

# Following Pesticide Laws and Regulations to Reduce Pesticide Exposure

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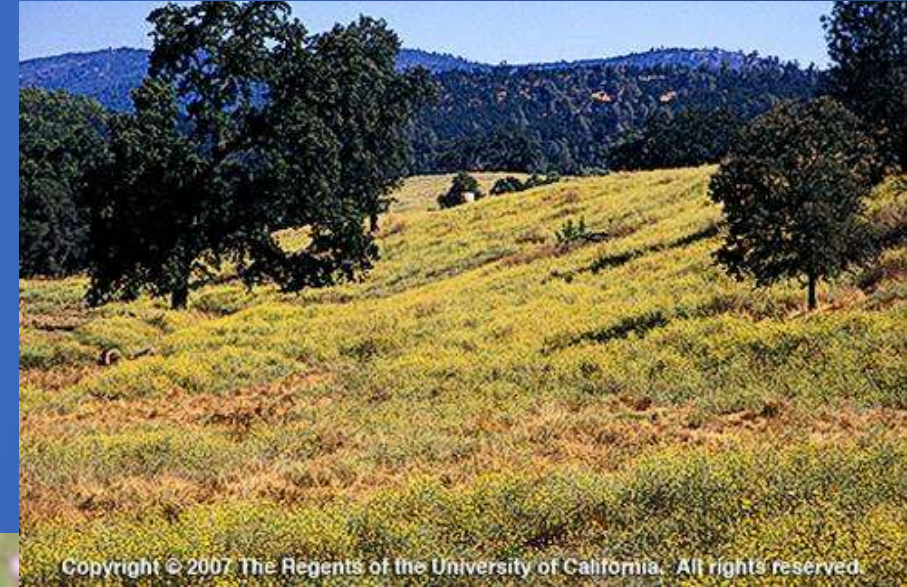
Natural Resources Advisor

Southern California

# Weeds are everywhere

We manage wildlands to:

- Reduce/eliminate effects of weed invasions
- Enhance plant communities
- Enhance wildlife populations
- Mitigate impacts of habitat loss



# So what can you do and what are you required to do

- First, read the label!
- “It is a violation of Federal law to use this product in a manner inconsistent with its labeling”
  - You have to follow all label instructions
- Every pesticide product has to have this statement on the label

# Labeling

- But how do you know what is “inconsistent” with the label?
- You have to read the label!
- You literally have to read it, its on the label!!

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## **Directions for Use**

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It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.



# Labeling

- “Read all directions for use carefully before applying”
- “Read the entire label before using this product”
- **And not just plain old reading, it says “carefully” or “the entire label”!**



# Some Important Herbicide Laws & Regulations

- Do not apply more than a total of XYZ fl oz per acre of Herbicide per year as a result of broadcast, spot or repeat applications
- Its very simple you cannot overapply herbicides
- Let's look at the Esplanade 200 SC label

Disclaimer: Mention of pesticide products is not a recommendation.

# Some Important Herbicide Laws & Regulations

- Do not exceed 7 fl oz per acre of Esplanade 200 SC in a single application for all Industrial Vegetation Management applications
- Do not exceed 10 fl oz per acre of Esplanade 200 SC for all Industrial Vegetation Management applications within a calendar year or in a 12-month period from the previous application
- You get one only 7 oz application and then one 3 oz application and no more for Espalanade for certain sites in a 12 month period
  - Some use sites only allow a 5 oz max single application
  - Again, read the label!

# Why do we not want to overapply herbicides?

- First and most important- Our goal is to be good stewards, good people and good neighbors
- We also want to use the right amount of herbicides for the job
  - Saves money, saves time, reduces chances of unintended damage
- If the label recommends a rate, then that rate will very often kill the weed
- You can't kill a weed twice!



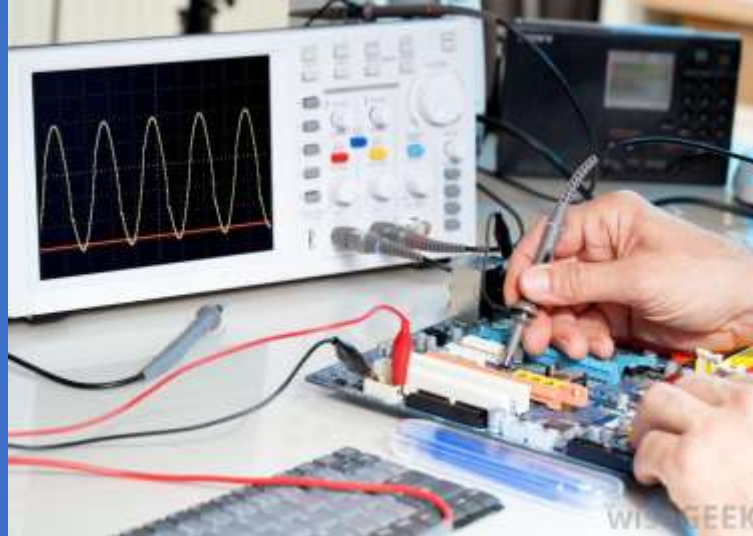


# Why do we not want to overapply herbicides?

- We have to calibrate our application to know how much herbicides we are applying to our site
- Calibrating our application will also reduce our exposure to herbicides

# Reduce Exposure By Calibrating

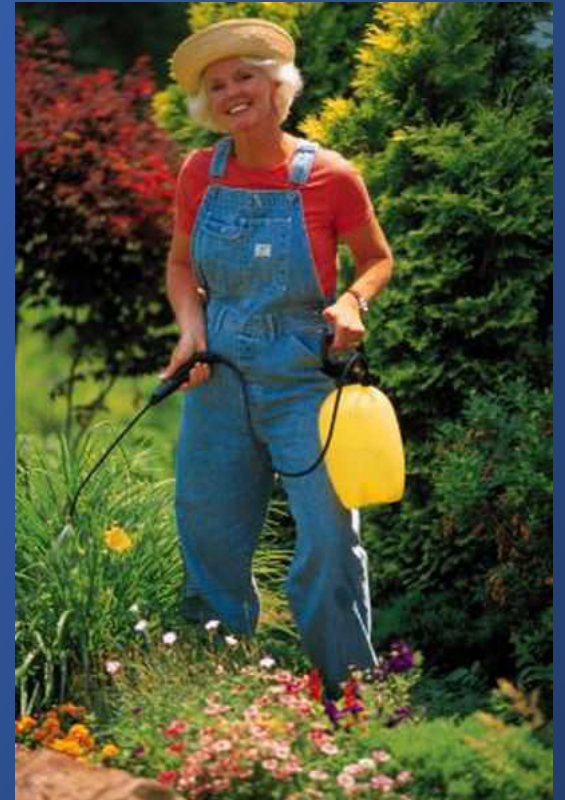
- What is calibrating?





# Reduce Exposure By Calibrating

- Do all herbicide applicators apply herbicides in the same way?



# Reduce Exposure By Calibrating

- Do all applicators spray herbicides in the same way?





# Reduce Exposure By Calibrating

- Do all applicators spray herbicides in the same way?

In our calibration workshops we find that applicators can vary in product application rates by ten fold!

For example, one person might apply at 10 gallons per acre another might apply at 100 gpa



# Reduce Exposure By Calibrating

- So should you fill everyone up with the same amount of herbicide?



Desired Volume	Amount of <b>Roundup PROMAX</b> herbicide					
	0.4%	0.7%	1.0%	1.5%	4%	7%
1 gal	0.5 oz	1 oz	1.3 oz	2 oz	5 oz	9 oz
25 gal	0.8 pt	0.7 qt	1 qt	1.5 qt	4 qt	7 qt
100 gal	1.6 qt	2.8 qt	1 gal	1.5 gal	4 gal	7 gal

2 tablespoons = 1 fluid ounce

For use in backpack, knapsack or pump-up sprayers, add the appropriate amount of this product, mixed with water in a larger container and then filling sprayer with the mixed solution.

# Reduce Exposure By Calibrating

- So should you fill everyone up with the same amount of herbicide?



# Reduce Exposure By Calibrating

- So if we all spray slightly differently and the label tells us we have to apply the same amount of herbicide per acre, then we have to fill up our tanks differently
- Adjust the amount of product to accurately apply the intended rate



# Reduce Exposure by Calibrating

- Rate= Amount of herbicide applied to an area
  - Amounts: ounces, pounds, gallons, grams, etc.
  - Area: acres, square feet



# Herbicide Rates

- Percent solution is not a rate (a percent of what?)

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100 gal	1.6 qt	2.8 qt	1 gal	1.5 gal	4 gal	7 gal
2 tablespoons = 1 fluid ounce						

For use in backpack, knapsack or pump-up sprayers, add the appropriate amount of this product, mixed with water in a larger container and then filling sprayer with the mixed solution.

**Table 1:** Amount of Milestone (in mL) to mix in 1 gallon of water

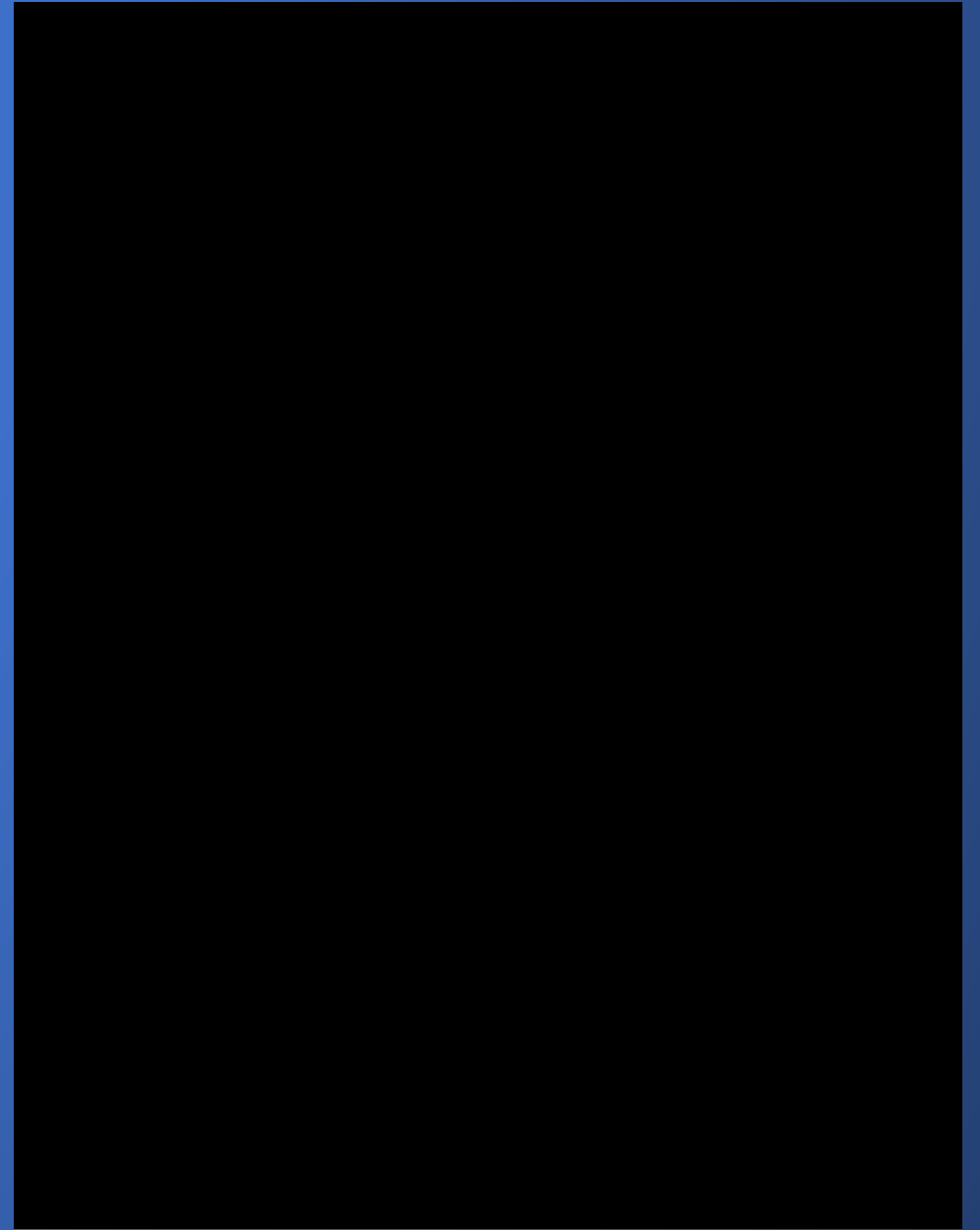
Gallons per acre	Milestone amount (in mL) to mix to achieve target application rates		
	5 fl oz/a	7 fl oz/a	14 fl oz/a
20	7.5	10.5	21.0
30	5.0	7.0	14.0
40	3.8	5.3	10.5
50	3.0	4.2	8.4
60	2.5	3.5	7.0
70	2.1	3.0	6.0
80	1.9	2.6	5.3
90	1.7	2.3	4.7
100	1.5	2.1	4.2

Use a syringe to  
measure cc

Note: Table 1 above shows mixes for various sprayer outputs in gallons per acre (GPA).

# How to Calibrate?

- Simplest way use the 128<sup>th</sup> Acre Method
- You can find this worksheet at the UC Weed Science Blog



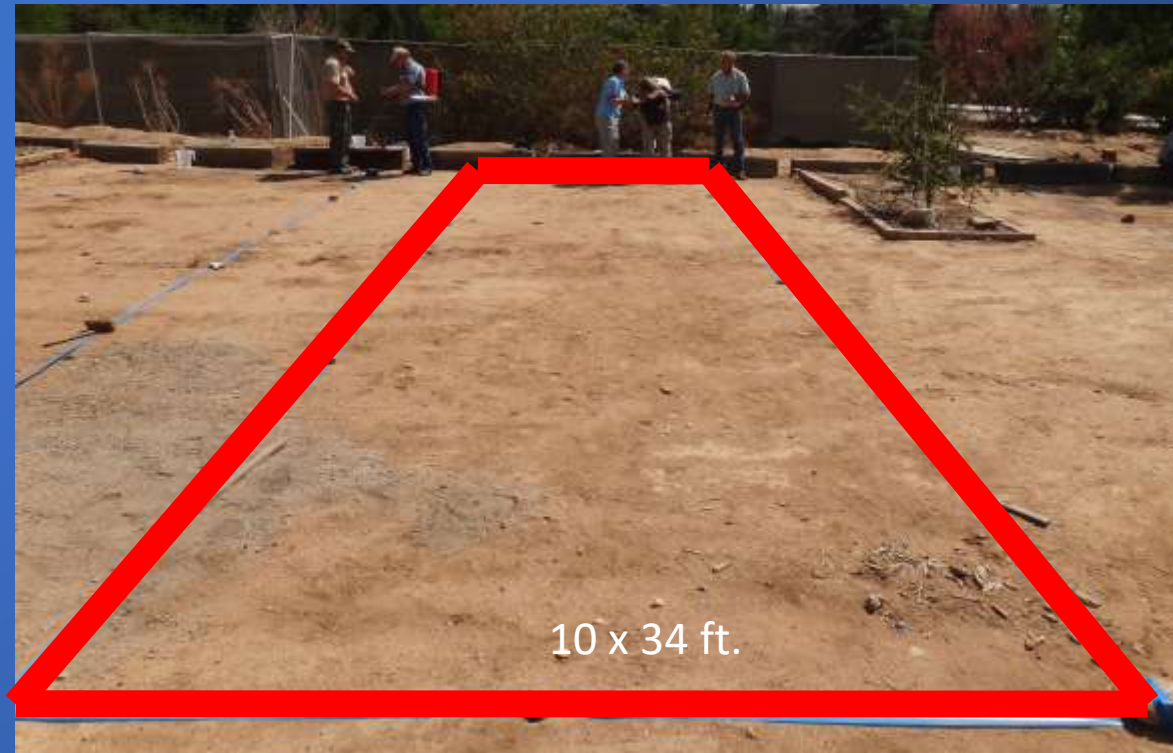
# 128<sup>th</sup> Acre Method

- 128 ounces per gallon
- You spray  $1 / 128^{\text{th}}$  acre
- Output of nozzle = Gallons per acre (GPA)



# 128<sup>th</sup> Acre Method

- Step 1: Measure out 128<sup>th</sup> acre (340 sq ft)
  - 18.5 x 18.5 ft (hypotenuse is 26 ft. 2 in.)
  - 10 x 34 ft
  - 13 x 26 ft
  - 15 x 22.5 ft



# 128<sup>th</sup> Acre Method

- Step 2: Spray entire 128<sup>th</sup> acre area while someone measures the time it takes to spray
  - Lets say it took 30 secs.

Applicator

Timer



# 128<sup>th</sup> Acre Method

- Step 3: Spray water into measuring bucket for same amount of time, then measure water in bucket  
30 seconds = 40 ozs = 40 GPA



# 128<sup>th</sup> Acre Method

- The rest of the worksheet will guide you through the next 4 steps:
- Adjustments to size of spray tank
- Amount of herbicide to apply from the label
- Acres your tank will cover (ac/tank)
- Ounces of herbicide to add per tank
- Fill Tank

The Milestone label is helpful and is one of the few labels with a GPA to ounces of herbicide conversation table

**Table 1: Amount of Milestone (in mL) to mix in 1 gallon of water**

Gallons per acre	Milestone amount (in mL) to mix to achieve target application rates		
	5 fl oz/a	7 fl oz/a	14 fl oz/a
20	7.5	10.5	21.0
30	5.0	7.0	14.0
40	3.8	5.3	10.5
50	3.0	4.2	8.4
60	2.5	3.5	7.0
70	2.1	3.0	6.0
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Use a syringe to measure cc

Note: Table 1 above shows mixes for various sprayer outputs in gallons per acre (GPA).



# Reduce Exposure By Calibrating

- Calibrating a few times a year will allow you to reduce your exposure by not overapplying herbicides
- Calibrate on a site similar to your typical application site



# Why do we want to reduce our exposure?

- Because using herbicides involves lots of scrutiny



# Hazard, Risk and Exposure

- To understand why we are allowed to spray herbicides and why there is a limit on how much herbicides we spray we need to understand hazard, risk and exposure
- Or another way, if herbicides are toxic why can we spray them?



[Newsofthenorthbay.com](http://Newsofthenorthbay.com)



[Madison.com](http://Madison.com)



# Hazards and Risk

- A hazard is a source of harm or danger





# Hazards and Risk

- A risk is the chance that something will actually cause you harm and the severity of that harm
- Risk = hazard and exposure



# Hazards and Risk

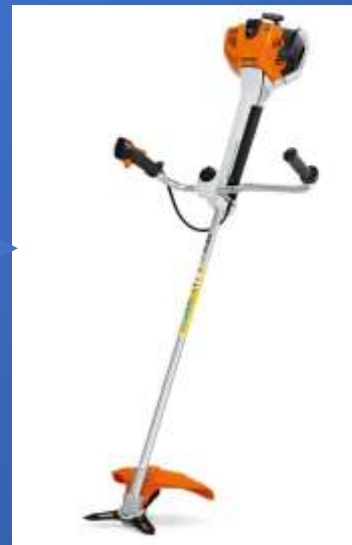
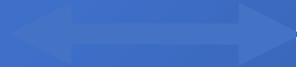
**PROPER  
PPE  
REQUIRED**

- Often we mitigate risk by reducing exposure or reducing hazard
- When spraying we wear PPE



# Hazard

- When using herbicides, hazard is the potential of that product to cause harm (humans, wildlife, environment, ...)
- We want weed management to be very toxic to our target species
- We want weed management to be benign to everything else
- We also have real world tradeoffs of hazards





# Exposure

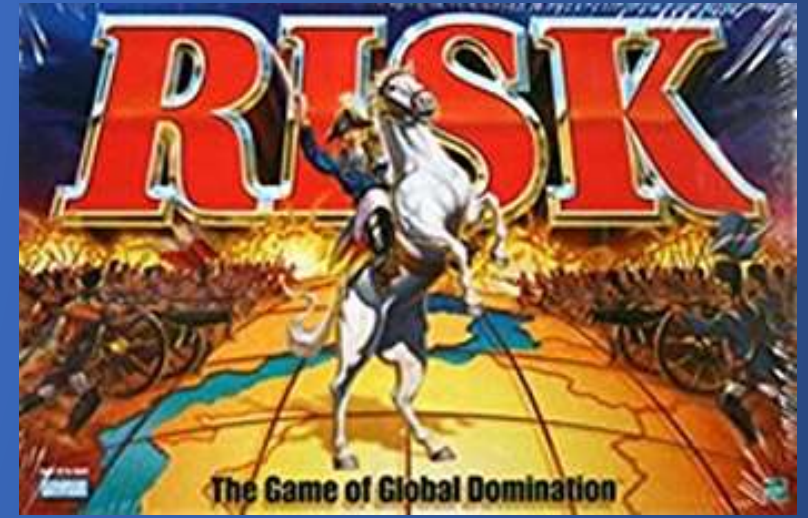
- Exposure is the amount of a product we encounter for a period of time
- Exposure = Dose and Time





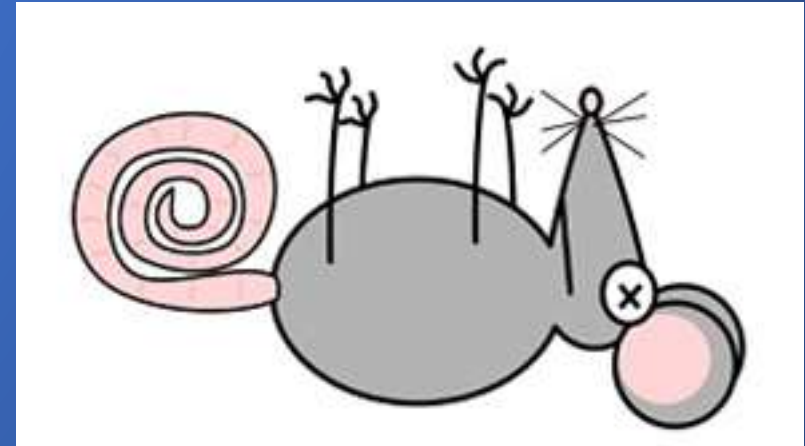
# Risk

- Risk = Hazard and Exposure
- Risk = Hazard (toxicity) and Exposure (dose and time)
- We can alter any of these three variables and change our risk
- There are multiple ways of being risky



# Short-term Risk

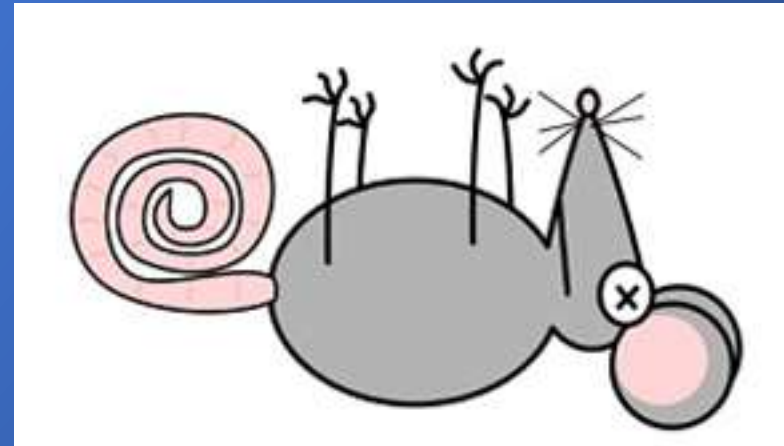
- Mitigate risk by avoiding or reducing hazard, dose and time
- Acute risk – short-term chance of danger
- A lethal dose (LD50) an easy way to measure acute risk
  - Feed product to animals in lab
  - Or measure accidental ingestions
- At what dose did 50% of animals die?



Teaspoon of sugar is 4 grams  
Can of soda ~360 grams

# Hazard, Risk and Cancer

- A lethal dose (LD50) is an easy way to measure acute risk
- Assume 70 kg person (~150 lbs.) approx. LD50=
  - Water = 6 liters
  - Vitamin C = 840 g
  - Glyphosate = 390 g
  - Table Salt = 210 g
  - Clove Oil = 180 g
  - Aspirin = 14 g
  - Caffeine = 11 g
  - Paraquat = 2.5 g
  - Cyanide = 0.4 g
  - Ricin = 0.00014 g
  - Polonium 210 = 0.0000007 g





# So my Coffee is going to Kill me?

- And it contains carcinogens, too!
- Acrylamide is found in coffee and cigarettes and is an IARC group 2A probable carcinogen





# Well, I'm not dead yet!

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- Caffeine LD50 (70 kg person) is 11 g ←this is the hazard
- How much is my exposure?
- There are about 95-165 mg of caffeine in a cup of coffee
- Assume high dose and convert to 0.165 g
- $11 \text{ g (LD50)} / 0.165 \text{ g per cup} = \text{about } 66 \text{ cups of coffee}$
- $= 4 \text{ gal of coffee or } 15 \text{ L (LD50 water is } 6 \text{ L)}$

# Well I'm not dead yet!

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- $11\text{g}/0.165\text{g per cup} = \text{about } 66 \text{ cups of coffee}$
- If you drink a few cups a day you will live!
- But why?

# Well I'm not dead yet!

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- $11\text{g}/0.165\text{mg}$  per cup = 66 cups of coffee
- If you drink a cup a day how are you still alive?
- Drink only a few cups a day (Time!)
- Coffee has low persistence in body
- Acute risks are short term, they dissipate quickly

# Herbicides and Acute Risks

LD50 (oral)		70 kg person
• Glyphosate	>5000 mg/kg	350 g
• Fluazifop	>2720 mg/kg	169 g
• 2,4-D	699 mg/kg	49 g
• Aminopyralid	>5000 mg/kg	350 g
• Triclopyr	712 mg/kg	50 g
• Chlorsulfuron	5545 mg/kg	388 g
• Imazapyr	>2000 mg/kg	140 g
• Paraquat	50 mg/kg	3.5 g

1000 mg/kg is  
the equivalent of  
70 g in a 70 kg  
person



# Herbicides and Acute Risks

LD50 (oral)		70 kg person
• Glyphosate	>5000 mg/kg	350 g

The probability of an herbicide applicator ingesting hundreds of grams of product in a short time period is relatively low.

# Herbicides and Acute Risks

LD50 (oral)

70 kg person

• Glyphosate >5000 mg/kg

350 g

The probability of an herbicide applicator  
of product in a short time period is relative

If our acute risks are low why all this?

Herbicide Handbook 10<sup>th</sup> ed.



# Chronic Risks

- Mitigate risk by avoiding or reducing hazard
- Chronic hazard – long-term danger (opposite of acute)
- More difficult to measure, tends to be in odds or ratios

Percentage of:

- Smokers who have cancer
- Coal miners with black lung disease
- Rock n roll musicians with hearing loss



# Hazard Risk and Cancer

- Risk of cancer is difficult to measure
- Background rate of cancer is not zero
- Need large sample sizes, long-time frames, find mechanism, ...
  - Some people are unlucky and are unfortunately going to get some cancers
  - ~20% of lung cancer cases are from non-smokers, non-tobacco users
    - ~6% of Americans develop lung cancer
- People who take risks may not get cancer
  - Smokers are 18 to 110 times more likely to get different types of lung cancer
  - Not all smokers get lung cancer



Warner Bros.



# IARC



- International Agency for Research on Cancer
- Part of World Health Organization (WHO)
- Mission to promote international collaboration on cancer research
- “Identify the causes of cancer so that preventative measures may be adopted...”
- Publish findings in monographs (long detailed studies)
- In general, they attempt to determine if a chemical can cause cancer

# IARC

- In 2015 IARC listed glyphosate as Group2A 'Probably Carcinogenic'
- "There is *limited evidence* in humans for the carcinogenicity of glyphosate."
- There is *sufficient evidence* in experimental animals for the carcinogenicity of glyphosate."

# IARC

- 5 categories on based strength of evidence of cancer
- Group 1 : The agent is carcinogenic
  - There is sufficient evidence of carcinogenicity in humans
- Group 2A: The agent is probably carcinogenic to humans
  - There is limited evidence of carcinogenicity in humans, and sufficient evidence in experimental animals
- Group 2B: The agent is possibly carcinogenic to humans
  - There is limited evidence of carcinogenicity in humans, and less than sufficient evidence in experimental animals
- Group 3: The agent is not classifiable in carcinogenicity
- Group 4: The agent is probably not carcinogenic to humans

# IARC

- Evaluates the strength of evidence that an agent causes cancer or not
- There is some consideration of the dose of the agent
- Toxicity of the agent is not the basis for determination
  - Low toxicity and high toxicity products can both be carcinogens
- In short, they ask: **Can** it give you cancer?
- They do not prioritize, **Will** it give you cancer? **How much** cancer does it cause? **Under what circumstances** could it give you cancer?
- Regulatory agencies ask the latter questions (EPA, EFSA BfR)



# What did others find?



- FAO/WHO JMPR– “The Meeting concluded that glyphosate is not carcinogenic in rats but could not exclude the possibility that it is carcinogenic in mice at very high doses.”

- What were the very high doses?
- 814–4348 mg/kg bw per day



# What did others find?

- FAO/WHO JMPR
- “In view of the absence of carcinogenic potential in rodents at human-relevant doses and the absence of genotoxicity by the oral route in mammals, and considering the epidemiological evidence from occupational exposures, the Meeting concluded that glyphosate is unlikely to pose a carcinogenic risk to humans from exposure through the diet.”

# Remember Risk?

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- IARC suggests glyphosate might cause cancer
- JMPR is also saying glyphosate might cause cancer, in mice at high doses, and not rats, and is unlikely to cause cancer from exposure through the diet
- They are similar statements and also different

# How do we relate this to our work

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- We can analyze the areas we take on risk and try to reduce it
- Many of our regulations in CA also require us to reduce risk





# Reduce Toxicity

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- Choose low toxicity method that is effective and efficient
- Can choose herbicides with lowest signal word (Caution, then Warning and last Danger) to reduce acute hazard
  - Very few cases where wildland weeds would need to be treated with a danger labeled product
- Products are not usually labeled with chronic risk warnings (SDS, prop. 65 list, will have some info)

# Reduce Exposure

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- We can apply the correct amount of herbicides to a site
  - By Calibrating!
- Never apply more than the label rate of a pesticide
- How else do you reduce exposure?

# Why Do We Have PPE Regulations?

- Wear PPE!
- PPE protects us from being exposed, reduces our dose
- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- We have evidence to support this link

# Why Do We Have PPE Regulations?

- Acquavella et al. 2004
  - Study of 48 farmers their spouses and their 79 children, measured glyphosate in urine samples
  - Urine measurements were day before, day of and 3 days after glyphosate application to crops
  - Tractor and boom sprayer, PPE was not up to current CA standards.





# Wear Your PPE!

- **Results**

- 60% of farmers had detectible levels of glyphosate in their urine on the day of application, 40% had levels too low to detect
- Farmers in Minnesota had lower levels of glyphosate exposure than South Carolina
- Wearing rubber gloves when mixing reduced exposure
- Size of area treated did not affect exposure
- More loads/tanks increased glyphosate exposure
- Open tractor cab had higher glyphosate exposure than closed cab

# Wear Your PPE!

- **More Results**
- Farmers who spilled during mixing had higher exposure
- Farmers who spilled during application had higher exposure
- Farmers with observed skin contact with glyphosate had higher exposure
- When they repaired equipment during application had higher exposure (close to significant  $p=0.06$ )

# What Were Farmer's Exposure Rates?

- Farmers on average were exposed to 0.004 mg/kg bw
- If they weighed 70 kg (~155 lbs) exposure is  
 $70 \times 0.004 = 0.28 \text{ mg glyphosate}$
- CA No Significant Risk Level = 1.1 mg/day,
- Acquavella's farmers had less exposure than CA NSRL
- "The Proposition 65 no-significant-risk value is one excess case of cancer per 100,000 people exposed" CA OEHHA

# Exposure Studies

- Agricultural setting with glyphosate (EPA 2016 p. 18)
- “Assuming no personal protective equipment (PPE), exposure estimates for mixer/loaders range from 0.03-7 mg/kg/day using the maximum application rate for high acreage agricultural crops (6 lb ai/acre)”
- “For applicators, exposure would be lower with estimates ranging from 0.02-0.03 mg/kg/day using the same application rate and acreage”
- For a 70 kg applicator or loader this is 1.4 – 490 mg/day
- Higher than CA No Significant Risk Level 1.1 mg/day



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# Exposure Studies

- USFS Glyphosate Human Health and Ecological Risk Assessment (Durkin 2011, 2010)
  - Worker exposure section
- Estimate of worker exposure backpack applied foliar directed spray
- Glyphosate = 0.003 mg/kg bw per lb applied
- 70 kg applicator exposed to 0.21 mg/lb applied
- CA No Significant Risk Level 1.1 mg/day

# PPE Design

- If you want to be exposed to less herbicides, you should wear your PPE so that you reduce skin exposure to herbicides
- You can wear more PPE to reduce your exposure
- Cotton gloves or other absorbent material can be worn under your chemical resistant gloves
- If you want to be exposed to less herbicides
- Create a system that reduces spills while mixing, loading and applying herbicides, use appropriate mixing cups, reduce splashes

# What are our regulations?

- Mixers, loaders, applicators, and anyone entering the treatment area must wear PPE
- In CA minimum PPE is: closed toed shoes, long pants, long sleeve shirt, chemical resistant gloves, protective eyewear
- Optional, unless violates label: face shield, goggles, coveralls, chemical resistant boots, dust mask, respirator, disposable head hood, apron (usually mixing/loading but required for warning/danger products)





# What are our regulations?

- You must work with equipment that is in good working condition
- You should have no leaks in sprayer
- Before you spray fill up spray with water (add food dye if necessary) check for leaks, sound seals and o-rings,
- Also check hoses, nozzles, screens in nozzles
- Farmers who spilled or repaired equipment had higher exposure levels!



# Reduce Exposure by Reducing Time

- Risk = Hazard (Toxicity) and Exposure (Dose and Time)
- When PPE becomes contaminated or dirty, you must either dispose of it or wash it.
- “The DuPont™ Tychem® Apron is resistant to over 42 different chemicals for at least 30 minutes.”
- Do not store or transport contaminated PPE in the cab of a vehicle
- You want to reduce the amount of time you are in contact with the product

# Reduce Exposure by Reducing Time

- **Risk** = Hazard (Toxicity) and **Exposure (Dose and Time)**
- CA Regulations and Label often state:
- Wash hands before eating, drinking, using the toilet, chewing gum, or using tobacco;
- Thoroughly wash or shower with soap and water;
- Change into clean clothes as soon as possible; and
- Wash work clothes separately from other laundry before wearing them again.

# Reduce Exposure by Reducing Time

## **USER SAFETY RECOMMENDATIONS:**

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if the product gets inside. Wash thoroughly and put on clean clothing.
- Remove PPE after handling this product.
- Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothes.



# Reduce Exposure by Reducing Time

- Remove PPE after handling this product.
- Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothes.

- Are all of these immediately practical for wildland applicators?



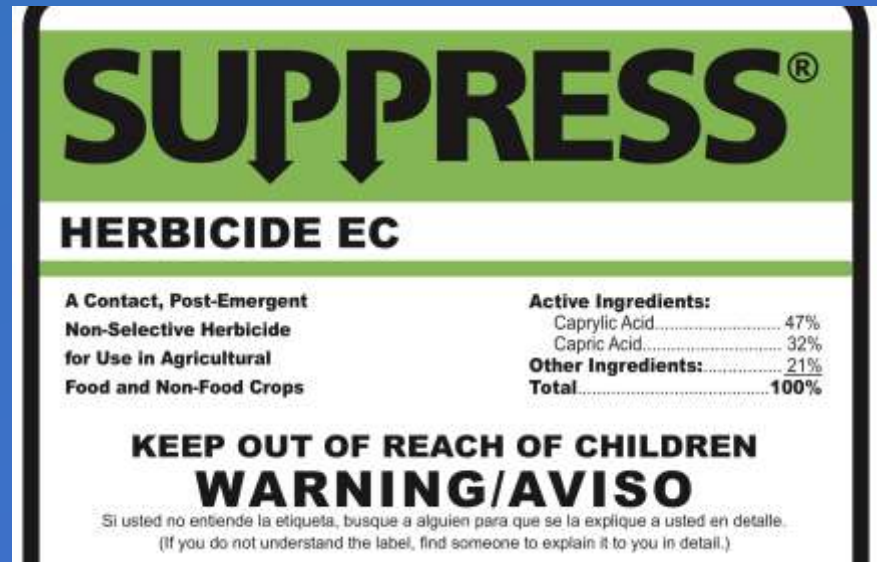
# Reduce Exposure by Reducing Time

- Remove PPE after handling this product.
- Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothes.

- Are all of these immediately practical for wildland applicators?
- You can keep an extra pair of clean clothes in your truck
- You can keep water jugs in your truck cab to rinse face, arms, neck at the end of the day



- Employees should wear coveralls whenever they handle pesticides with the signal word "DANGER" or "WARNING"
- Some labels have this warning



PERSONAL PROTECTIVE EQUIPMENT (PPE)
<p>Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for Category C on an EPA chemical-resistance selection chart.</p> <p><b><u>Applicators and other handlers must wear:</u></b></p> <ul style="list-style-type: none"> <li>• Protective eyewear</li> <li>• Coveralls worn over short-sleeved shirt and short pants</li> <li>• Shoes plus socks</li> <li>• Chemical resistant gloves such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, polyvinyl chloride or viton</li> </ul> <p>Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE items separately from other laundry.</p>



# Don't do it wrong



In one South African study workers conducted chemical control of invasive vegetation

“Interestingly, teams comprised of mostly women had the highest compliance rate” (for wearing appropriate PPE)



# Reducing Exposure by Reducing Drift

- Labels are very specific as to drift statement
- We cannot spray when wind is over 10 mph
- How do you measure the wind?
- Anemometer



# Reduce Exposure by Reducing Drift

- Don't walk into drift
- Spray with the wind when possible
- Spray to your side when spot spraying
- Spray at low pressures

Don't be this guy



# Reduce Exposure by Reducing Drift

- Don't walk into drift
- Spray into the wind when possible
- Spray to your side when spot spraying
- Spray at low pressures

Spray next to where you walk  
Be this guy



# Summary

- Different herbicides have a higher or lower toxicity profile
  - Read the label, read the SDS too!
- Wildland applicators can have a relatively low exposure
- PPE can reduce exposure and increase safety margins
  - But specific occupational exposure levels may not be available for each herbicide
- CA's additionally strict regulations regarding PPE reduce exposure and by using careful mixing, loading and application methods you can reduce your exposure level even further