The Glyphosate/Roundup Controversy

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npic

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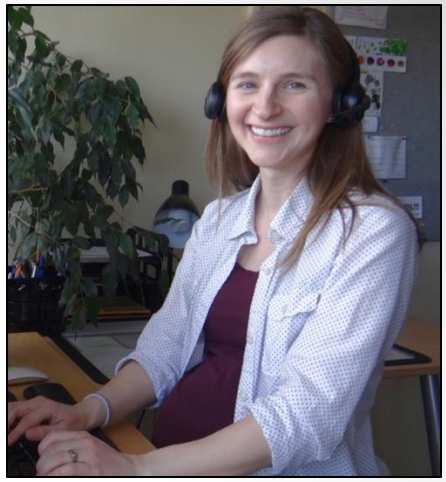
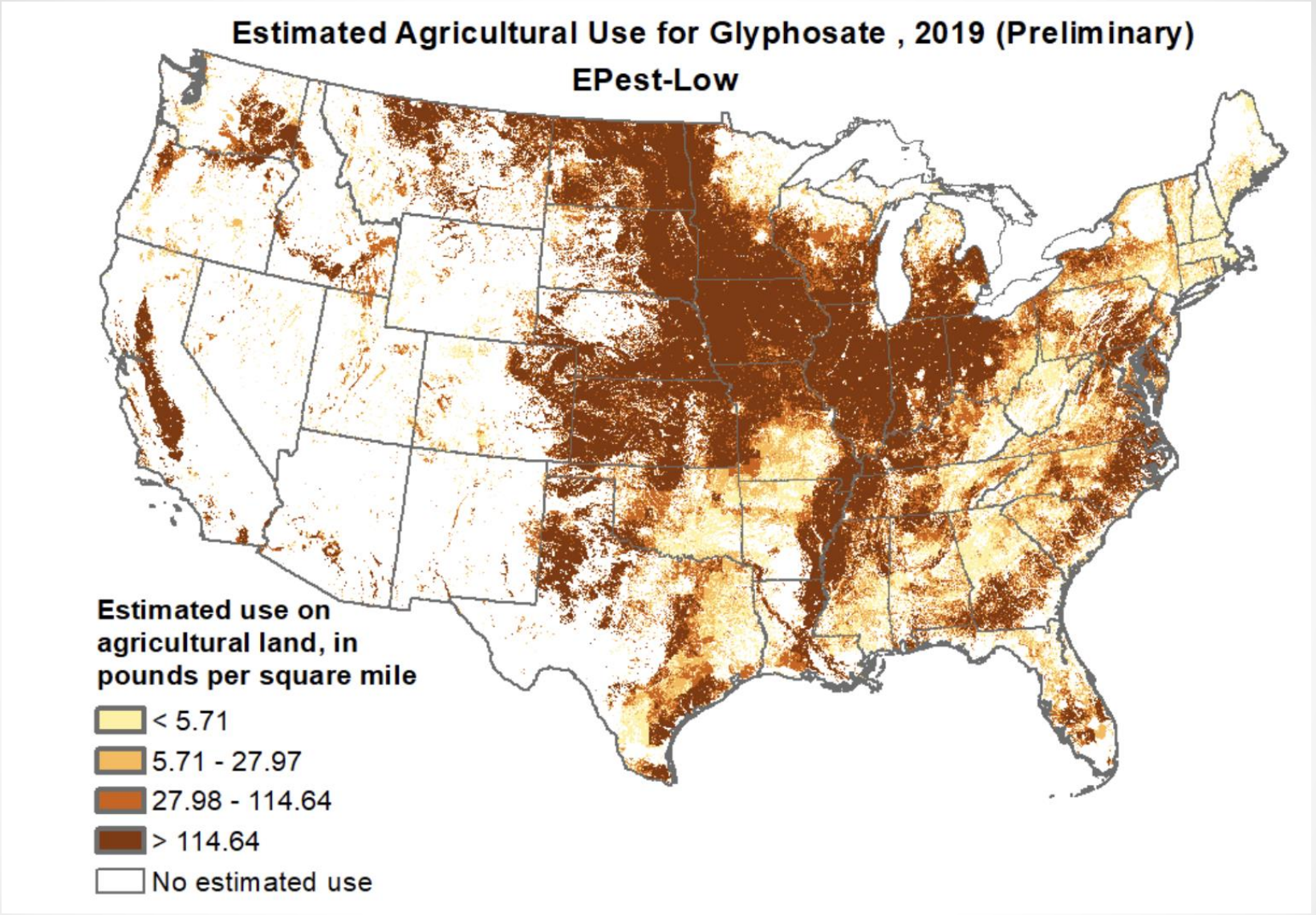
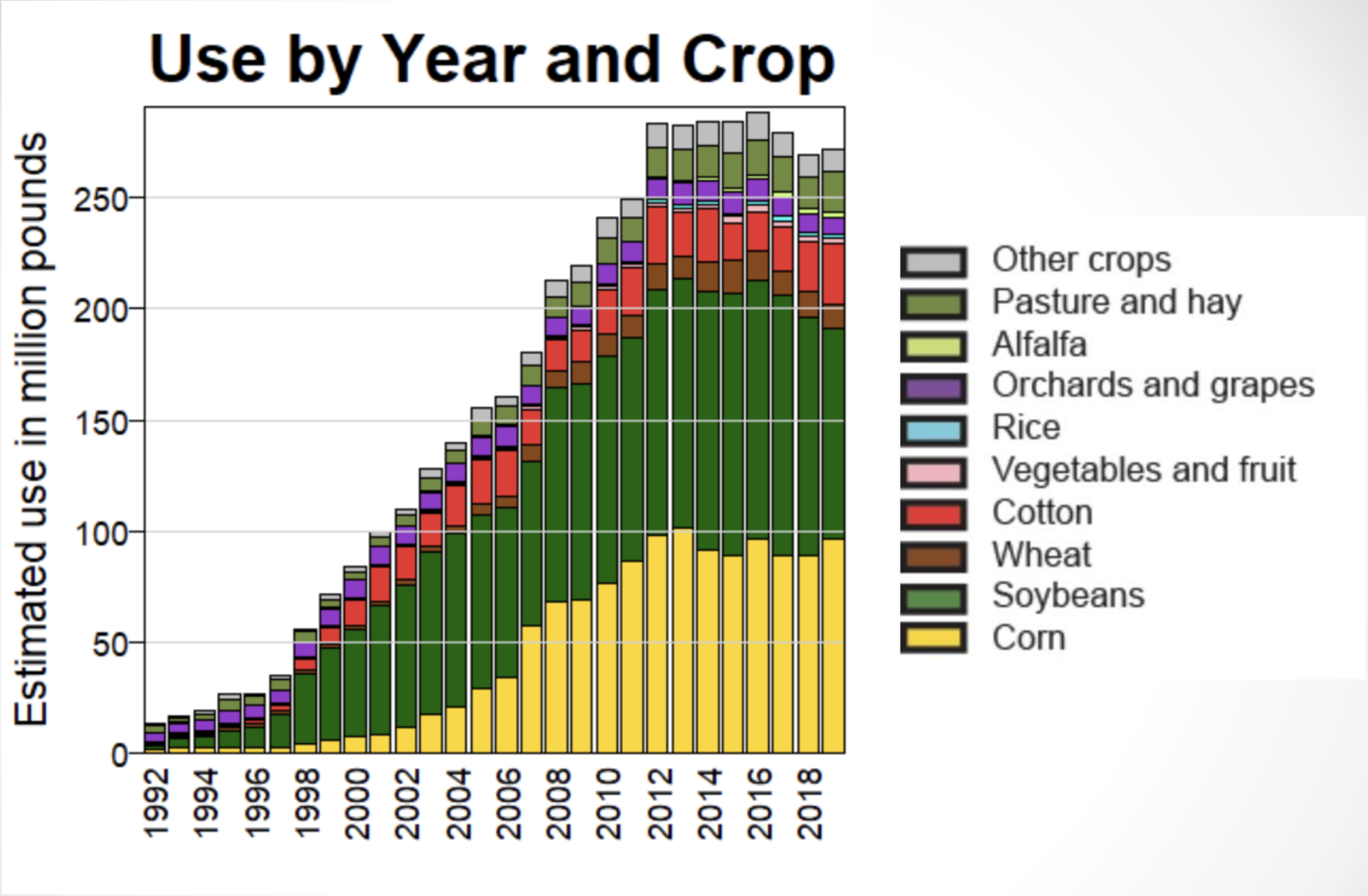


"Pesticide Information, How can I help you?"

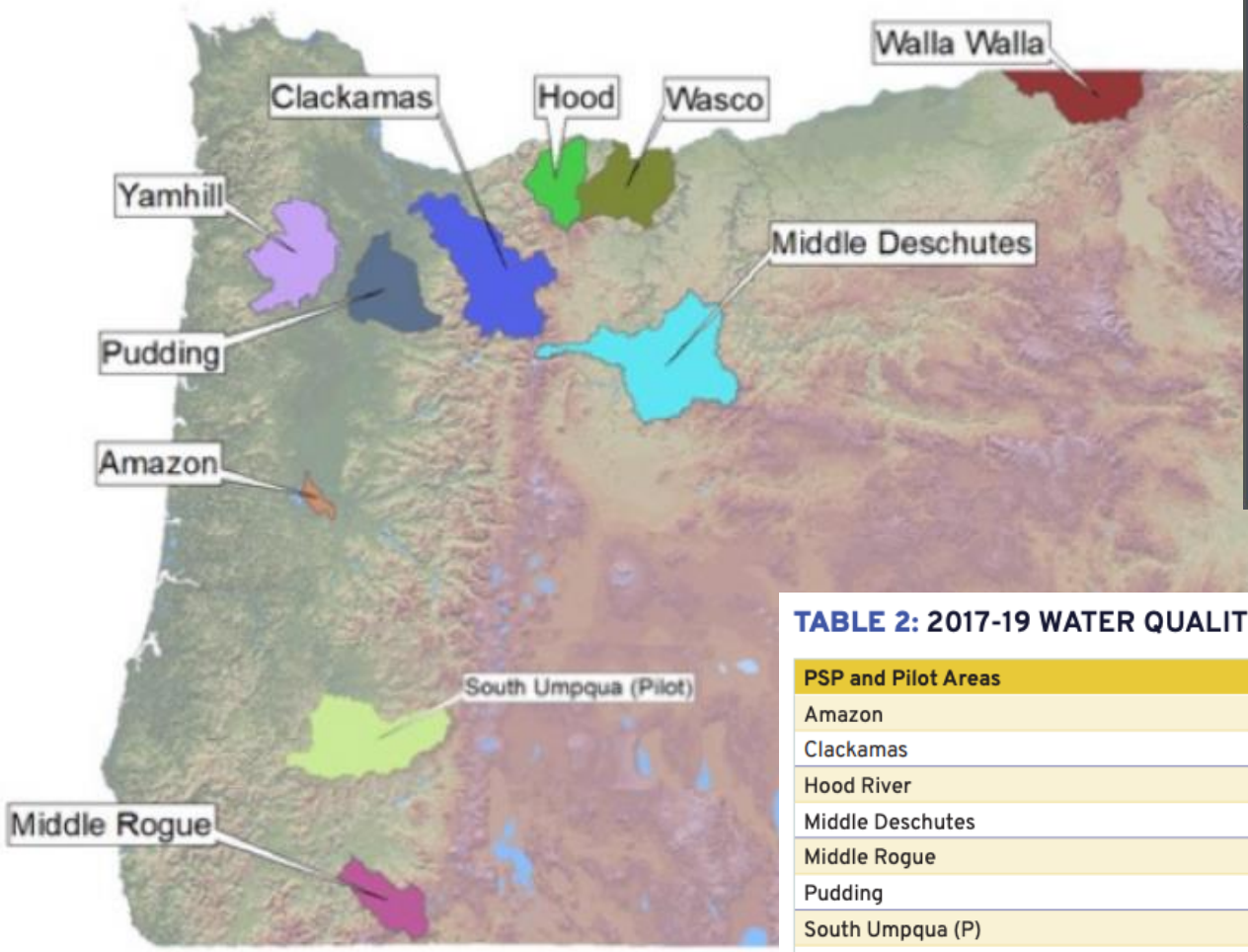

Estimated Agricultural Use for Glyphosate , 2019 (Preliminary)
EPest-Low
Estimated use on agricultural land, in pounds per square mile
< 5.71
5.71 - 27.97
27.98 - 114.64
> 114.64
No estimated use



Glyphosate sticks to soil strongly.

Many products registered for application to aquatic areas.

FIGURE 1: CURRENTLY PARTICIPATING PSP WATERSHEDS AND PILOT AREAS (2017-19)



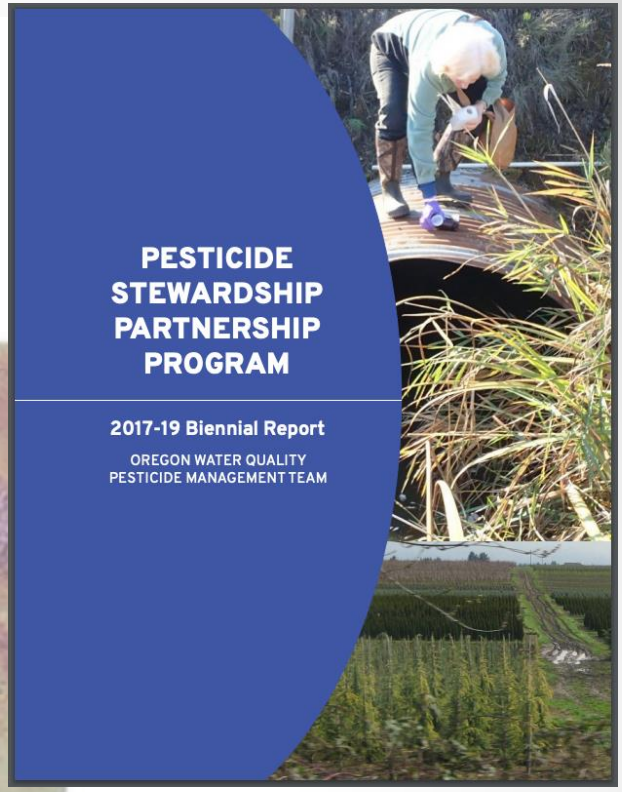


TABLE 2: 2017-19 WATER QUALITY SAMPLING DISTRIBUTION

PSP and Pilot Areas	Number of Sampling Sites
Amazon	5
Clackamas	6
Hood River	6
Middle Deschutes	5
Middle Rogue	11
Pudding	6
South Umpqua (P)	5
Walla Walla	9
Wasco	5
Yamhill	6
	64

Reference User Guide

All PSP Jan 1 2016 to Dec 31 2020

All Analytes | Analyte Per Year | Station Summary | Custom Plot (Beta) | Detection Map

Inputs:

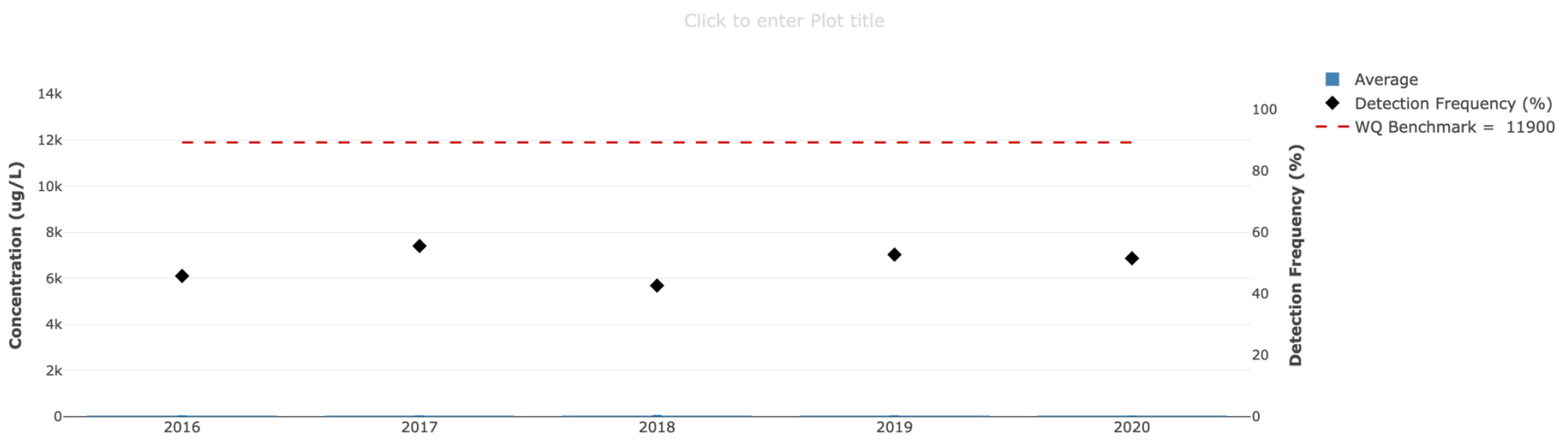
Station ID: All

Analyte: Glyphosate

All PSP Stations: Glyphosate Summary

Average/Max | Detection Frequency | Detections by Station

Variable: Average



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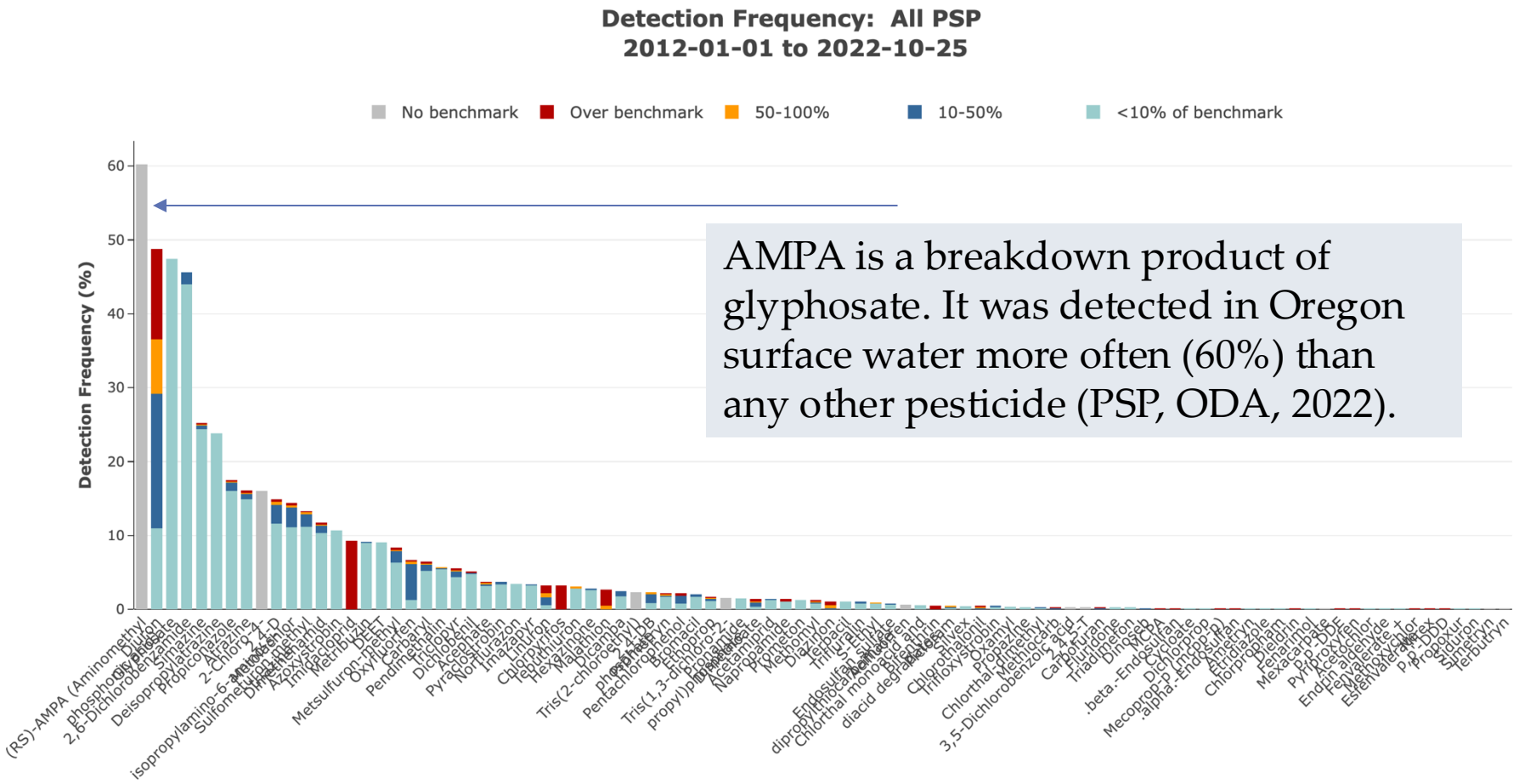

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TOXICITY CLASSIFICATION - GLYPHOSATE

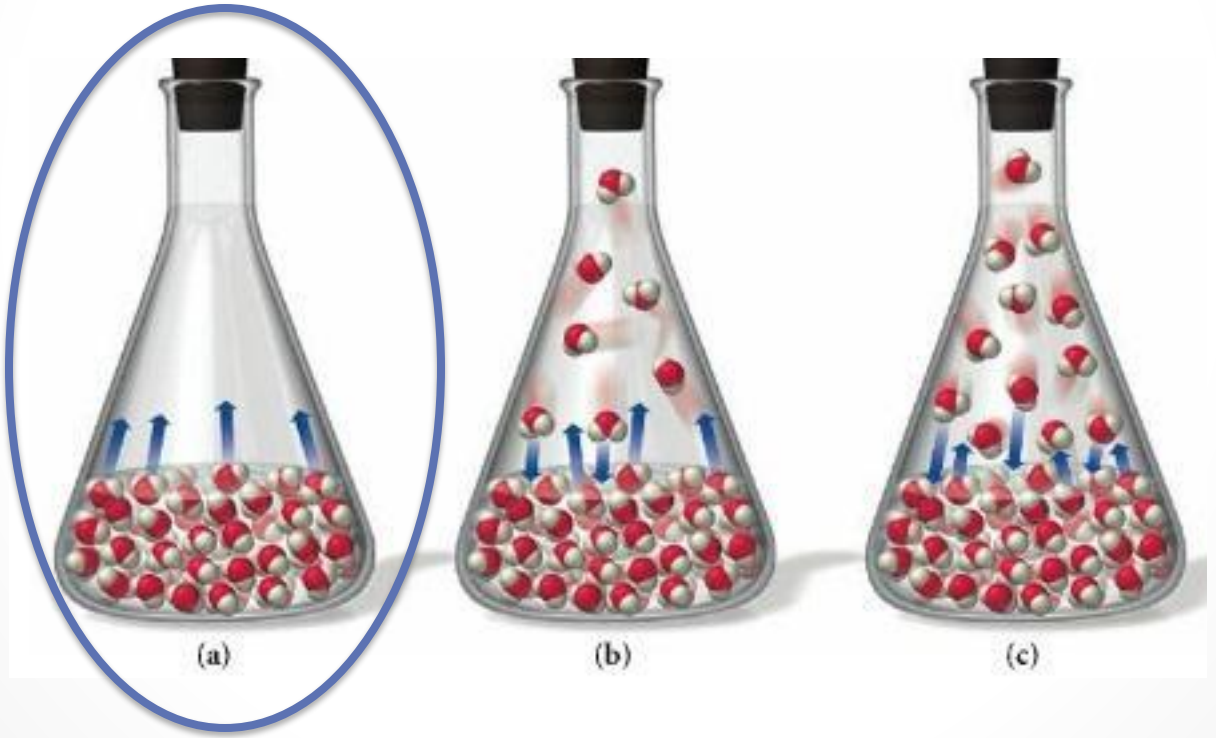
	High Toxicity	Moderate Toxicity	Low Toxicity	Very Low Toxicity
Acute Oral LD_{50}	Up to and including 50 mg/kg (≤ 50 mg/kg)	Greater than 50 through 500 mg/kg (>50-500 mg/kg)	**Greater than 500 through 5000 mg/kg (>500-5000 mg/kg)**	**Greater than 5000 mg/kg (>5000 mg/kg)**
Inhalation LC_{50}	Up to and 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 LD_{50}	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

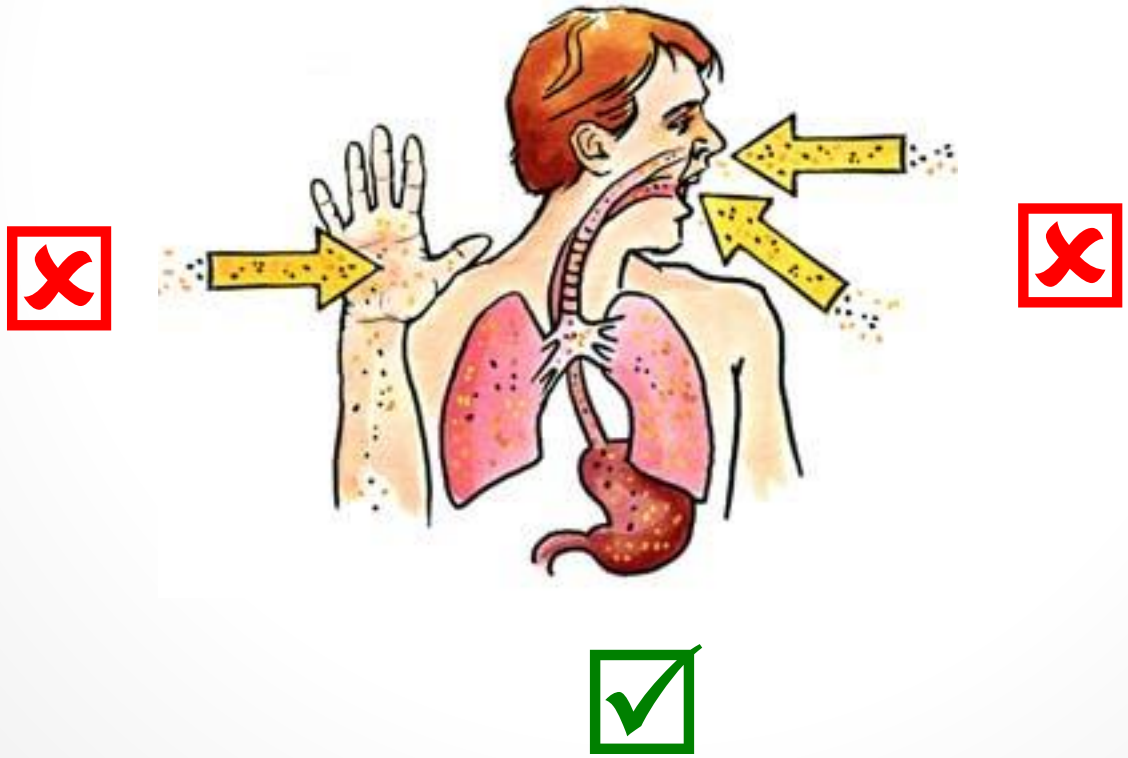
http://npic.orst.edu/factsheets/archive/glyphotech.html

Does glyphosate become vaporous?

No.



- 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"

$$\frac{\text{4 cancers in the population WITH exposure}}{\text{4 cancers in the population with NO exposure}}$$

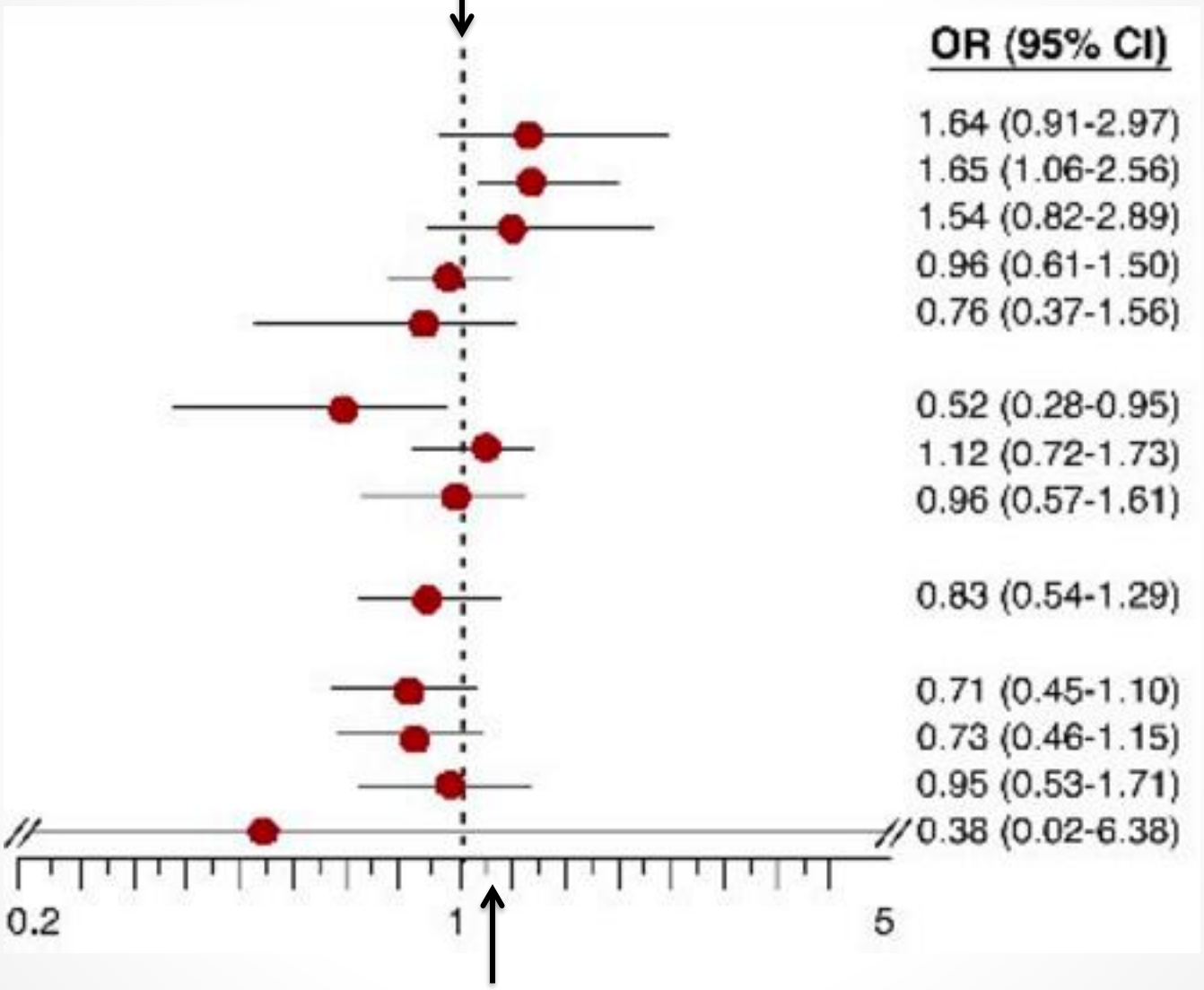
4/4 = 1

$$\frac{\text{5 cancers in the population WITH exposure}}{\text{4 cancers in the population with NO exposure}}$$

5/4 = 1.25

25% higher risk of cancer with exposure

4/4 = 1


OR (95% CI)
1.64 (0.91-2.97)
1.65 (1.06-2.56)
1.54 (0.82-2.89)
0.96 (0.61-1.50)
0.76 (0.37-1.56)
0.52 (0.28-0.95)
1.12 (0.72-1.73)
0.96 (0.57-1.61)
0.83 (0.54-1.29)
0.71 (0.45-1.10)
0.73 (0.46-1.15)
0.95 (0.53-1.71)
0.38 (0.02-6.38)
0.2
1
5

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

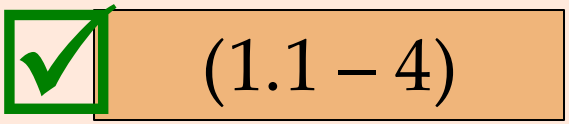
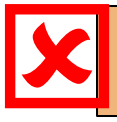
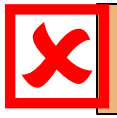


Table 2.2 (continued)

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)	



(0.98 – 2.1)



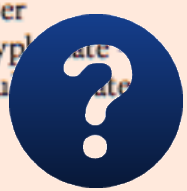
(0.4 – 3.3)

(0.83 – 1.74)

(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	4	2.3 (0.4–13)	Not specified in the multivariable analysis
			Ever glyp… mu…	NR	5.8 (0.6–54)	
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)	8	3.04 (1.08–8.5)	Age, county, study …s, …s in …te
			Ever glyphosate exposure (multivariate)	8	1.85 (0.55–6.2)	analysis



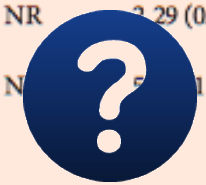
(0.6 – 54)

(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, Linkoping, Orebro and Umea) 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)	
			Any glyphosate*	29	1.51 (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)	
		NHL	1–10 yrs	NR	1.11 (0.24–5.08)	
			> 10 yrs	NR	2.26 (1.16–4.4)	
		B-cell lymphoma	Exposure to glyphosate	NR	1.87 (0.99–3.5)	
		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	N	5 (1.44–22)	



(1.1 – 3.71)

(0.77 – 2.94)

(0.24 – 5.08)

(1.16 – 4.4)

(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).*

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?

EPA Releases Draft Risk Assessments for Glyphosate

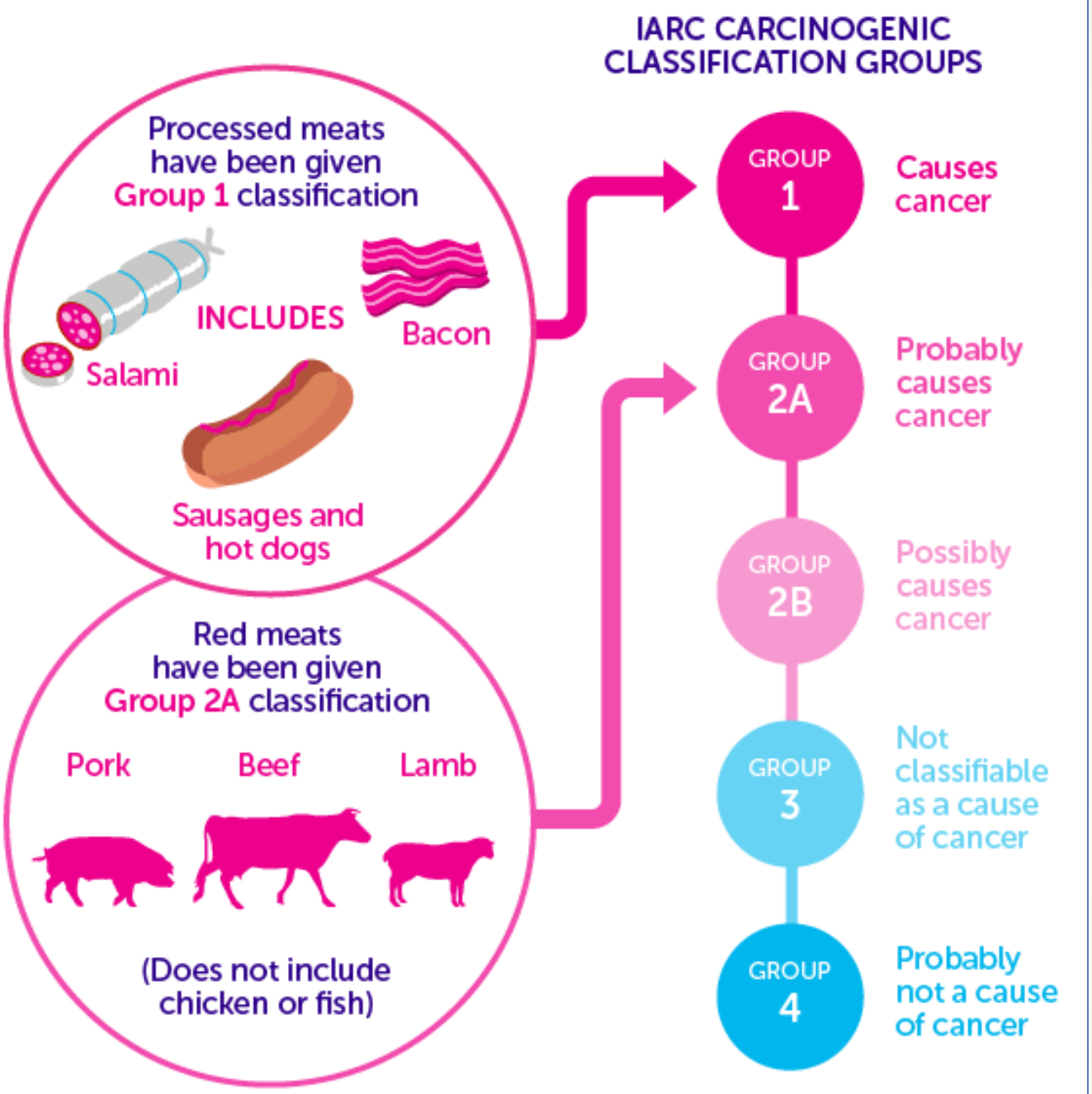
For Release: December 18, 2017

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.

Many governments have published risk assessments about glyphosate, finding it is **unlikely to cause cancer in humans** when used according to the label directions as required.

- US Environmental Protection Agency, December 18, 2018
- European Food Safety Authority, November 12, 2015
- Australian Pesticides and Veterinary Medicine Authority, March 15, 2017
- New Zealand Environmental Protection Authority, August 2016
- Health Canada, April 2015
- International assembly of experts: FAO/WHO May 16, 2016



glyphosate

2,4-D

GROUP 1

Causes accidents

GROUP 2A

Probably causes accidents

GROUP 2B

Possibly causes accidents

GROUP 3

Not classifiable

GROUP 4

Probably doesn't cause accidents

https://aghealth.nih.gov/

PubMed.gov
US National Library of Medicine
National Institutes of Health

PubMed

Advanced

Format: Abstract

Send to

J Natl Cancer Inst. 2017 Nov 9. doi: 10.1093/jnci/djx233. [Epub ahead of print]

Glyphosate Use and Cancer Incidence in the Agricultural Health Study.

Andreotti G[1], Koutros S[1], Hofmann JN[1], Sandler DP[1], Lubin JH[1], Lynch CF[1], Lerro CC[1], De Roos AJ[1], Parks CG[1], Alavanja MC[1], Silverman DT[1], Beane Freeman LE[1].

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.

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

California Jury Finds Roundup Caused Man's Cancer

March 19, 2019 · 9:09 PM ET

VANESSA ROMO

Jury Awards $80 Million In Damages In Roundup Weed Killer Cancer Trial

March 27, 2019 · 8:31 PM ET

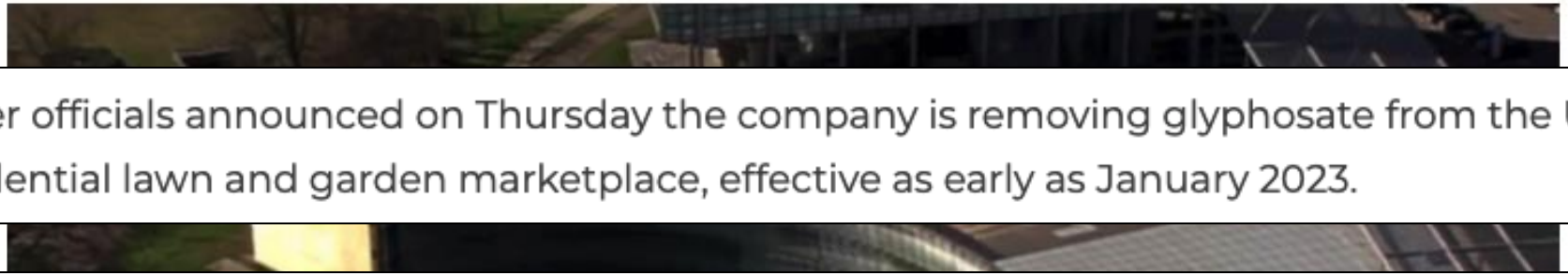
RICHARD GONZALES

Edwin Hardeman sits with his wife, Mary, at a news conference after a San Francisco jury awarded him $80 million in damages over his claim that Roundup weedkiller caused his cancer.

Jeff Chiu/AP

CROP PRODUCTION

Bayer to pull Glyphosate from U.S. Lawn and Garden Markets



Bayer officials announced on Thursday the company is removing glyphosate from the U.S. residential lawn and garden marketplace, effective as early as January 2023.

More than 90% of the Roundup litigation claims Bayer has faced in recent years have come from the U.S. residential lawn and garden market business segment and is what led to the company deciding to abandon it, according to Werner Baumann, CEO of Bayer AG.

"Let me be very clear that (this decision) is exclusively geared at managing litigation risk and not because of any safety concerns," Baumann said.

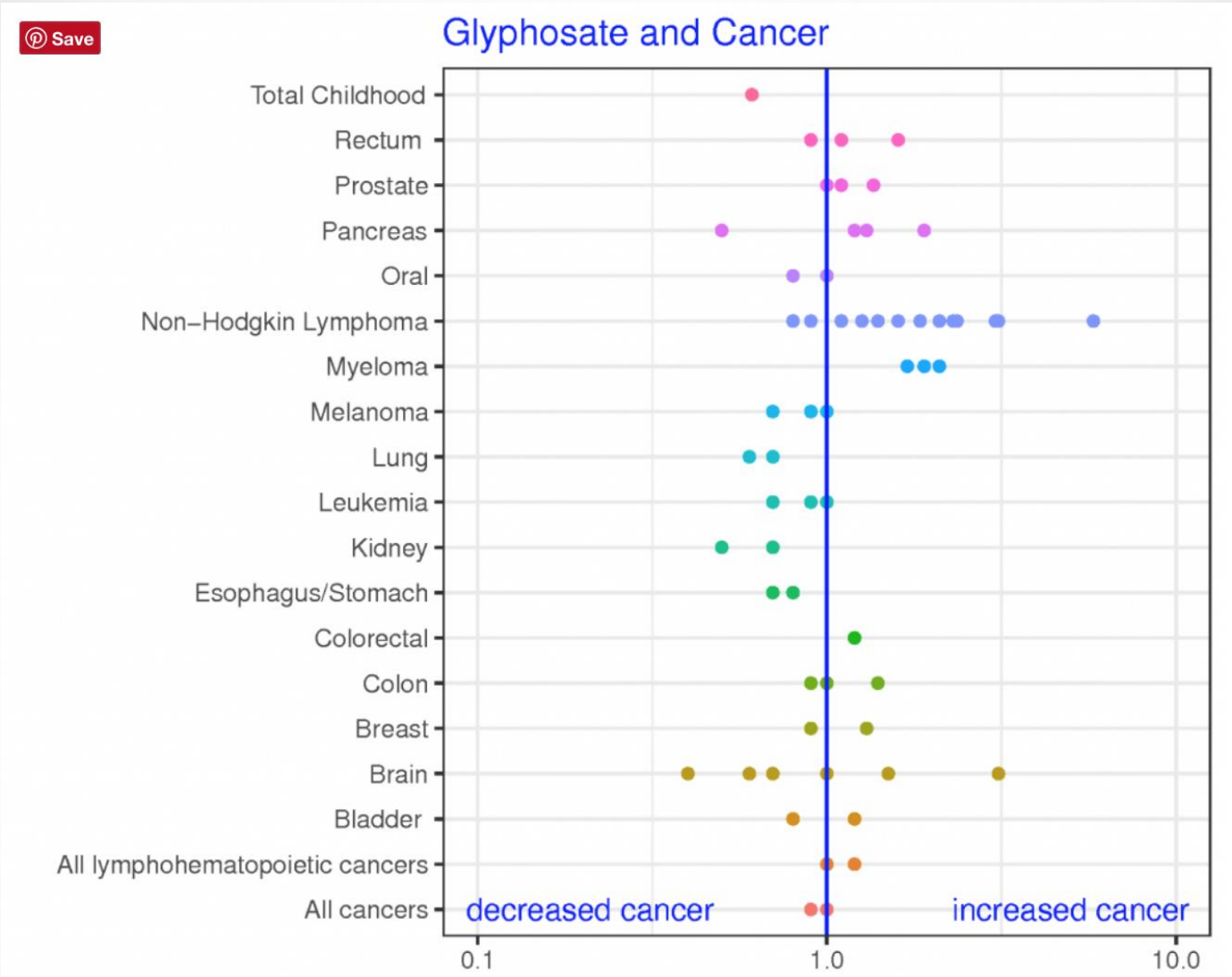
Bayer on winning streak in Roundup litigation after huge initial losses

By Brendan Pierson September 22, 2022

The logo of Bayer AG is pictured at the facade of the historic headquarters of the German pharmaceutical and chemical maker. REUTERS/Wolfgang Rattay

Bayer said in 2021 that it will stop selling glyphosate-based weedkillers in the U.S. residential market for non-professional gardeners, which the company has said accounts for the "vast majority" of lawsuits. It will continue to sell glyphosate-based weedkillers to farmers, who rely on it heavily.

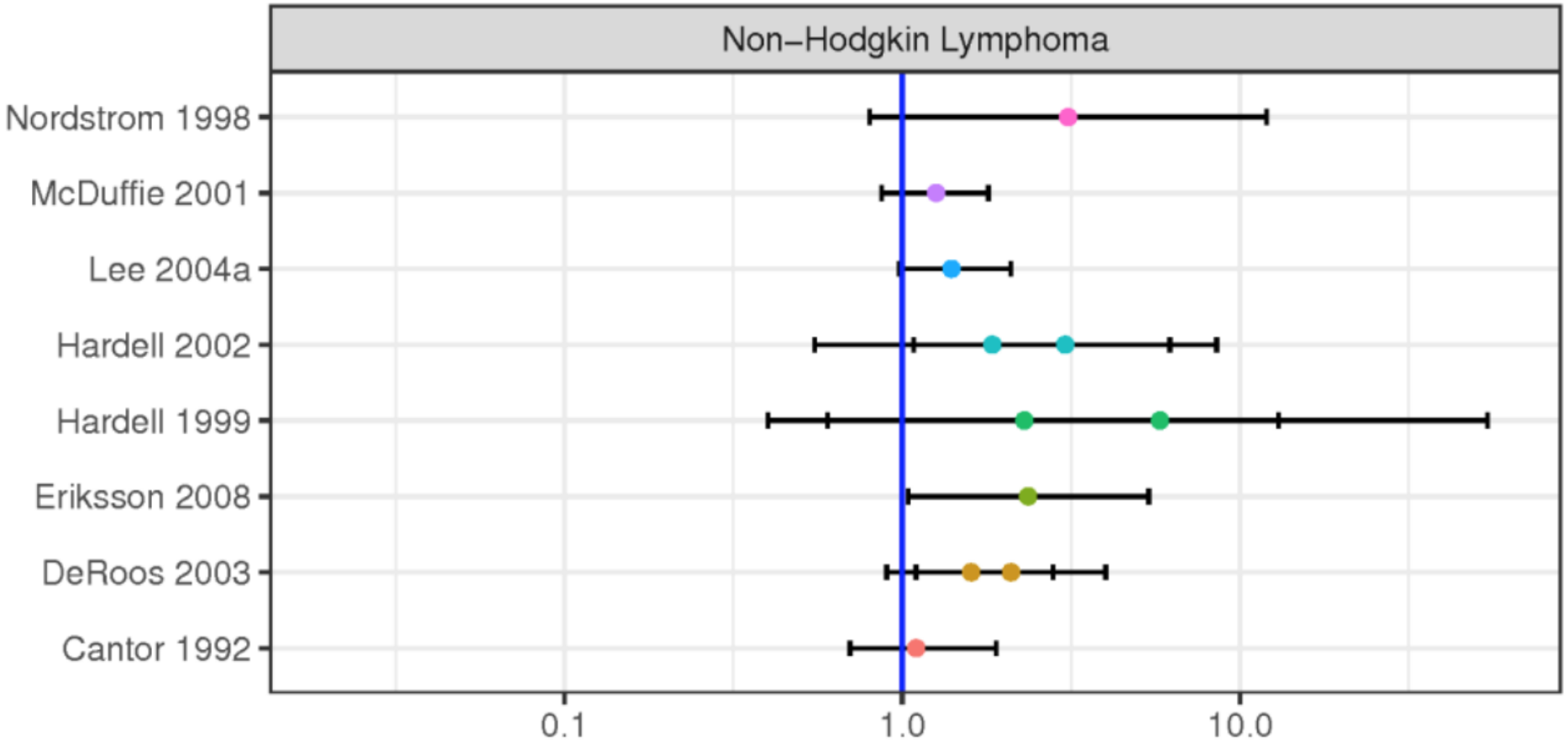
(Reuters) - Bayer AG has won its fifth consecutive trial over claims that its weedkiller Roundup causes cancer, the company announced Thursday.



HERBICIDES / RESEARCH

Glyphosate and cancer – revisited

August 11, 2018 - by **Andrew Kniss**



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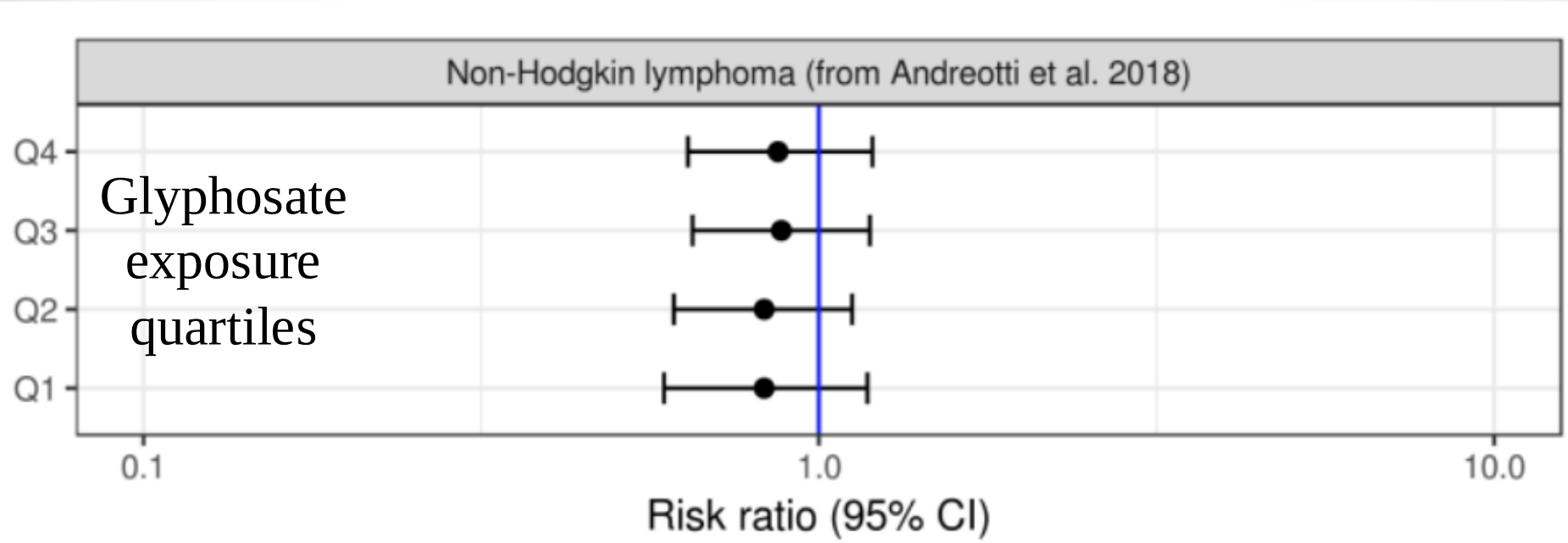

HERBICIDES / RESEARCH

Glyphosate and cancer – revisited

August 11, 2018 - by **Andrew Kniss**

BARRON'S

FROM AFP NEWS

Austria Dismisses Claims Against Bayer Over Glyphosate

By AFP - Agence France Presse March 19, 2024

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Vienna prosecutors have dismissed claims by an NGO grouping alleging that chemicals firm Bayer withheld data showing health risks from exposure to its herbicide glyphosate, they said Tuesday.

The European Commission in November said it would allow the use of the controversial herbicide glyphosate for another 10 years, breaking the stalemate between EU states divided over its safety.

Several NGOs, including Global 2000, lodged a claim in Vienna in September last year against Bayer over the weedkiller.

Environmental activists have long cited scientific evidence that glyphosate may cause cancer, poison aquatic life and be fatal to key pollinators like bees, which Bayer and some experts dispute.

"All complaints concerning glyphosate have been checked, and there are no more probes ongoing. All have been dismissed or closed," a spokeswoman for the Vienna prosecutor's office told Agence French Presse.

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 Q&A

Authors: K. Buhl, Statewide Pesticide Safety Education Program, and C. Bubl, OSU Extension Service

To put the IARC determination in context, they put the following items in the same category as glyphosate, Group 2A "Probable human carcinogens."

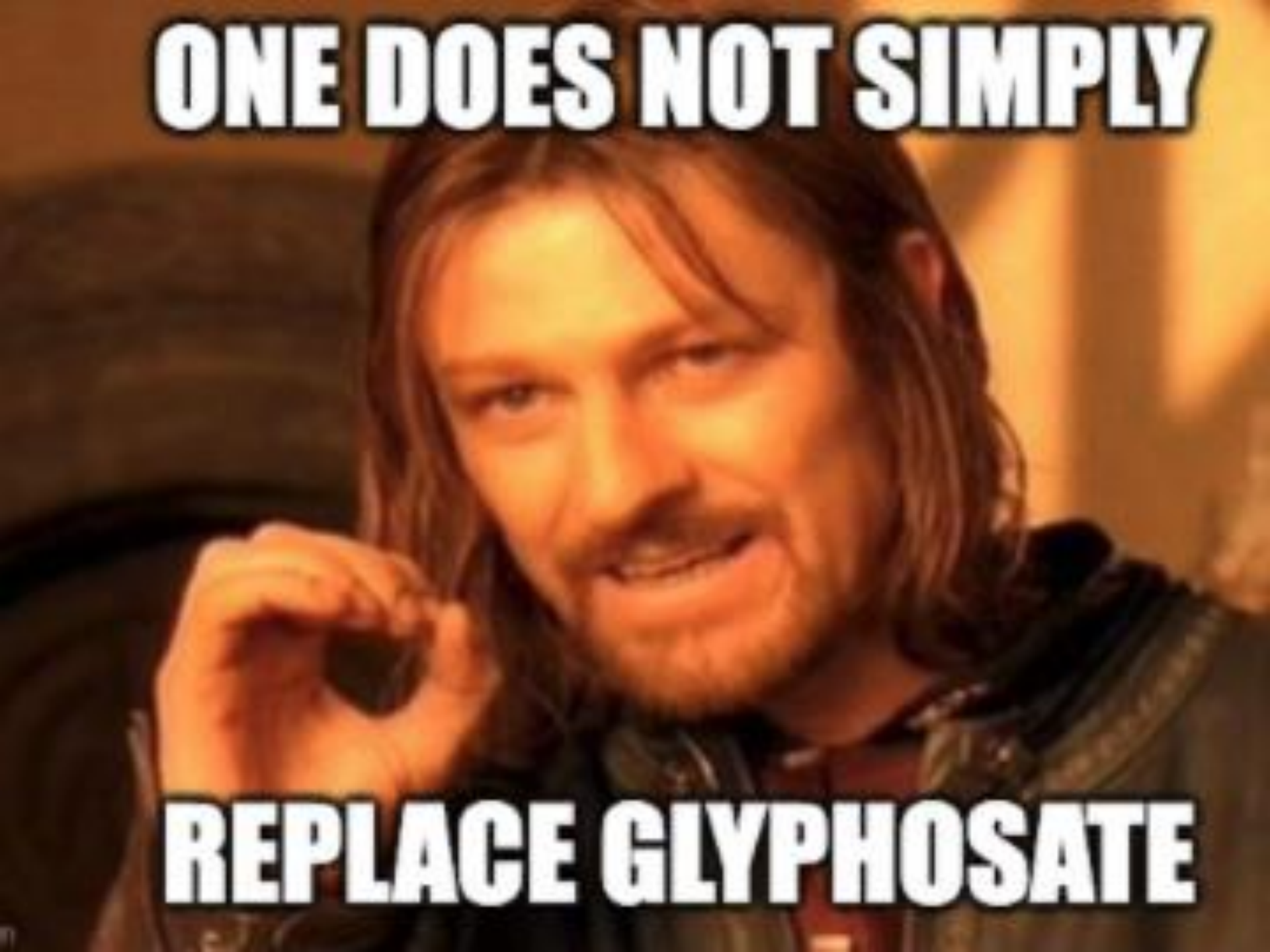
- Red meat
- Indoor emissions from burning wood
- High-temperature frying
- Late-night work shifts

GLYPHOSATE Q&A

Authors: K. Buhl, Statewide Pesticide Safety Education Program, and C. Bubl, OSU Extension Service

The following items were placed in a stronger-evidence category, "Known human carcinogens."

- Processed meats
- All alcoholic beverages
- Sunlight
- Engine exhaust
- Outdoor air pollution


ONE DOES NOT SIMPLY
REPLACE GLYPHOSATE

Glyphosate

- Glyphosate is a systemic (translocated) herbicide that moves from the treated foliage to other plant parts, including the roots. In this way, glyphosate kills annual and perennial weeds.
- Glyphosate is non-selective. This means a single herbicide can be used to control most weeds – grasses, sedges and broadleaves.
- Glyphosate has little or no residual activity in soil. It is rapidly bound by clay particles in the soil rendering it inactive. This means you can spray weeds beneath shrubs and trees without damaging the desirable plants – as long as you keep the spray **on** the weeds and **off** the shrubs.
- Glyphosate is relatively inexpensive – compared to other herbicides.

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Chemical Glyphosate Alternatives?

*Trade names can vary

Scythe – pelargonic acid (non-selective contact)

- Slower during colder temps
- Rapid burn-down in warmer temps
- Not certified organic though is often talked about in that category
- Weeds should be less than 6”
- Reduced efficacy on perennial weeds
- Expensive compared to glyphosate
- Contact only
- Warning Label

Chemical Glyphosate Alternatives?

*Trade names can vary

Finale or Cheetah Pro – glufosinate ("locally systemic")

- Moves within treated foliage but acts similar to a non-selective contact
- Reduced efficacy on perennial weeds
- Weeds should be less than 6"
- Expensive compared to glyphosate
- Warning Label- Finale, Cheetah Pro - Caution

Chemical Glyphosate Alternatives?

*Trade names can vary

Weed Zap – Cinnamon oil, clove oil

- OMRI Listed
- Not effective in cooler temps
- Weeds should be under 6”
- Expensive compared to glyphosate
- Reduced efficacy on perennial weeds
- Contact only
- Caution Label

Glyphosate Alternative Expectations

Although there are effective alternatives to glyphosate, each of these alternatives will be, in some way, less effective, less convenient, and / or more expensive.

- Selective postemergence grass herbicides will be convenient but more expensive and do not control broadleaf weeds.
- Mechanical controls or hand removal will be labor intensive and expensive.

Use of Pre-emergent herbicides may reduce the need for post-emergent weed control.

PNAS

RESEARCH ARTICLE | AGRICULTURAL SCIENCES | FREE ACCESS

Environmental and economic concerns surrounding restrictions on glyphosate use in corn

Ziwei Ye, Felicia Wu, and David A. Hennessy Authors Info & Affiliations

April 26, 2021 | 118 (18) e2017470118 | https://doi.org/10.1073/pnas.2017470118

Significance

Since IARC classified glyphosate as a Group 2A probable human carcinogen in 2015, multiple regulations restricting glyphosate use have emerged worldwide. One question that has been insufficiently addressed is how weed-control alternatives to glyphosate compare in terms of health, environmental, and market effects. Our study analyzes these

"Our results suggest that caution is warranted when regulating glyphosate, if only because replacement herbicides may cause more harm."

social welfare loss, mostly driven by the increased cost of corn production. Our results suggest that caution is warranted when regulating glyphosate, if only because replacement herbicides may cause more harm.

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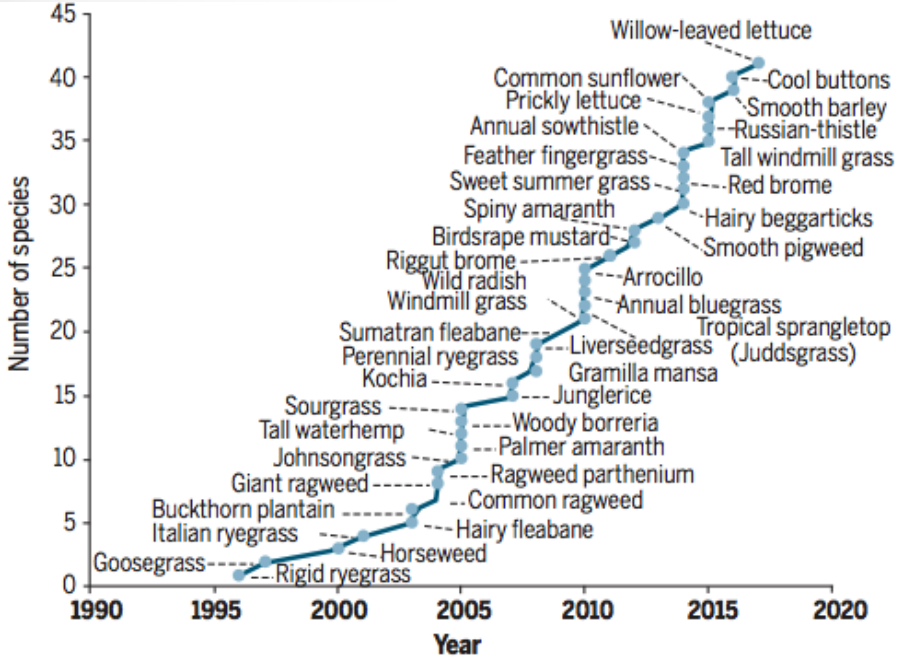

CREDIT: I. HEAP, WEEDSCIENCE.ORG 2018, ADAPTED BY H. BISHOP

Increase in glyphosate-resistant weeds worldwide

Fig. 1. Weed species with resistance to herbicides. (**Left**) Cumulative number of weed species with resistance to glyphosate. (**Right**) Cumulative number of weed species with resistance to herbicides in the major mechanism of action groupings.

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
- Glyphosate Questions & Answers for gardeners
  - http://blogs.oregonstate.edu/mgcoordinators/2018/10/15/glyphosphate-questions-answers/

The Glyphosate/Roundup Controversy

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