

Glyphosate and Communicating Risk

Kaci Buhl, MS



Jurors give \$289 million to a man they say got cancer from Monsanto's Roundup weedkiller



By **Holly Yan**, CNN

Updated 9:28 PM ET, Sat August 11, 2018



Judge reads final verdict in Monsanto case 01:32

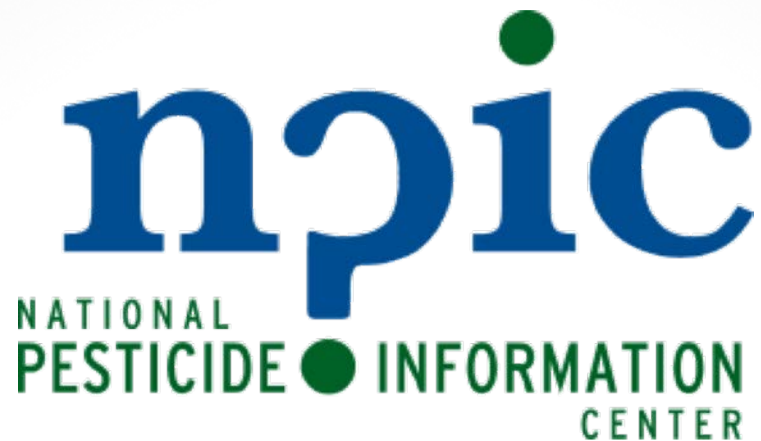
More from CNN



Reality star Lyric McHenry dies at 26



Camping for the first time in Airstream's tiny new luxury trailer



1.800.858.7378

npic@ace.orst.edu

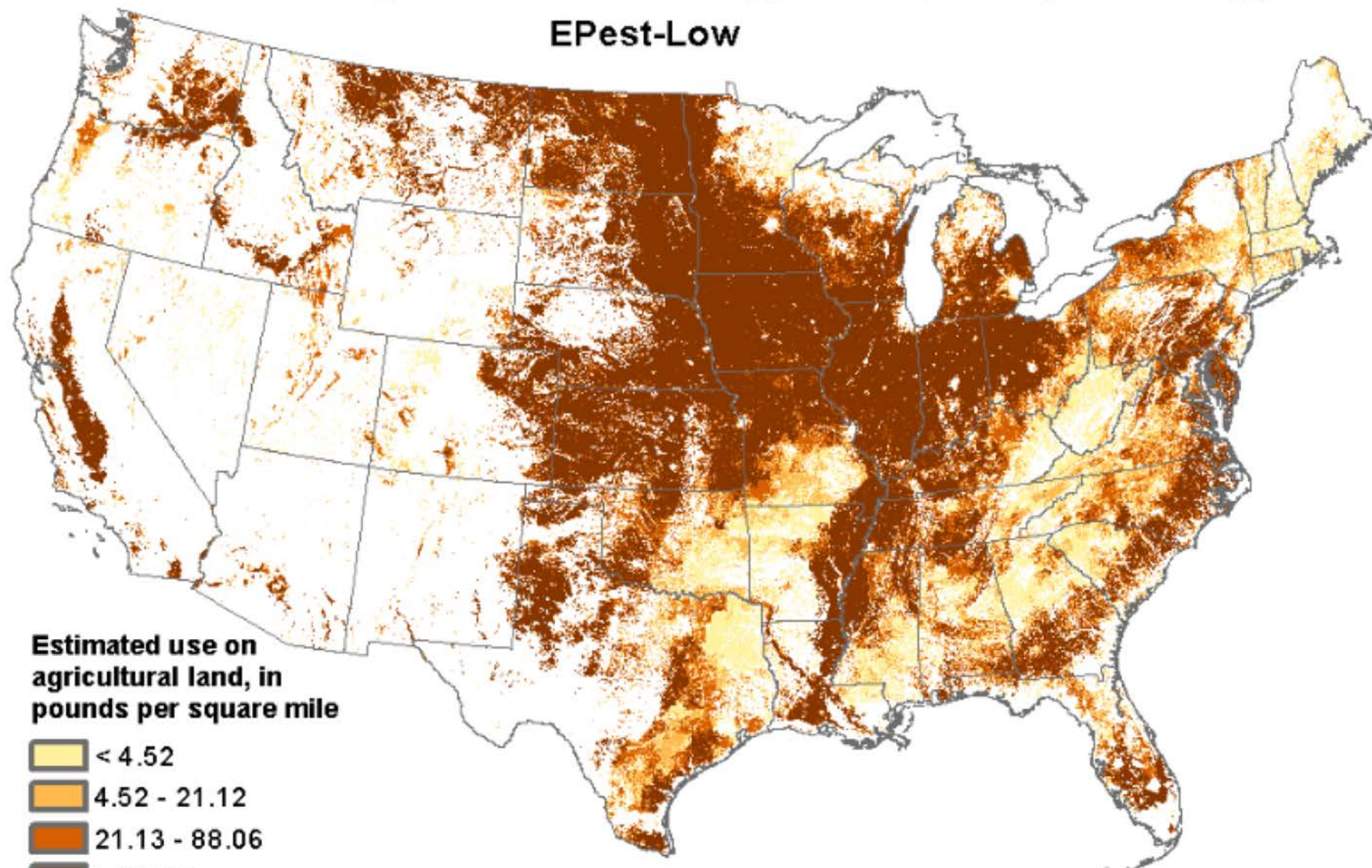
Environmental & Molecular Toxicology



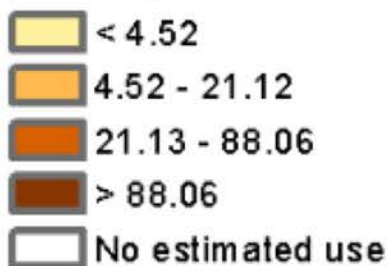


Estimated Agricultural Use for Glyphosate , 2015 (Preliminary)

E Pest-Low



**Estimated use on
agricultural land, in
pounds per square mile**



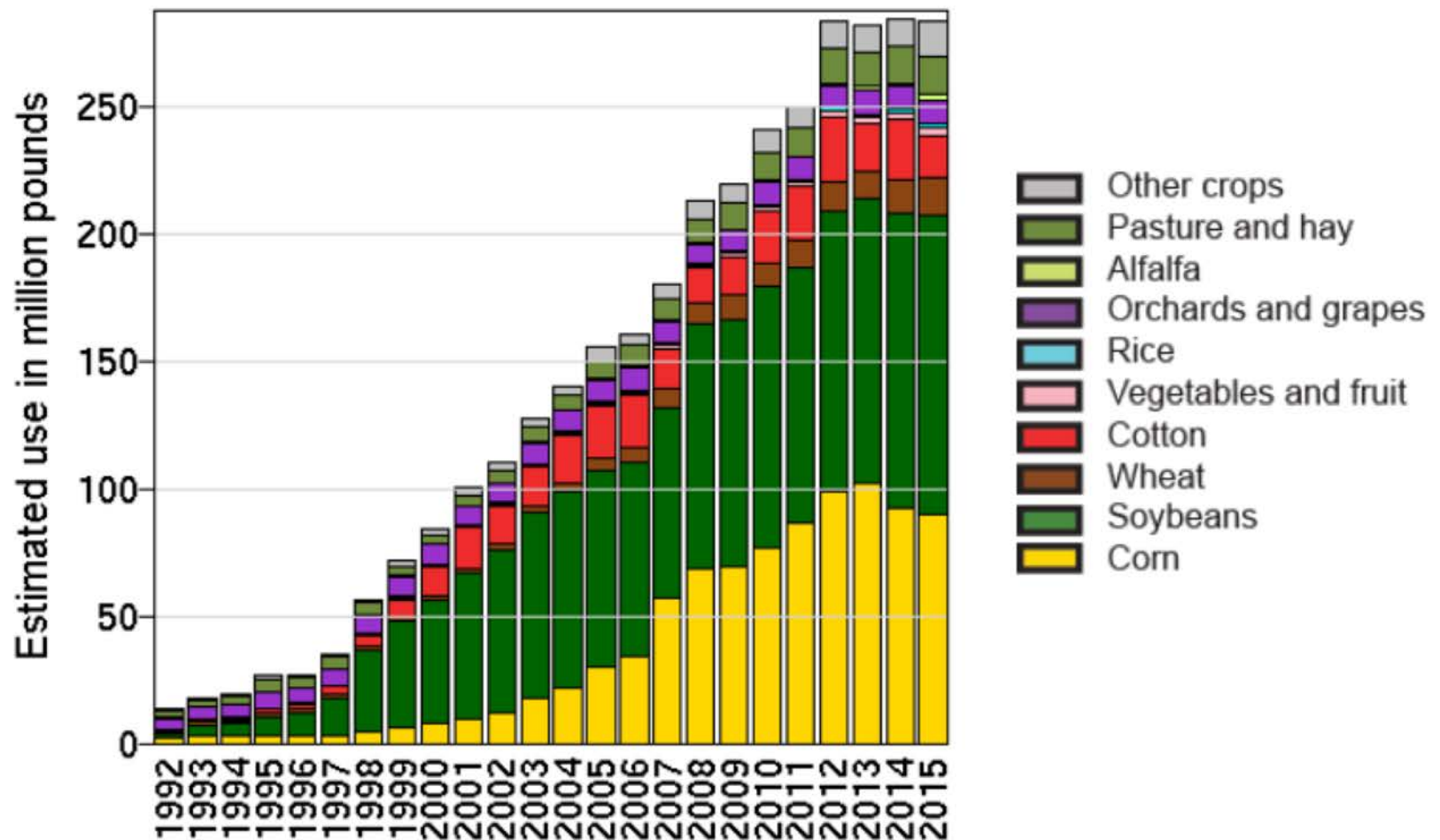
[U.S. Department of the Interior](http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map) | [U.S. Geological Survey](http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map)

URL: http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.

Page Contact Information: gs-w_nawqa_whq@usgs.gov

Page Last Modified: January 17 2017 09:55:22.

Use by Year and Crop



[U.S. Department of the Interior | U.S. Geological Survey](http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2012)

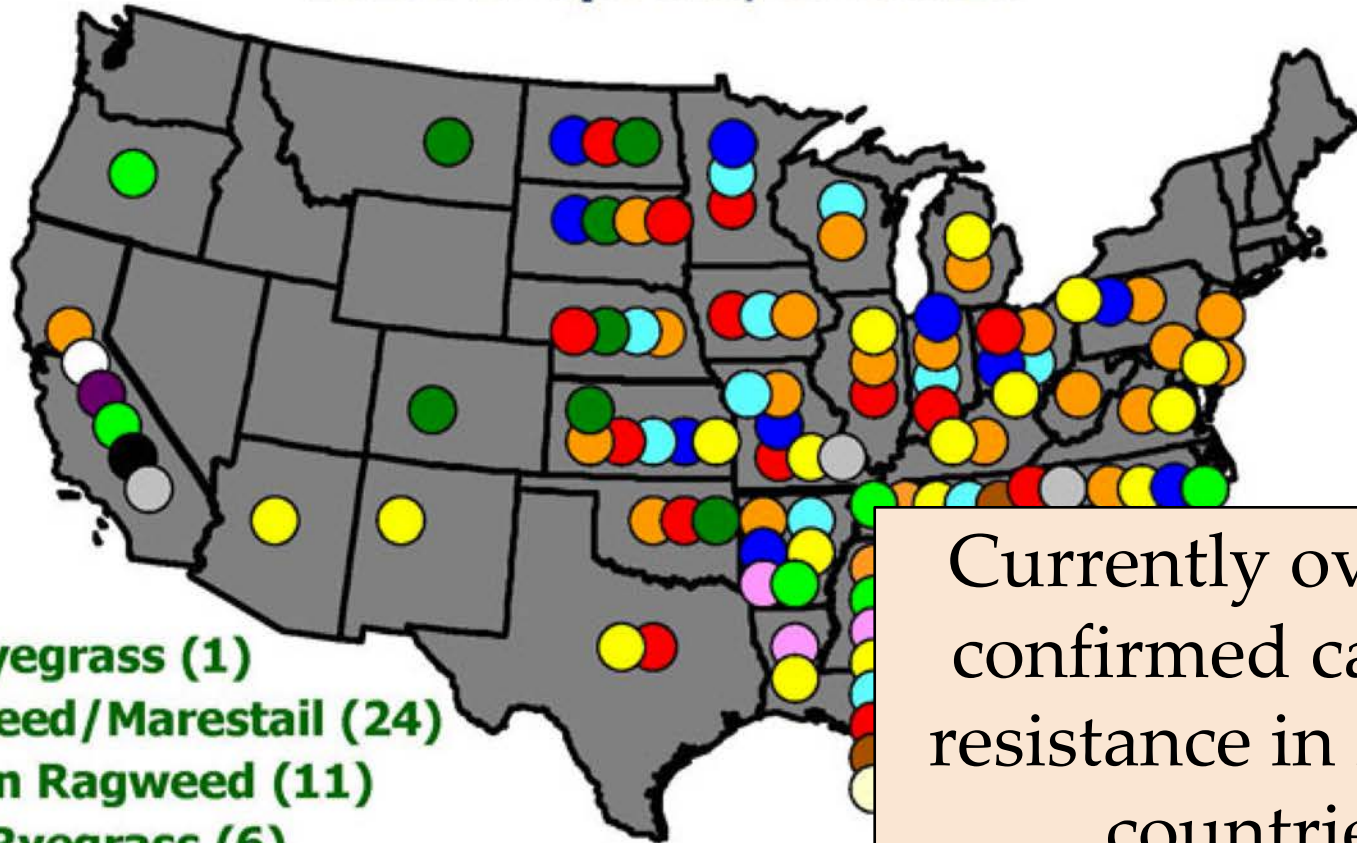
URL: http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=2012

Page Contact Information: gs-w_nawqa_whq@usgs.gov

Page Last Modified: March 18 2015 13:44:16.

Glyphosate-resistant Weed Development in the U.S.

2013: 14 species; 35 states



Currently over 300 confirmed cases of resistance in several countries

- Rigid Ryegrass (1)
- Horseweed/Marestail (24)
- Common Ragweed (11)
- Italian Ryegrass (6)
- Giant Ragweed (11)
- Waterhemp (14)
- Palmer Amaranth (19)
- Hairy Fleabane (1)
- Johnsongrass (3)
- Kochia (7)
- Junglerice (1)
- Annual Bluegrass (3)
- Goosegrass (2)
- Spiny Amaranth (1)

©Dr. Kevin Bradley, University of Missouri



RISK PERCEPTION IT'S PERSONAL

.....

**In the face of contradictory information, people must rely on their
instincts as much as the facts to size up potential threats.** © Corbis

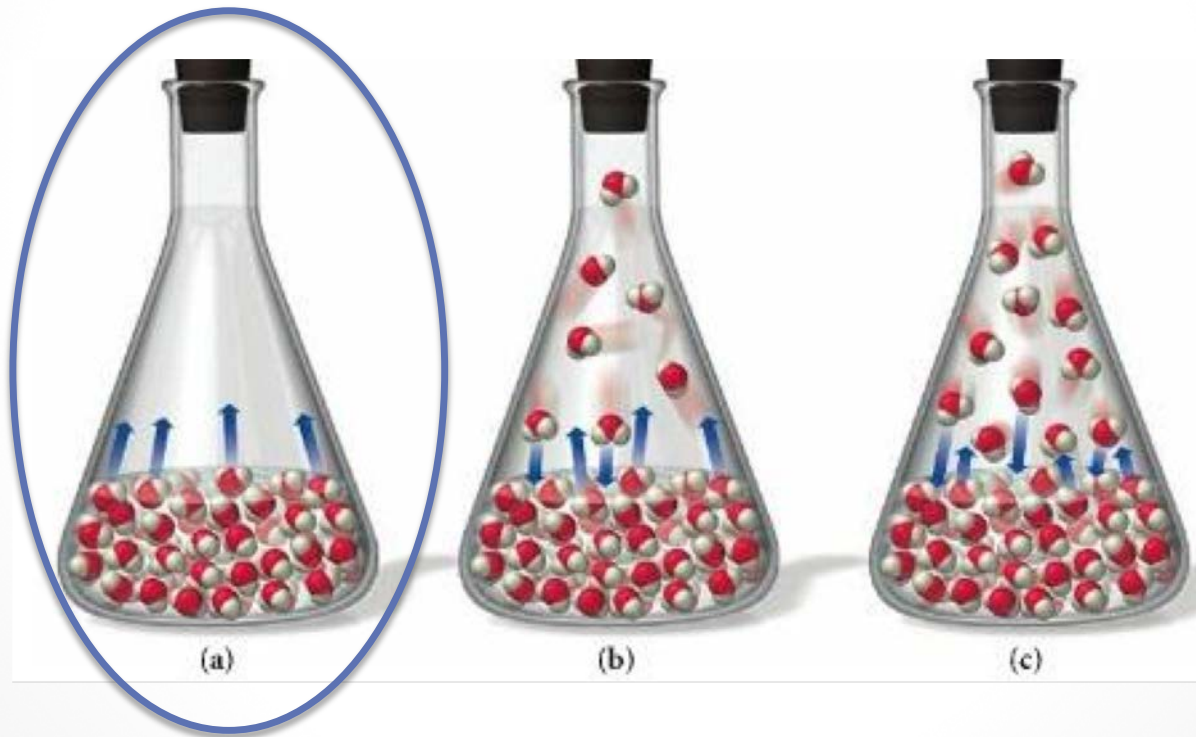
Glyphosate sticks to soil strongly.



Many products registered for application to aquatic areas.

Does glyphosate become vaporous?

No.



TOXICITY CLASSIFICATION - GLYPHOSATE

	High Toxicity	Moderate Toxicity	Low Toxicity	Very Low Toxicity
Acute Oral LD₅₀	Up to and including 50 mg/kg (≤ 50 mg/kg)	Greater than 50 through 500 mg/kg (>50-500 mg/kg)	Greater than 500 through 5000 mg/kg (>500-5000 mg/kg)	Greater than 5000 mg/kg (>5000 mg/kg)
Inhalation LC₅₀	Up to and including 0.05 mg/L (≤0.05 mg/L)	Greater than 0.05 through 0.5 mg/L (>0.05-0.5 mg/L)	Greater than 0.5 through 2.0 mg/L (>0.5-2.0 mg/L)	Greater than 2.0 mg/L (>2.0 mg/L)
Dermal LD₅₀	Up to and including 200 mg/kg (≤200 mg/kg)	Greater than 200 through 2000 mg/kg (>200-2000 mg/kg)	Greater than 2000 through 5000 mg/kg (>2000-5000 mg/kg)	Greater than 5000 mg/kg (>5000 mg/kg)
Primary Eye Irritation	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8 - 21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or erythema)

The highlighted boxes reflect the values in the "Acute Toxicity" section of this fact sheet. Modeled after the U.S. Environmental Protection Agency, Office of Pesticide Programs, Label Review Manual, Chapter 7: Precautionary Labeling. <http://www.epa.gov/oppfead1/labeling/lrm/chap-07.pdf>

- When swallowed, about 1/3 of glyphosate is absorbed.
- About 2% of glyphosate is absorbed through skin.



Cancer

- Animal studies have mixed results, but mostly negative.
- A long-term study with over 50,000 applicators found no association with overall cancer rates or most subtypes.
- Epidemiological data show a suggested association with Non-Hodgkins Lymphoma (NHL).
- EPA classification: “Evidence of non-carcinogenicity”
- IARC classification: “Probable carcinogen”

“Odds Ratios”

4 cancers in the population

WITH exposure

$$4/4 = 1$$

4 cancers in the population

with NO exposure

5 cancers in the population

WITH exposure

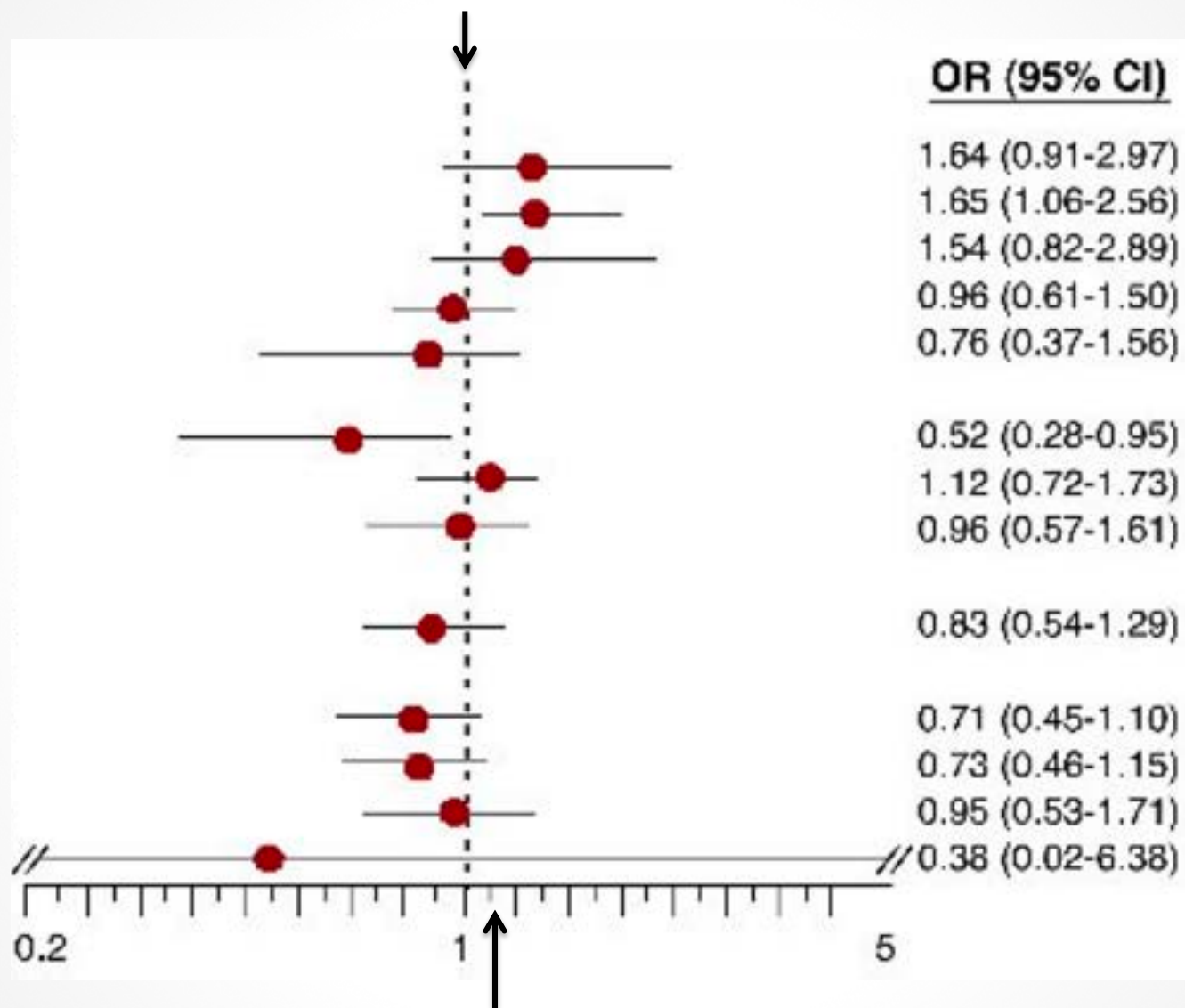
$$5/4 = 1.25$$

4 cancers in the population

with NO exposure

*25% higher risk of
cancer with exposure*

$$4/4 = 1$$



$$5/4 = 1.25$$

Table 2.2 Case-control studies of leukaemia and lymphoma and exposure to glyphosate

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
USA						
Brown et al. (1990) Iowa and Minnesota, USA 1981–1983	Cases: 578 (340 living, 238 deceased) (response rate, 86%); cancer registry or hospital records Controls: 1245 (820 living, 425 deceased) (response rate, 77–79%); random-digit dialling for those aged < 65 years and Medicare for those aged ≥ 65 years Exposure assessment method: questionnaire	Leukaemia	Any glyphosate	15	0.9 (0.5–1.6)	Age, vital status, state, tobacco use, family history lymphopoietic cancer, high-risk occupations, high risk exposures
Cantor et al. (1992) Iowa and Minnesota, USA 1980–1982	Cases: 622 (response rate, 89.0%); Iowa health registry records and Minnesota hospital and pathology records Controls: 1245 (response rate, 76–79%); population-based; no cancer of the lympho-haematopoietic system; frequency-matched to cases by age (5-year group), vital status, state. Random-digit dialling (aged < 65 years); Medicare records (aged ≥ 65 years); state death certificate files (deceased subjects) Exposure assessment method: questionnaire; in-person interview	NHL	Ever handled glyphosate	26	1.1 (0.7–1.9)	Age, vital status, state, smoking status, family history lymphopoietic cancer, high-risk occupations, high-risk exposures

(0.7 – 1.9)



Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Brown et al. (1993) Iowa, USA 1981–1984	Cases: 173 (response rate, 84%); Iowa health registry Controls: 650 (response rate, 78%); Random-digit dialling (aged < 65 years) and Medicare (aged > 65 years) Exposure assessment method: questionnaire	Multiple myeloma	Any glyphosate	11	1.7 (0.8–3.6)	Age, vital status
De Roos et al. (2003) Nebraska, Iowa, Minnesota, Kansas, USA 1979–1986	Cases: 650 (response rate, 74.7%); cancer registries and hospital records Controls: 1933 (response rate, 75.2%); random-digit dialling, Medicare, state mortality files Exposure assessment method: questionnaire; interview (direct or next-of-kin)	NHL	Any glyphosate exposure	36	2.1 (1.1–4)	Age, study area, other pesticides



(1.1 – 4)

Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Lee et al. (2004a) Iowa, Minnesota and Nebraska, USA 1980–1986	Cases: 872 (response rate, NR); diagnosed with NHL from 1980 to 1986 Controls: 2381 (response rate, NR); frequency-matched controls Exposure assessment method: questionnaire; information on use of pesticides and history of asthma was based on interviews	NHL	Exposed to glyphosate – non-asthmatics	53	1.4 (0.98–2.1)	Age, vital status,
			Exposed to glyphosate – asthmatics	6	1.2 (0.4–3.3)	
Canada						
McDuffie et al. (2001) Canada 1991–1994	Cases: 517 (response rate, 67.1%), from cancer registries and hospitals Controls: 1506 (response rate, 48%); random sample from health insurance and voting records Exposure assessment method: questionnaire, some administered by telephone, some by post	NHL	Exposed to glyphosate	51	1.2 (0.83–1.74)	Age, province of residence
			Unexposed	464	1	
			> 0 and ≤ 2 days	28	1.0 (0.63–1.57)	
		> 2 days	23	2.12 (1.2–3.73)		

Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/deaths	Risk estimate (95% CI)	Covariates controlled
Hardell & Eriksson (1999) Northern and middle Sweden 1987–1990	Cases: 404 (192 deceased) (response rate, 91%); regional cancer registries Controls: 741 (response rate, 84%); live controls matched for age and county were recruited from the national population registry, and deceased cases matched for age and year of death were identified from the national registry for causes of death Exposure assessment method: questionnaire	NHL (ICD-9 200 and 202)	Ever glyphosate – univariate Ever glyphosate – multivariate	4 NR	2.3 (0.4–13) 5.8 (0.6–54)	Not specified in the multivariable analysis
Hardell et al. (2002) Sweden; four Northern counties and three counties in mid Sweden 1987–1992	Cases: 515 (response rate, 91% in both studies); Swedish cancer registry Controls: 1141 (response rates, 84% and 83%); national population registry Exposure assessment method: questionnaire	NHL and HCL	Ever glyphosate exposure (univariate) Ever glyphosate exposure (multivariate)	8 8	3.04 (1.08–8.5) 1.85 (0.55–6.2)	Age, county, study site



(0.6 – 54)









(1.08 – 8.5)



(0.55 – 6.2)

Table 2.2 (continued)

Reference, location, enrolment period	Population size, description, exposure assessment method	Organ site (ICD code)	Exposure category or level	Exposed cases/ deaths	Risk estimate (95% CI)	Covariates controlled
Eriksson et al. (2008) Sweden. Four health service areas (Lund, Linköping, Örebro and Umeå) 1999–2002	Cases: 910 (response rate, 91%); incident NHL cases were enrolled from university hospitals Controls: 1016 (response rate, 92%); national population registry Exposure assessment method: questionnaire	NHL	Any glyphosate	29	2.02 (1.1–3.71)	 (1.1 – 3.71)
			Any glyphosate*	29	1.51 (0.77–2.94)	 (0.77 – 2.94)
			≤ 10 days per year use	12	1.69 (0.7–4.07)	
			> 10 days per year use	17	2.36 (1.0–5.37)	 (0.24 – 5.08)
		NHL	1–10 yrs	NR	1.11 (0.2–5.08)	
			> 10 yrs	NR	2.26 (1.16–4.4)	
		B-cell lymphoma	Exposure to glyphosate	NR	1.87 (0.99–3.52)	 (1.16 – 4.4)
		Lymphocytic lymphoma/B-CLL	Exposure to glyphosate	NR	3.35 (1.42–7.89)	
		Diffuse large B-cell lymphoma	Exposure to glyphosate	NR	1.22 (0.44–3.35)	
		Follicular, grade I–III	Exposure to glyphosate	NR	1.89 (0.62–5.79)	
		Other specified B-cell lymphoma	Exposure to glyphosate	NR	1.63 (0.53–4.96)	
		Unspecified B-cell lymphoma	Exposure to glyphosate	NR	1.47 (0.33–6.61)	
		T-cell lymphoma	Exposure to glyphosate	NR	2.29 (0.51–10.4)	
		Unspecified NHL	Exposure to glyphosate	NR	5.5 (1.44–22)	 (1.44 – 22)

6.1 Cancer in humans

There is *limited evidence* in humans for the carcinogenicity of glyphosate. A positive association has been observed for non-Hodgkin lymphoma.

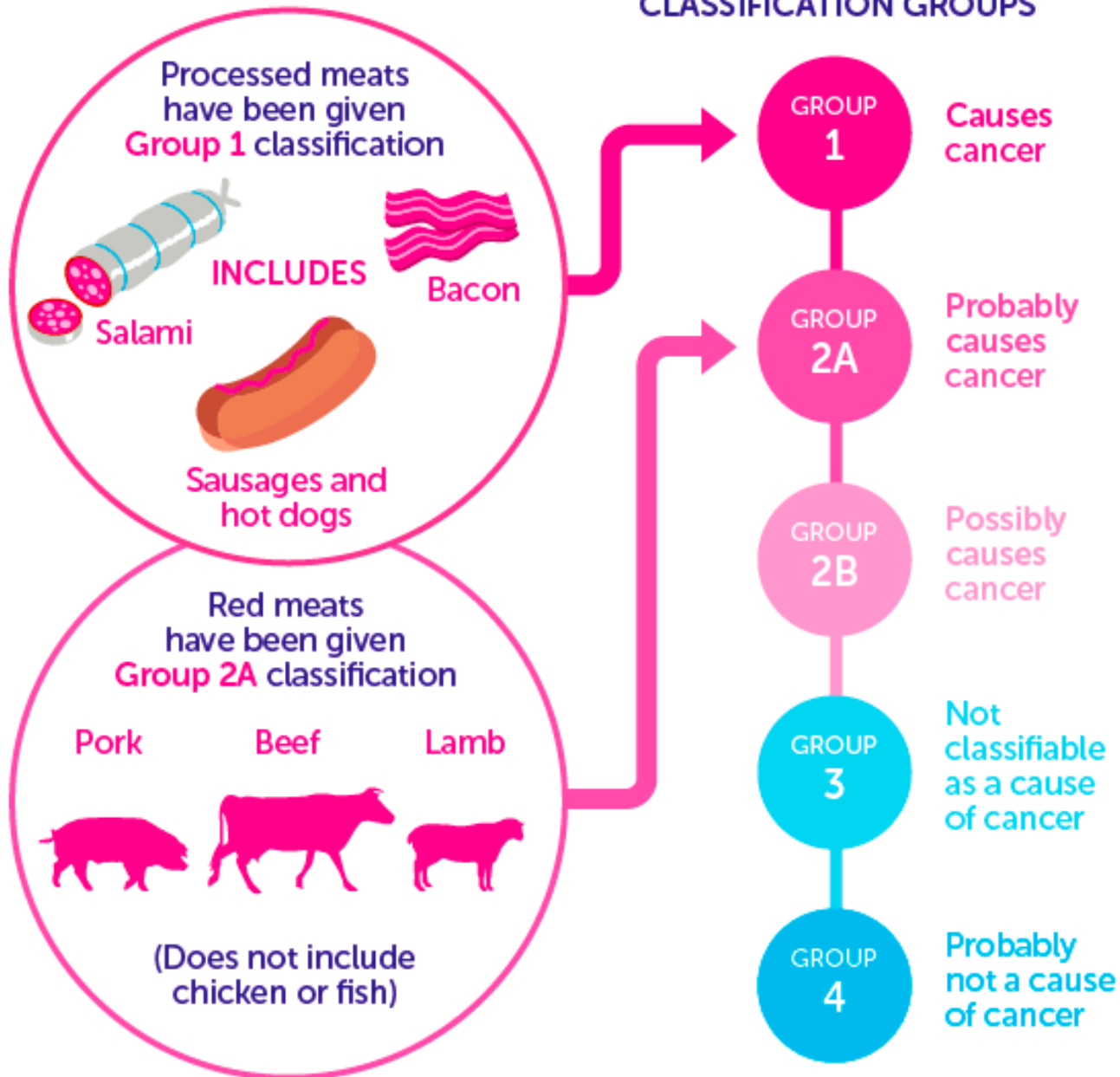
6.2 Cancer in experimental animals

There is *sufficient evidence* in experimental animals for the carcinogenicity of glyphosate.

6.3 Overall evaluation

Glyphosate is *probably carcinogenic to humans (Group 2A)*.

IARC CARCINOGENIC CLASSIFICATION GROUPS



glyphosate

2,4-D

These categories represent how likely something is to cause cancer in humans, not how many cancers it causes.



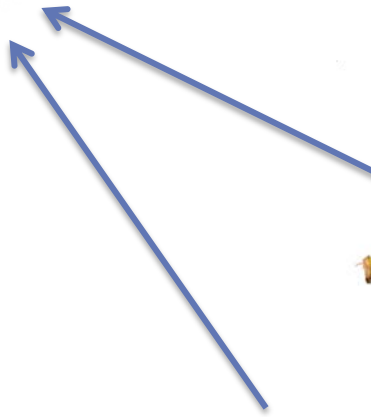
Causes
accidents

Probably
causes
accidents

Possibly
causes
accidents

Not
classifiable

Probably
doesn't cause
accidents



International Agency for Research on Cancer



World Health
Organization

Can it cause cancer?



United States Environmental Protection Agency

Can it cause
cancer?

+

What level of
exposure is
expected?

=

Is that
exposure level
likely to result
in cancer?

**Glyphosate Issue Paper:
Evaluation of Carcinogenic Potential**

**EPA's Office of Pesticide Programs
September 12, 2016**



For cancer descriptors, the available data and weight-of-evidence clearly do not support the descriptors “carcinogenic to humans”, “likely to be carcinogenic to humans”, or “inadequate information to assess carcinogenic potential”. For the “suggestive evidence of carcinogenic potential” descriptor, considerations could be looked at in isolation; however, following a thorough integrative weight-of-evidence evaluation of the available data, the database would not support this cancer descriptor. The strongest support is for “not likely to be carcinogenic to humans” at doses relevant to human health risk assessment.

Page 141 of 227

<http://bit.ly/glypho-cancer-2016>

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EFSA Finds Glyphosate 'Unlikely to Cause Cancer in Humans'

BY DAN FLYNN | NOVEMBER 13, 2015

Europe's gardeners and farmers probably won't have their Monsanto Roundup weed killer or other similar herbicides taken away from them now that the influential European Food Safety Authority (EFSA) has found that the ingredient glyphosate is unlikely to cause cancer in humans.

Glyphosate, which has been around since the 1970s, is used in herbicides around the world, including Monsanto's popular Roundup.

EFSA's [research findings](#) appear to trump the [conclusion](#) this past March by the International Agency for Research on Cancer (IARC), which listed glyphosate as "probably carcinogenic to humans."

EFSA's assessment will be used by the European Commission in deciding whether to keep glyphosate on the EU list of approved active substances. Currently, glyphosate is widely used in both Roundup and in generic brands of herbicides for home gardening and agriculture.



Cancer agency left in the dark over glyphosate evidence

The World Health Organization's cancer agency says a common weedkiller is "probably carcinogenic." The scientist leading that review knew of fresh data showing no cancer link - but he never mentioned it and the agency did not take it into account.

By KATE KELLAND | Filed June 14, 2017, 1:05 p.m. GMT

- “Known to the state of California as a carcinogen”
- Curtailed use in public spaces
- Monsanto facing lawsuits



SENIOR SCIENTIST: Aaron Blair, a retired epidemiologist, led the review of several pesticides, including glyphosate, by the International Agency for Research on Cancer in 2015. CREDIT: National Cancer Institute/Bill Branson/Handout via Reuters

Yet if the IARC panel experts had been in a position to take into account Blair’s fresh data, IARC’s analysis of the evidence on glyphosate would have been different, Blair acknowledged in the court documents reviewed by Reuters.

<http://www.reuters.com/investigates/special-report/glyphosate-cancer-data/>

Glyphosate Use and Cancer Incidence in the Agricultural Health Study.

Andreotti G¹, Koutros S¹, Hofmann JN¹, Sandler DP¹, Lubin JH¹, Lynch CF¹, Lerro CC¹, De Roos AJ¹, Parks CG¹, Alavanja MC¹, Silverman DT¹, Beane Freeman LE¹.

CONCLUSIONS:

In this large, prospective cohort study, no association was apparent between glyphosate and any solid tumors or lymphoid malignancies overall, including NHL and its subtypes.

highest exposure quartile, there was an increased risk of acute myeloid leukemia (AML) compared with never users (RR = 2.44, 95% CI = 0.94 to 6.32, Ptrend = .11), though this association was not statistically significant. Results for AML were similar with a five-year (RRQuartile 4 = 2.32, 95% CI = 0.98 to 5.51, Ptrend = .07) and 20-year exposure lag (RRTertile 3 = 2.04, 95% CI = 1.05 to 3.97, Ptrend = .04).

CONCLUSIONS: In this large, prospective cohort study, no association was apparent between glyphosate and any solid tumors or lymphoid malignancies overall, including NHL and its subtypes. There was some evidence of increased risk of AML among the highest exposed group that requires confirmation.

Recently In Europe

- The EU voted in November, 2017 to extend registration for glyphosate until 2022 (instead of the typical 15-year re-registration)
- In a tweet after the vote, French President said he will order a ban on the use of glyphosate in France "as soon as alternatives are found, and within three years at the latest"

EPA Releases Draft Risk Assessments for Glyphosate

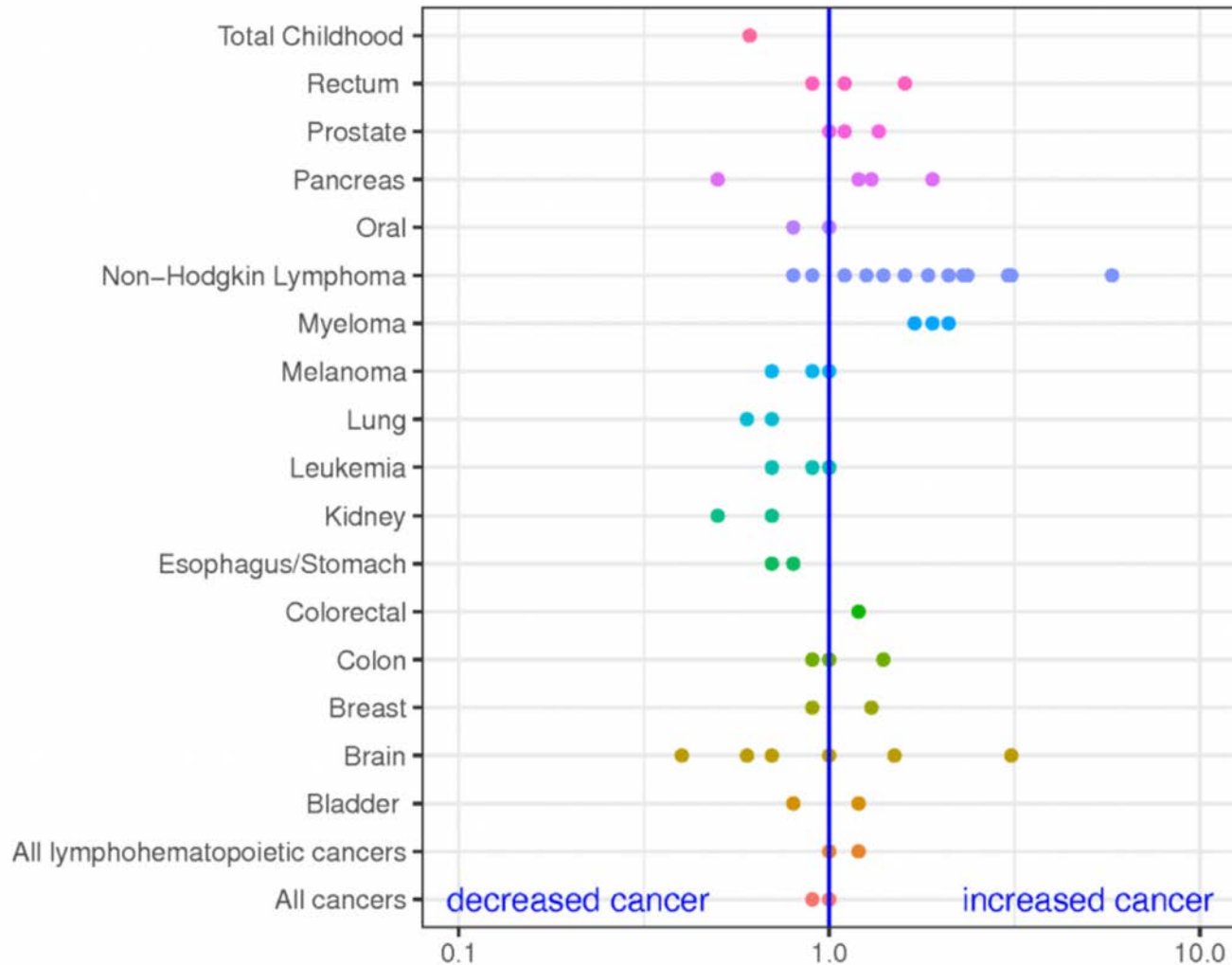
For Release: December 18, 2017

CONCLUSIONS:

The draft human health risk assessment concludes that glyphosate is not likely to be carcinogenic to humans.

humans. The Agency's assessment found no other meaningful risks to human health when the product is used according to the pesticide label. The Agency's scientific findings are consistent with the conclusions of science reviews by a number of other countries as well as the [2017 National Institute of Health Agricultural Health Survey](#).

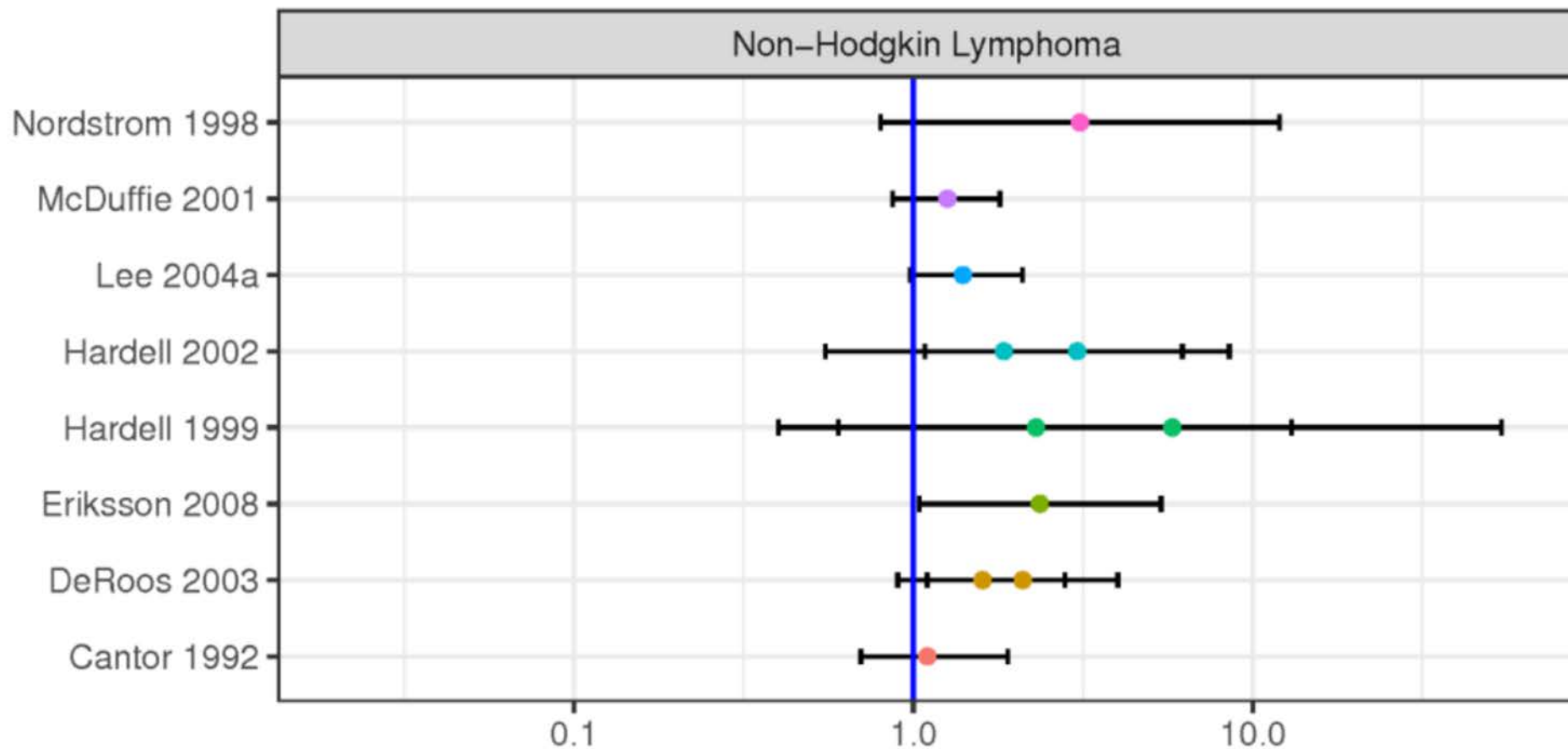
Glyphosate and Cancer



HERBICIDES / RESEARCH

Glyphosate and cancer – revisited

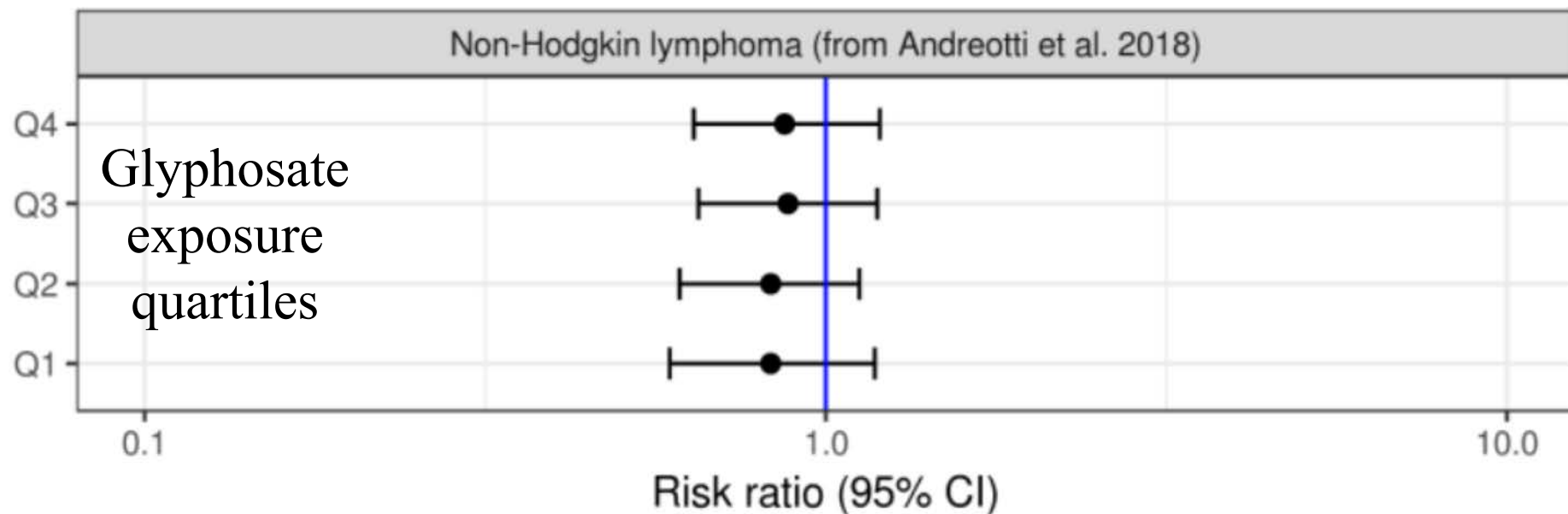
August 11, 2018 - by Andrew Kniss



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Glyphosate and cancer – revisited

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Glyphosate and cancer – revisited

August 11, 2018 - by Andrew Kniss

The Science of Risk Perception

...

Every hazard is unique

Every person is unique

Acknowledgement: Dr. Paul Slovic, University of Oregon

Talking about toxicity and exposure

$$\text{Risk} = \text{Toxicity} \times \text{Exposure}$$



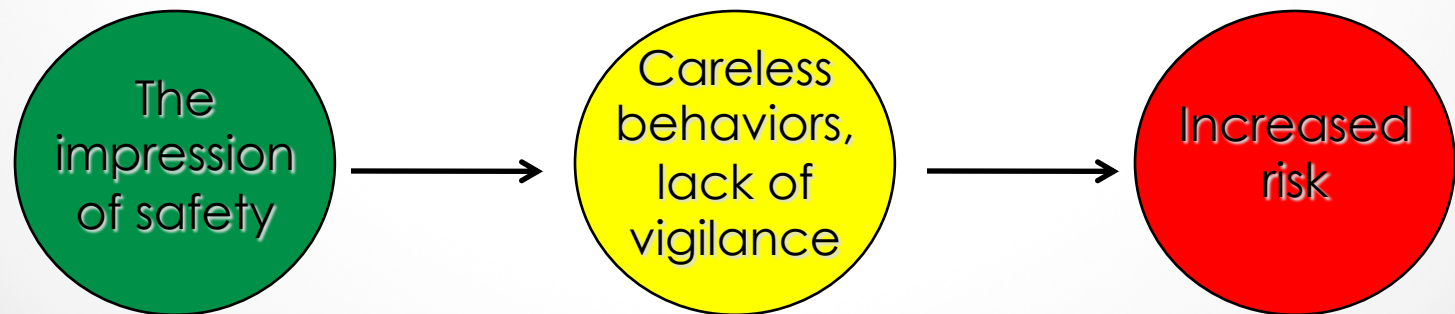
- Toxicology of active ingredient
- Product signal word
- Dose estimate
- Effects (signs, symptoms) reported in the literature
- Onset, duration and resolution of symptoms



- Distance to application site
- Route of potential exposure
- Physical/chemical properties of active ingredient
- Duration/frequency of exposure
- Bioavailability by the route in question

Why “risk”, ... when people ask about “safety?”

Safety	Risk
Yes or No	More risky-----Less risky
No precautions necessary	Precautions reduce risk
Safe is safe for everyone	Risk is higher for certain people
Easy to explain	Harder to explain



Re-framing the 'safe' question

Is it
safe?

The risk is low, but tell me
about your specific
concerns...



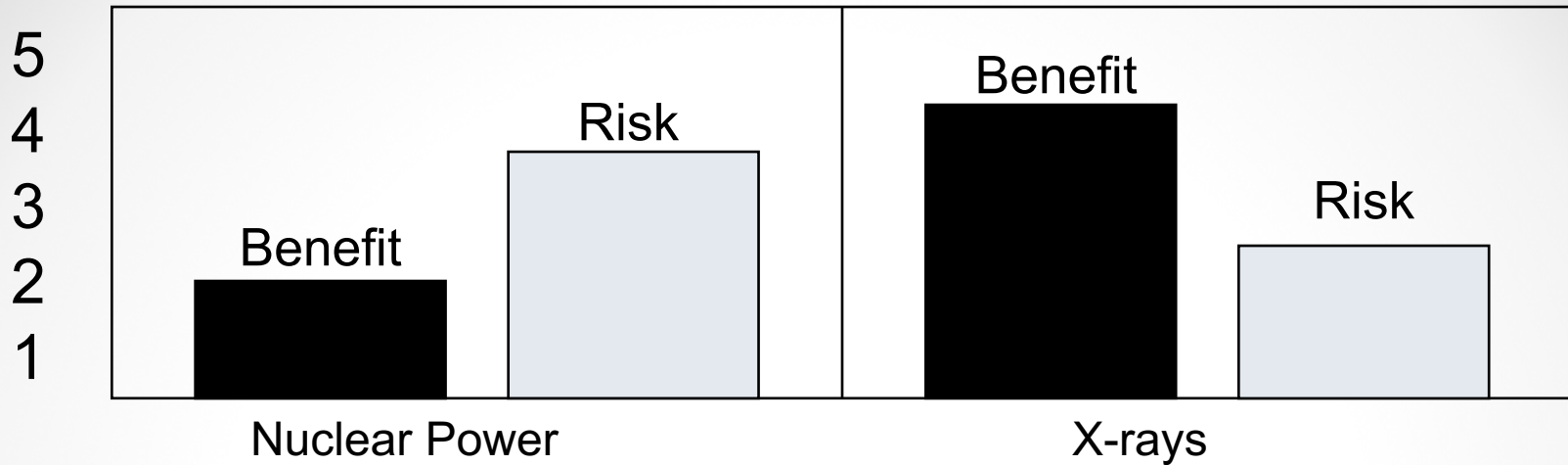
- Listen
- Consider tailored approaches
- Quickly explain why "safe" isn't the right word or mindset
- Discuss the level of risk and things that affect it

Risks are less likely to be acceptable if the benefits are hidden from view, or if they are not fairly distributed among those who bear the risks.



Benefits of Pesticides

Radiation



Chemicals

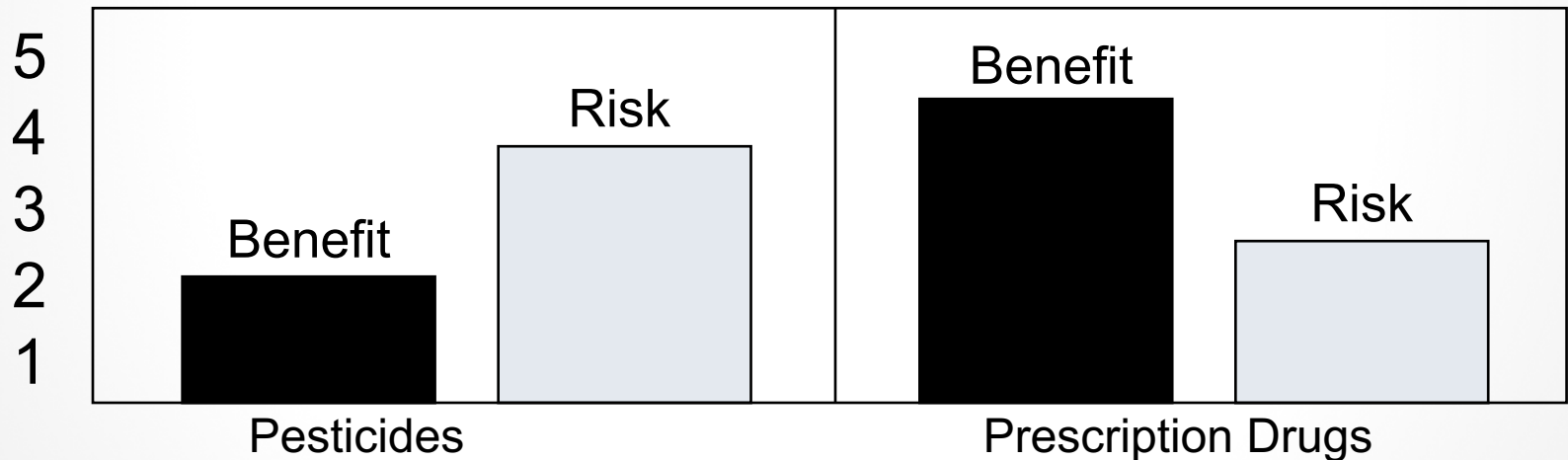
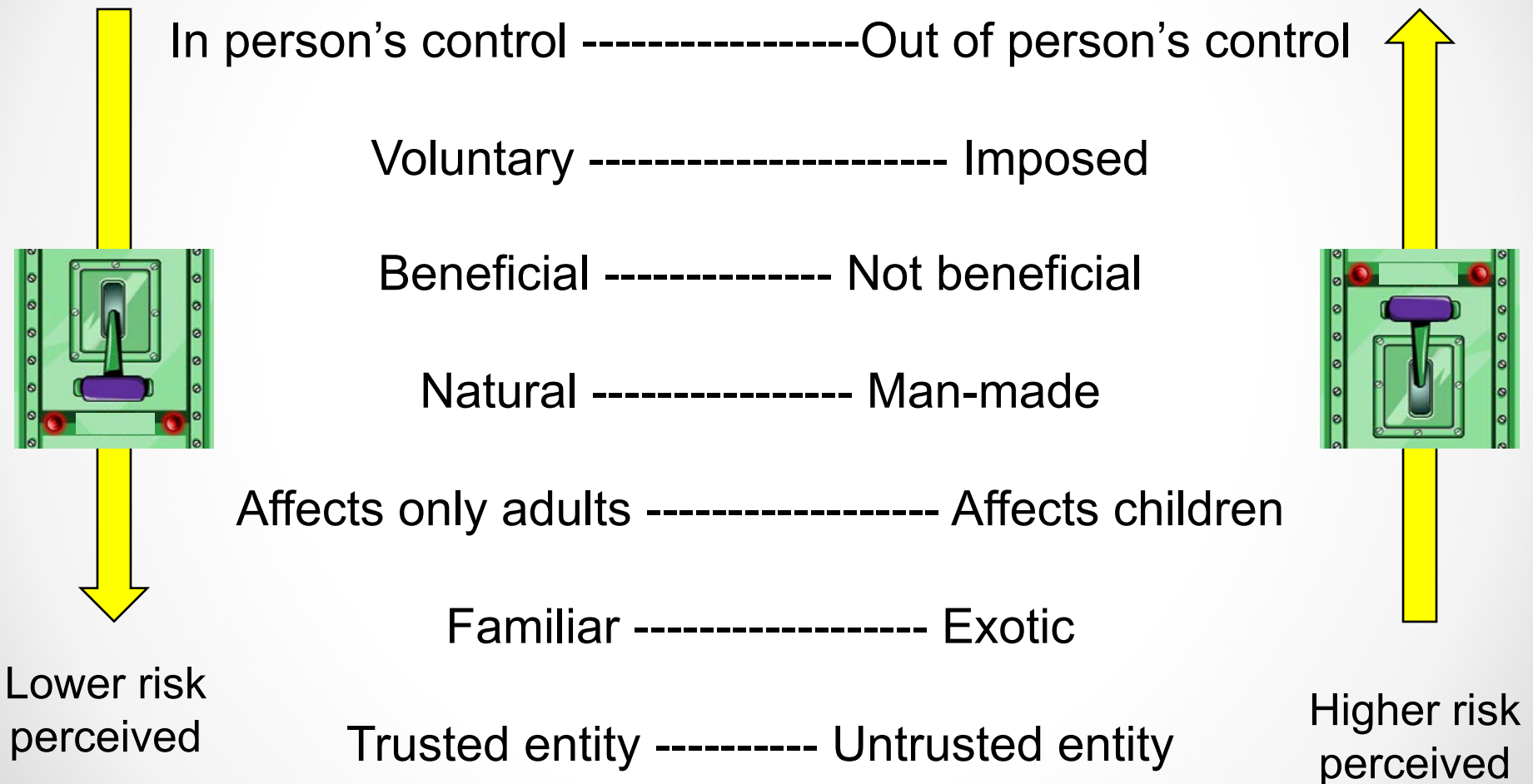


Figure 3. Mean perceived risk and perceived benefit for medical and nonmedical sources of exposure to radiation and chemicals. Each item was rated on a scale of perceived risk ranging from 1 (very low risk) to 7 (very high risk) and a scale of perceived benefit ranging from 1 (very low benefit) to 7 (very high benefit). Data are from a national survey in Canada by Slovic et al., 1991.



Personal 'Outrage Factors'



Worldview affects risk perception



The government should stop telling people how to live their lives (Individualism)

The government should do more to advance society's goals, even if that limits the freedom of individuals (Communitarian)

Our society would be better off if the distribution of wealth was more equal (Egalitarianism)

We should let the experts make all the risk decisions for society (Hierarchism)

People with different worldviews were asked about their attitudes towards nanotechnology, before and after being given information about nanotechnology.

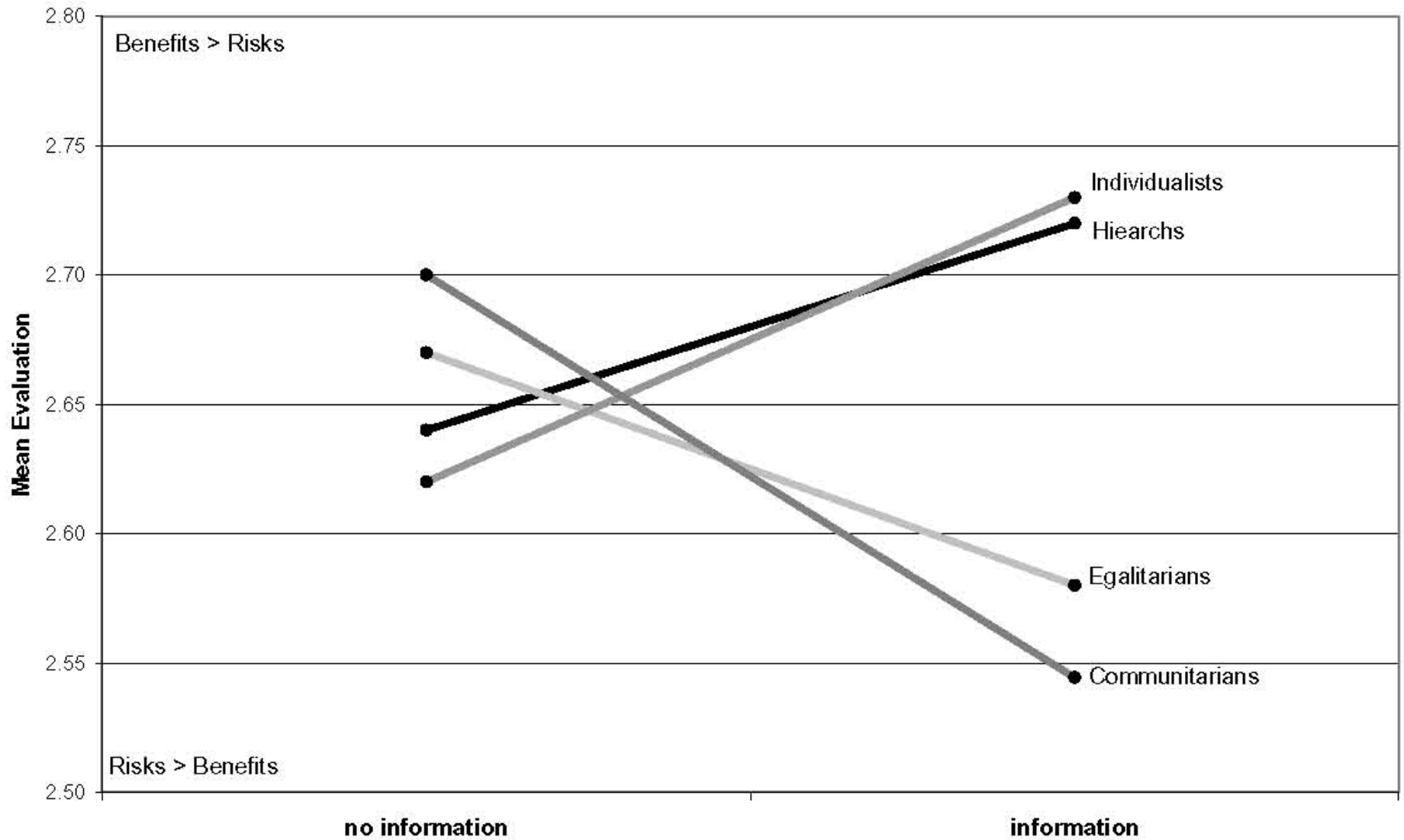


Figure 4. Impact of Information Across Condition by Dimension of Cultural Worldview

Risk denial increases with perceived control

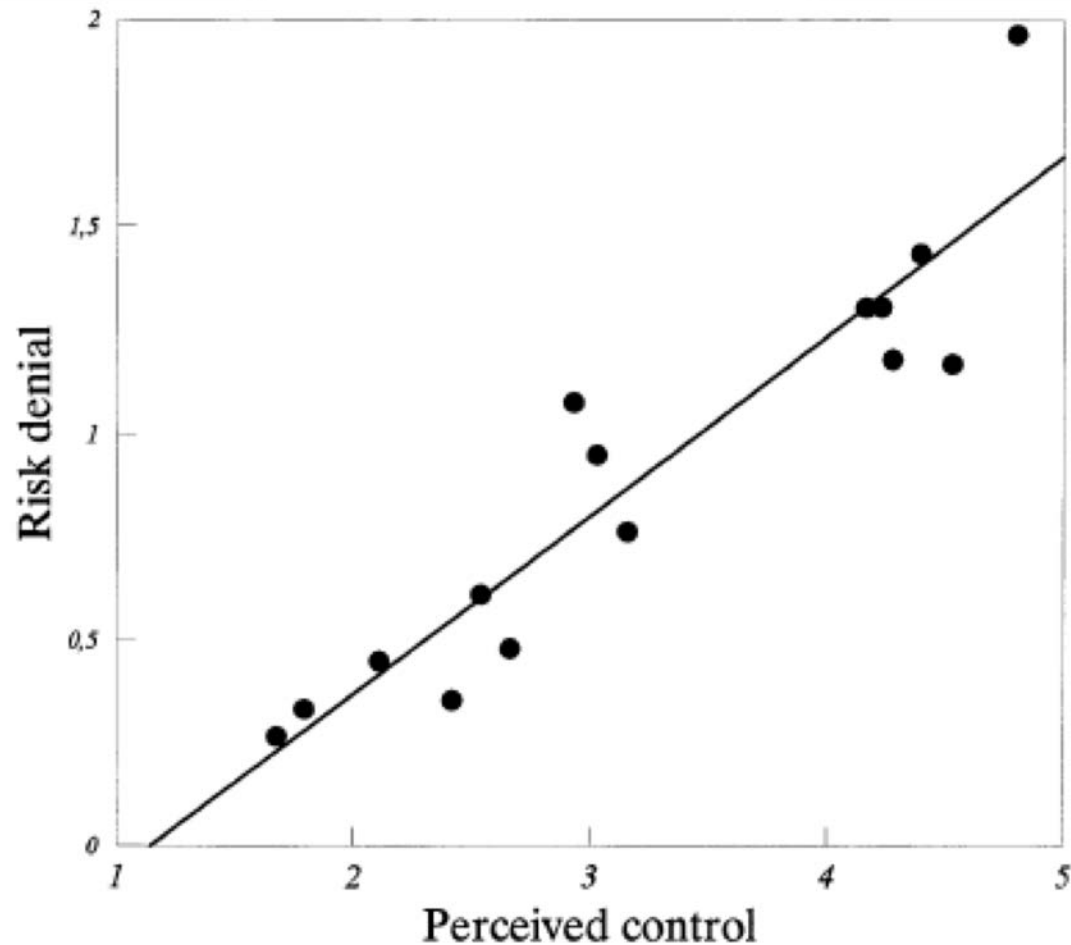
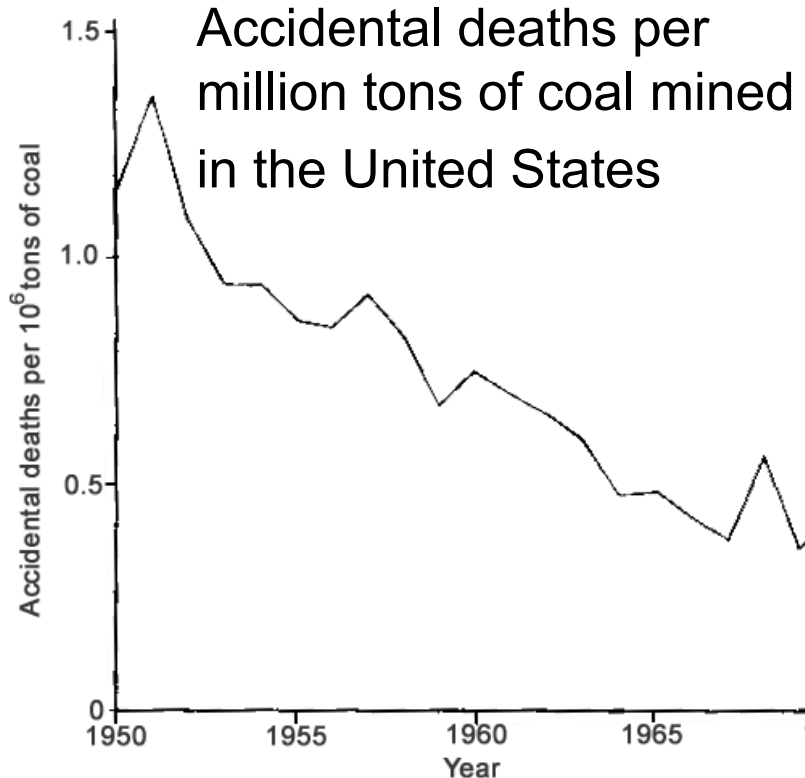


Fig. 2. Risk denial (general minus personal risk) plotted against perceived control over risks. Each point corresponds to one hazard; mean ratings are plotted.

How is Risk Defined? Who Decides?

Is coal mining getting safer?



Counting fatalities gives equal weight to:

- Young and old
- Painful and painless deaths
- Voluntary and involuntary exposure(s)
- Fair (beneficial) and unfair (no benefit)

Whoever controls the definition of risk is in control.

Defining Risk is an Act of *Power*

Probability – Proba-shmility

- Feelings about **probabilities** and feelings about **outcomes** are often confused.
- When strong emotions are involved, there is 'probability neglect.'

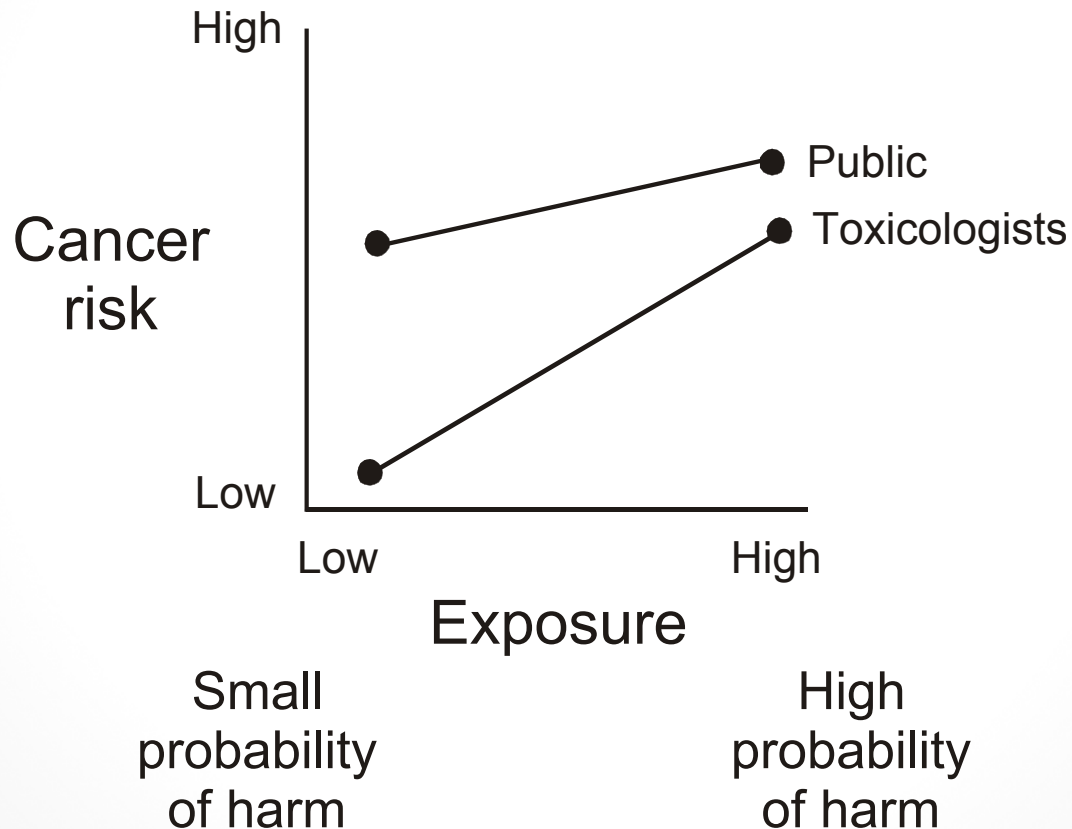
Cass R. Sunstein

The Journal of Risk and Uncertainty, 26(2/3); 2003

- People are prone to . . . probability neglect, especially when their emotions are intensely engaged. When probability neglect is at work, people's attention is focused on the bad outcome itself, and they are inattentive to the fact that it is unlikely to occur.
- Probability neglect is highly likely in the aftermath of terrorism. People fall victim to probability neglect when the intensity of their reaction does not change much, even with large differences in the likelihood of harm.

Many people lack dose-response sensitivity for exposure to chemicals that can produce effects that are dreaded, such as cancer.

If large exposures are bad, small exposures are also bad.



The risk equation as scaffolding



Risk Communication Checklist:

Listen, ask questions, paraphrase: _____

Frame as risk rather than safety: _____

Toxicity information: _____

Exposure information: _____

Benefit(s) of the application: _____

Action items in person's control: _____

Where to get more info: _____

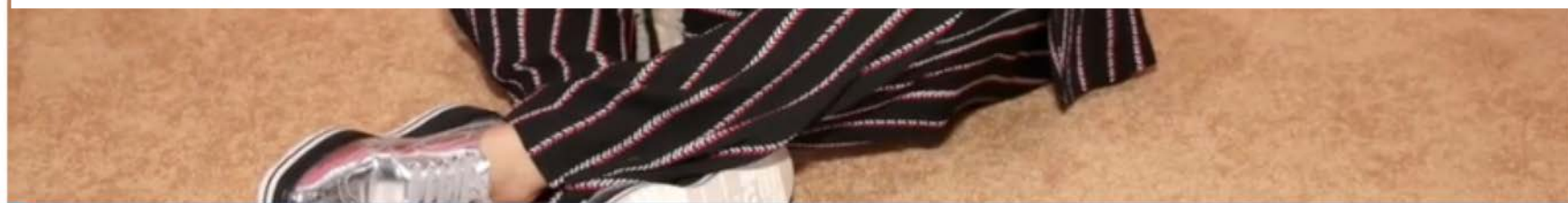


RETAIL • PET FOOD

A \$5 Million Lawsuit Claims Rachael Ray's Dog Food Brand Contains a Potentially Harmful Ingredient



A man from New York is suing Rachael Ray's "natural" dog food brand, Nutrish, for allegedly containing the "potentially harmful" herbicide glyphosate. In the \$5 million class action lawsuit, Bronx resident Markeith Parks argues that it is deceiving for Nutrish to market its food as natural.



WEED KILLER INGREDIENT FOUND IN CHEERIOS, QUAKER OATS AND OTHER BREAKFAST CEREALS

BY CAMMY HARBISON ON 8/15/18 AT 11:59 PM

Fri, Aug 17, 2018

Newsweek



Weed Killer For Breakfast

Risk Communication Checklist:

Listen, ask questions, paraphrase: _____

Frame as risk rather than safety: _____

Toxicity information: _____

Exposure information: _____

Benefit(s) of the application: _____

Action items in person's control: _____

Where to get more info: _____





Resources

- National Pesticide Information Center
 - <http://npic.orst.edu> 1-800-858-7378
- Glyphosate Technical Fact Sheet
 - <http://npic.orst.edu/factsheets/archive/glyphotech.html>
- Glyphosate General Fact Sheet
 - <http://npic.orst.edu/factsheets/glyphogen.html>
- PlainLanguage.gov
 - <http://www.plainlanguage.gov/>
- Debunking Handbook
 - https://www.skepticalscience.com/docs/Debunking_Handbook.pdf
- Book: Risk Communication: A Handbook for Communicating Environmental, Safety, & Health Risks by Regina Lundgren & Andrea McMakin

Glyphosate and Communicating Risk

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