

Assessing PFAS Uptake by Vegetables

**Andrew Smith SM, ScD, Thomas Simones PhD,
Sara Gillooly MPH**

Maine Center for Disease Control and Prevention

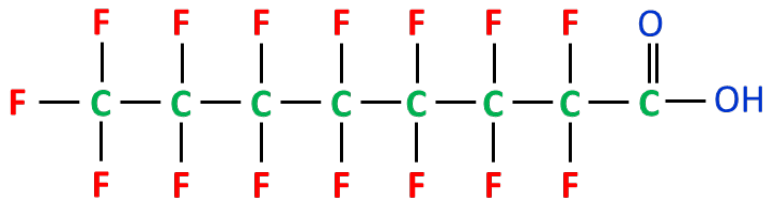
**Presented at the Maine Resource and Recovery
Association Conference**

May 8, 2023



PFAS – Perfluoroalkyl Substances

Naming conventions



Perfluorooctanoic acid (PFOA)

8 carbons

Perfluoroheptanoic acid (PFHpA)

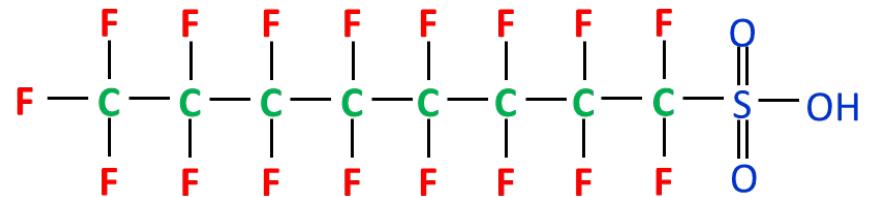
7 carbons

Perfluorononanoic acid (PFNA)

9 carbons

Perfluorodecanoic acid (PFDA)

10 carbons



Perfluorooctanesulfonic acid (PFOS)

8 carbons

Perfluorohexanesulfonic acid (PFHxS)

6 carbons

Perfluorobutanesulfonic acid (PFBS)

4 carbons

Case Study

How Much is Too Much PFAS in Soil?



PFOS 17 ppb

PFOA 9 ppb

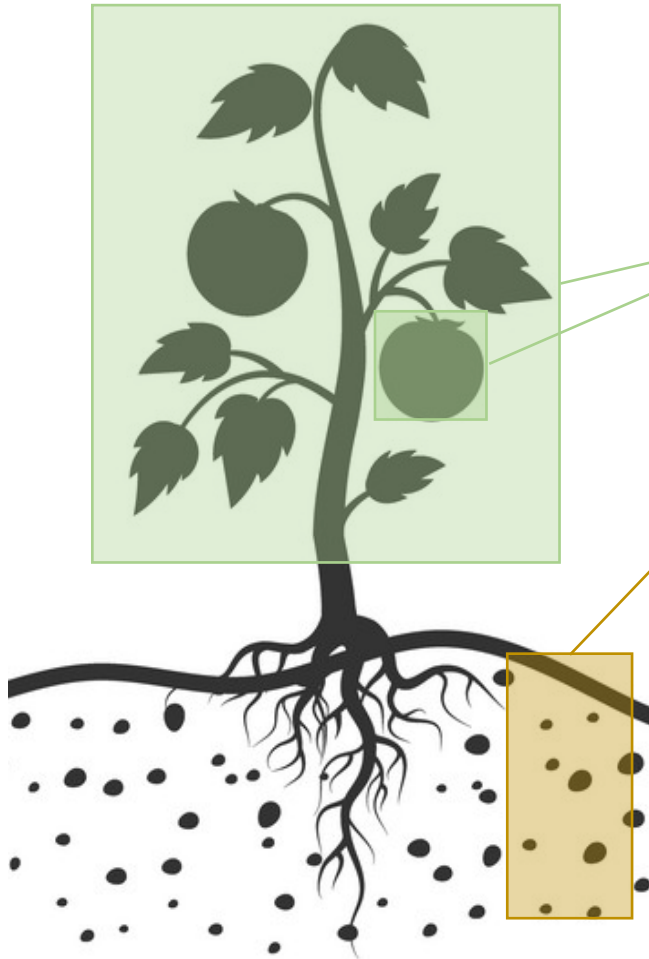
PFNA 16 ppb

PFDA 57 ppb

PFUnA 12 ppb

PFDoA 18 ppb

Plant “Transfer Factor”



$$\frac{[Plant_{PFAS} \text{ } ww]}{[Soil_{PFAS} \text{ } dw]}$$

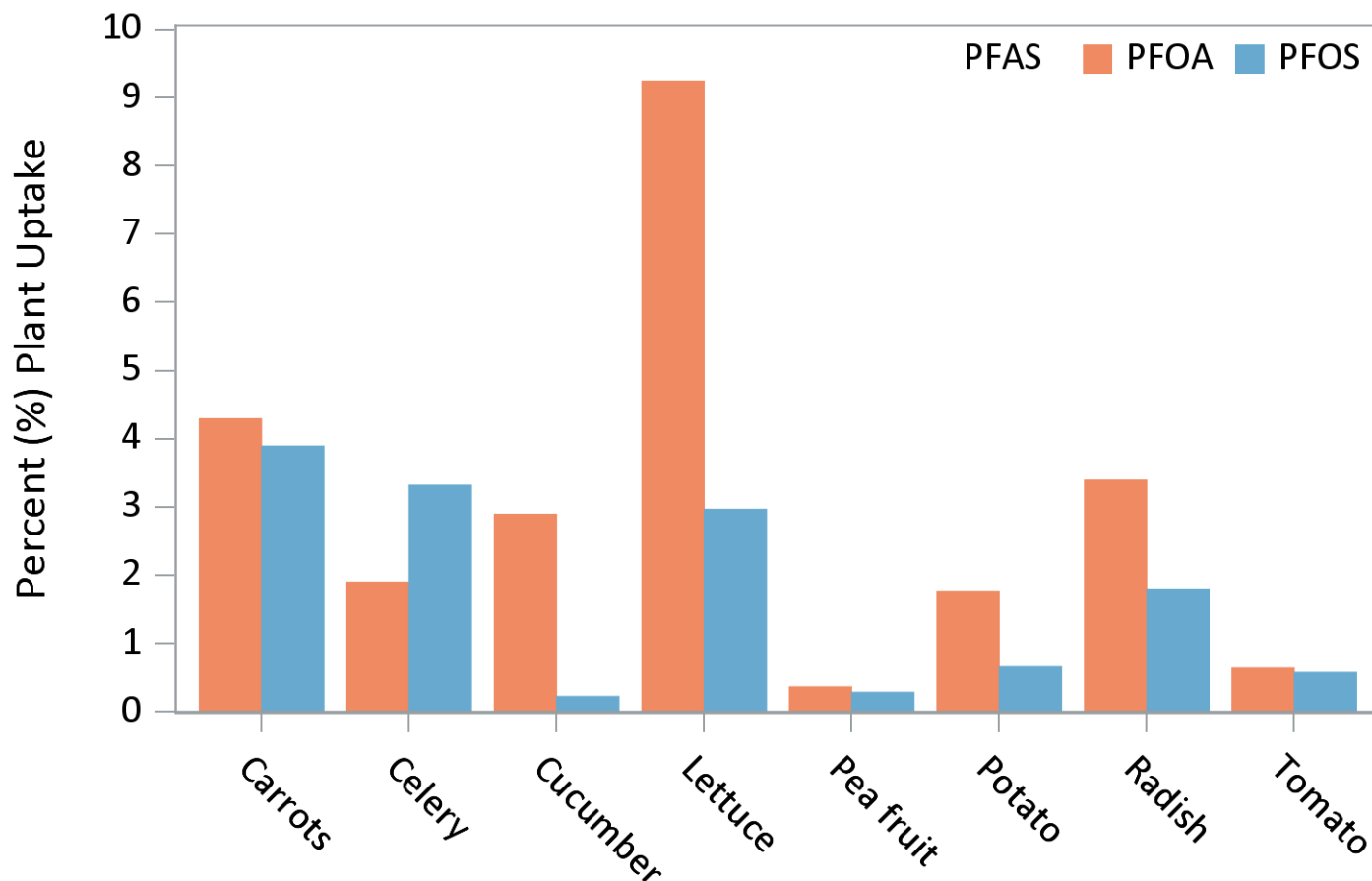
Transfer Factor = Ratio of PFAS concentration in the plant on a wet weight basis to the PFAS concentration to the soil on a dry weight basis

“Percent Plant Uptake”

$$\frac{[Plant_{PFAS} \text{ } ww]}{[Soil_{PFAS} \text{ } dw]} \times 100$$

What we know about vegetable uptake of PFAS from scientific literature

Average Plant Uptake Estimates Across Multiple Studies

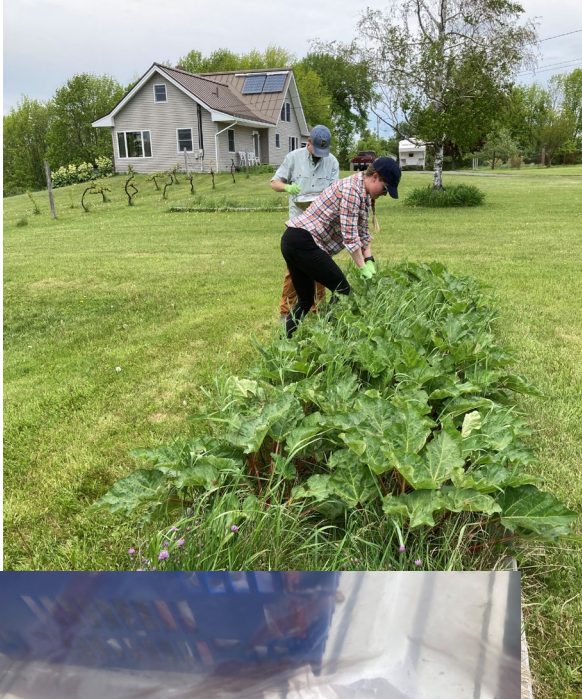


Sources: Blaine et al. 2013 <https://pubs.acs.org/doi/abs/10.1021/es403094q>

Blaine et al. 2014 <https://pubs.acs.org/doi/abs/10.1021/es500016s>

Lechner and Knapp. 2011. <https://pubs.acs.org/doi/10.1021/jf201355y>

Opportunistic Field Sampling



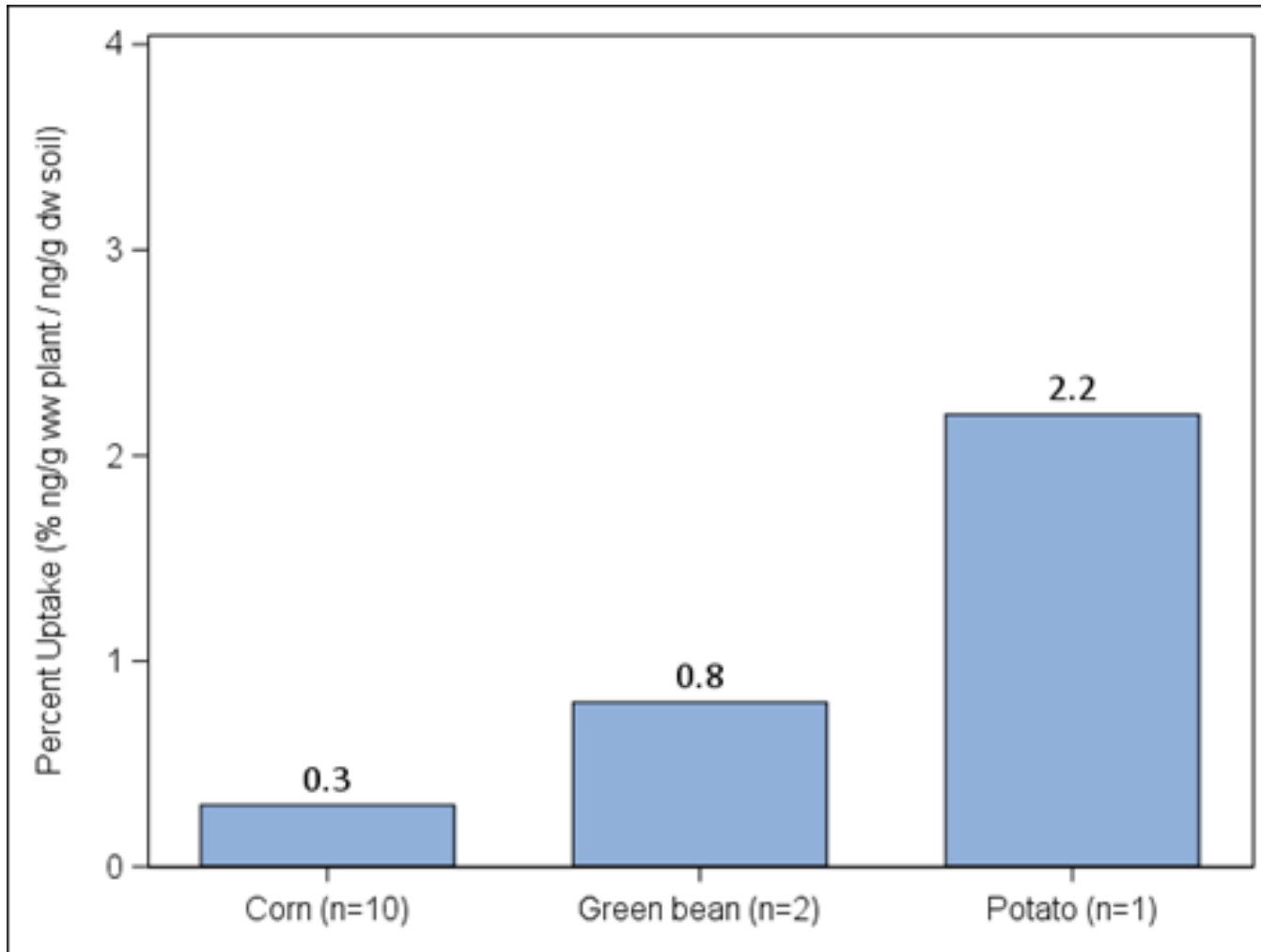
Methods



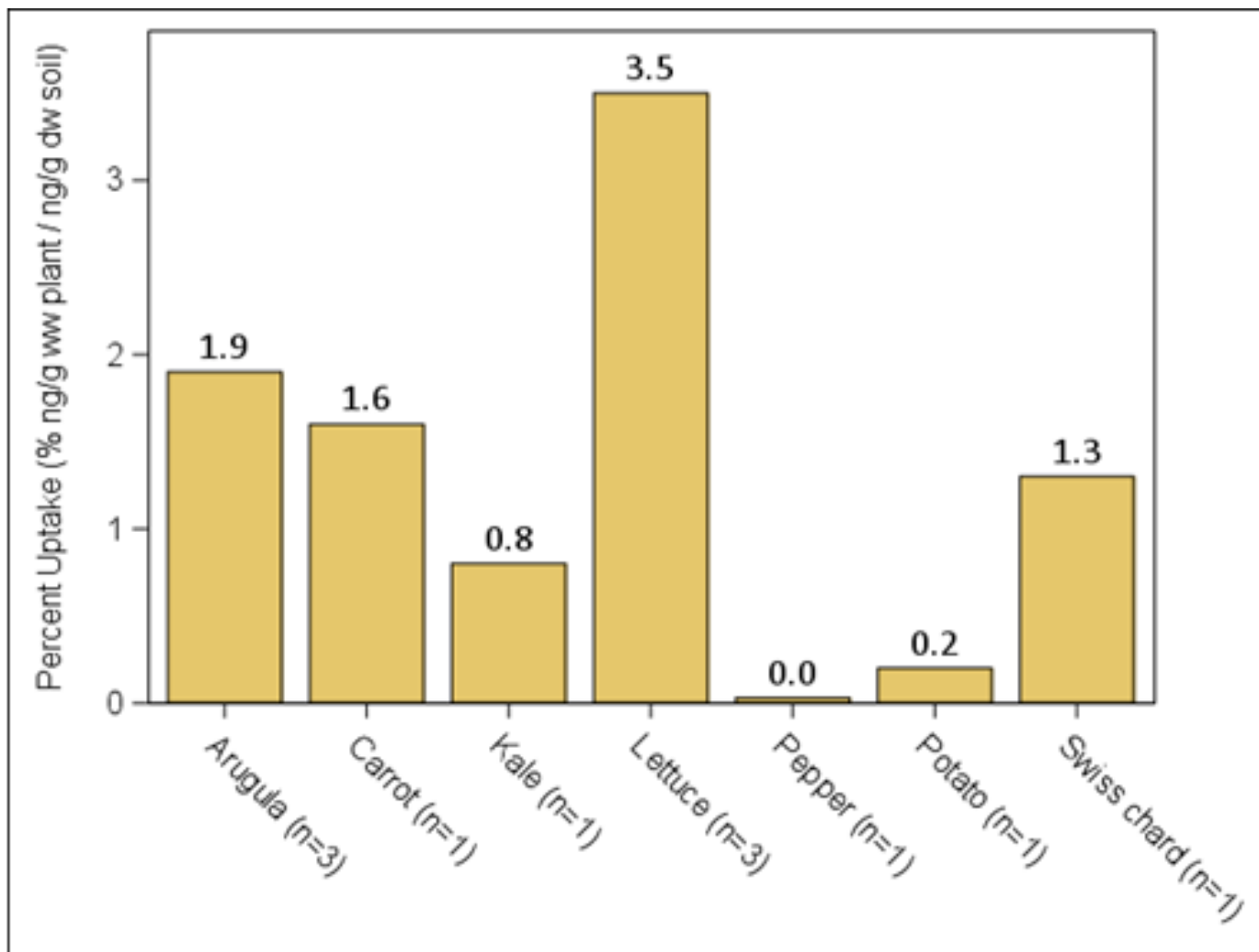
Work in Progress – Do not cite

Maine Department of Health and Human Services

PFOA Transfer Factors for Vegetables



PFOS Transfer Factors for Vegetables



Other vegetables that take up very little PFOS from Soil



How much is too much PFAS in soil?

$$\frac{\textit{Plant Action Level}}{\textit{Plant: Soil Transfer Factor}} = \textit{Soil Level}$$

How much is too much PFAS in food?



$$\frac{\textit{Toxicity Value}}{\textit{Consumption Rate}} = \textit{Action Level}$$



Example: How much is too much PFAS in soil for growing lettuce?

$$\text{PFOS} \quad \frac{1.4 \text{ ppb}}{0.035} = 40 \text{ ppb}$$

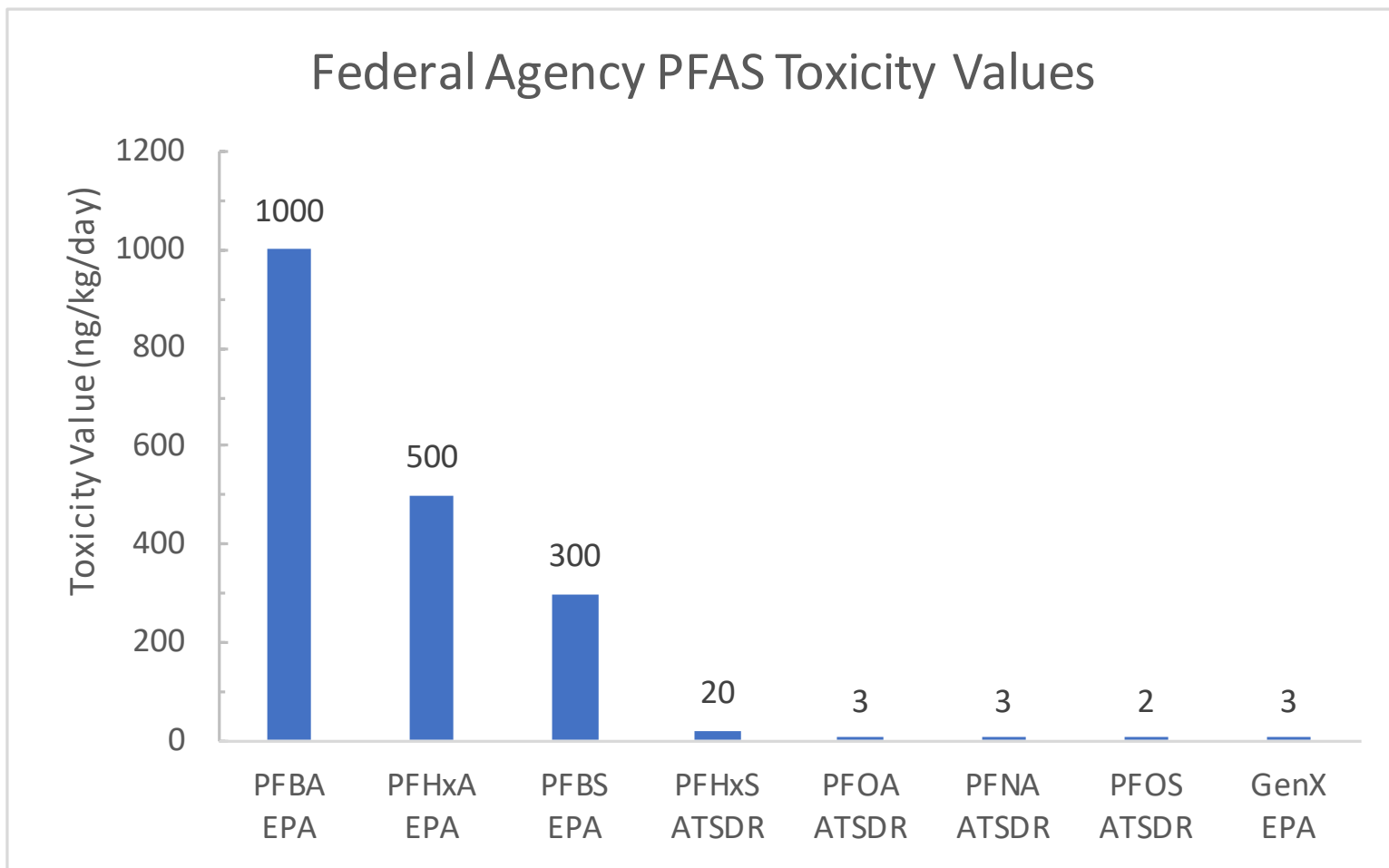
$$\text{PFOA} \quad \frac{2.1 \text{ ppb}}{0.12} = 18 \text{ ppb}$$

Example: How much is too much PFAS in soil for growing potatoes?

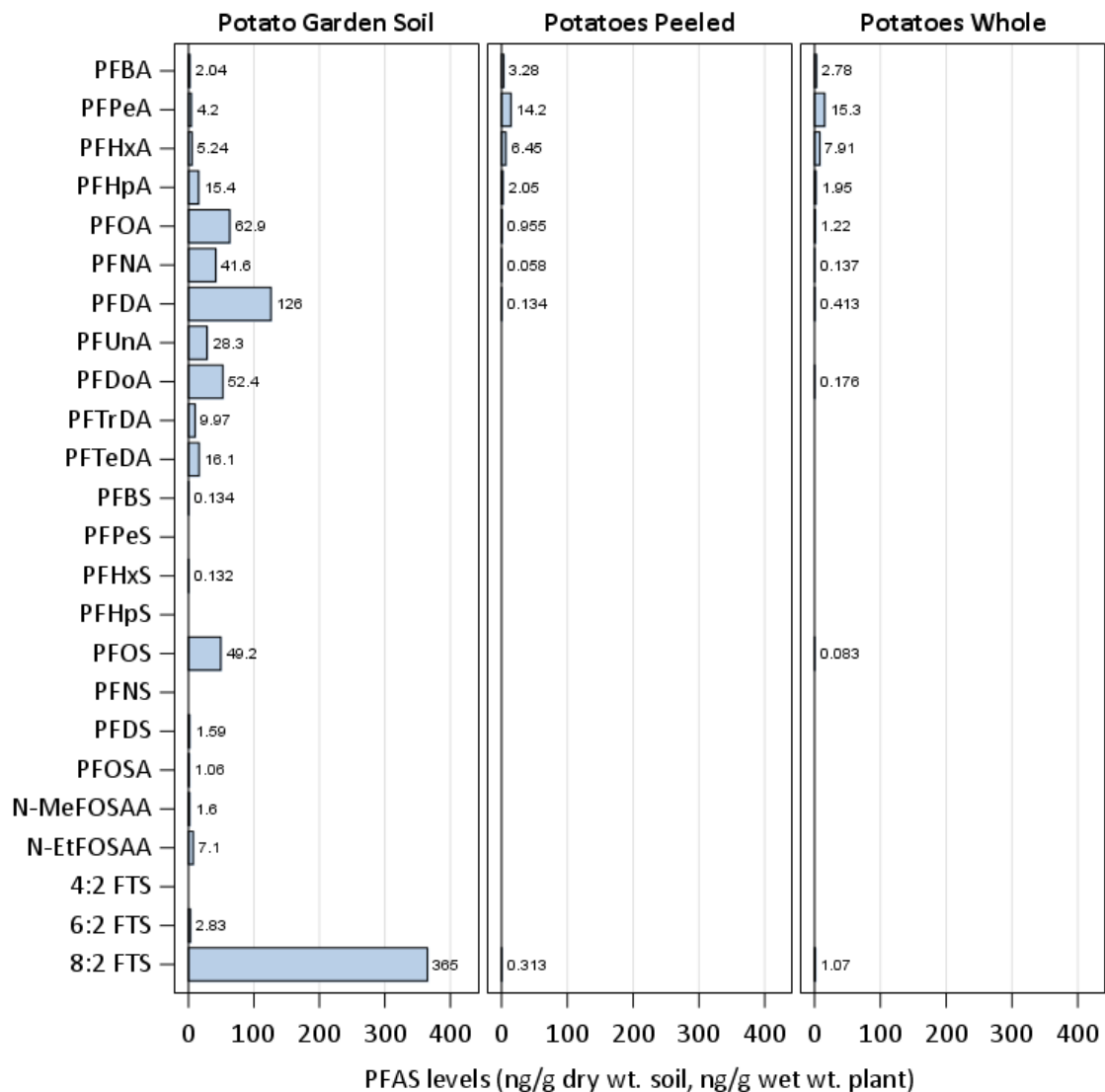
$$\text{PFOS} \quad \frac{0.3 \text{ ppb}}{0.002} = 150 \text{ ppb}$$

$$\text{PFOA} \quad \frac{0.5 \text{ ppb}}{0.02} = 23 \text{ ppb}$$

Available Toxicity Values



What about other PFAS?



Case Study

How Much is Too Much PFAS in Soil?



PFOS 17 ppb

PFOA 9 ppb

PFNA 16 ppb

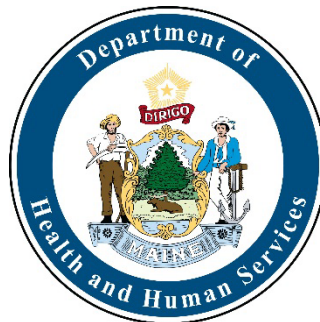
PFDA 57 ppb

PFUnA 12 ppb

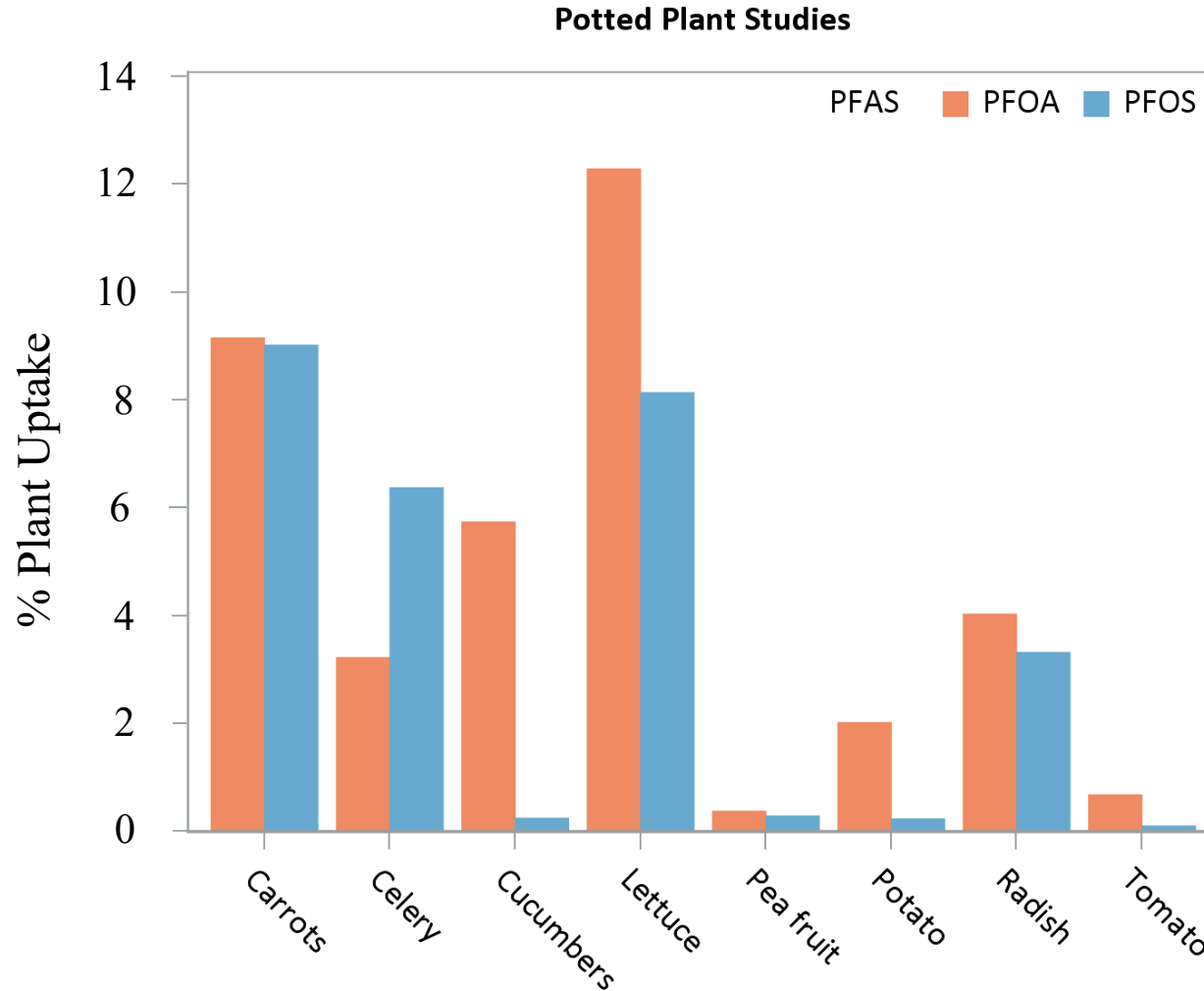
PFDoA 18 ppb

Questions?

Andrew Smith, SM, ScD
State Toxicologist
Maine Center for Disease
Control and Prevention
andy.e.smith@maine.gov



What we know about vegetable uptake of PFAS from scientific literature



Sources: Blaine et al. 2013 <https://pubs.acs.org/doi/abs/10.1021/es403094q>

Blaine et al. 2014 <https://pubs.acs.org/doi/abs/10.1021/es500016s>

Lechner and Knapp. 2011. <https://pubs.acs.org/doi/10.1021/jf201355y>

What about other PFAS?

