Roundup?
https://www.ewg.org/childrenshealth/glyphosateincereal/ and
https://cdn3.ewg.org/sites/default/files/u352/EWG_Glyphosate-2_Table_New_C01_0.pdf

Slide 100: FDN and EWG residues as % of tolerance
Links from slides 98 and 99 and link for tolerances (https://www.law.cornell.edu/cfr/text/40/180.364)

Slides 103-105: Table of alternatives to glyphosate
http://westchester.cce.cornell.edu/resources/glyphosate-alternatives-in-the-landscape lists the alternatives. Then researched each sample product label to compare to Glyphosate Pro label.

Slide 110 statement about amount of exhaust and Slides 113, 114, 115, 116, and 119:
https://www.for.gov.bc.ca/hfp/publications/00012/3-Dost-PowersawEmissions.pdf

Slide 111: Hearing loss
https://blogs.cdc.gov/niosh-science-blog/2018/05/24/noise-forestry/

Slide 112: Injuries to silvicultural workers
https://www.scopus.com/record/display.uri?eid=2-s2.0-0028780881&origin=inward&txGid=b09dbc090b5cab827a62537ef0adc101

Slide 117: IARC monograph on gasoline engine exhaust
https://publications.iarc.fr/129

Slide 118: IARC monograph on benzene:
http://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Benzene-2018