

Assessing PFAS in Agricultural Settings

“Things we have learned in the past 5 years”

Andrew Smith, SM, ScD

State Toxicologist

Maine Center for Disease Control and Prevention

Presented to the Joint Committee on Agriculture
Conservation and Forestry

February 17, 2022

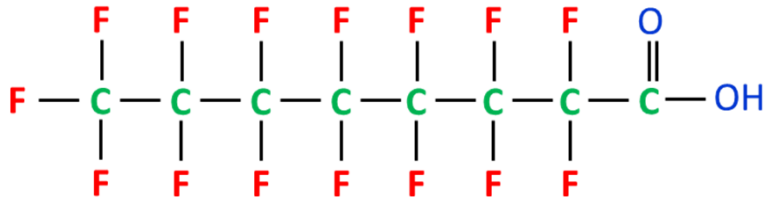


Topics

- There is a lot of variability in what we are finding for PFAS in soils, in crops, and even within a plant
- The “Forever Chemicals” are not forever in all things
- PFAS are not all the same when it comes to their movement in the environment
- Models for how much is too much PFAS in soil
- The challenge of changing guidance on what is a tolerable daily intake of PFAS

PFAS – Perfluoroalkyl Substances

Naming conventions

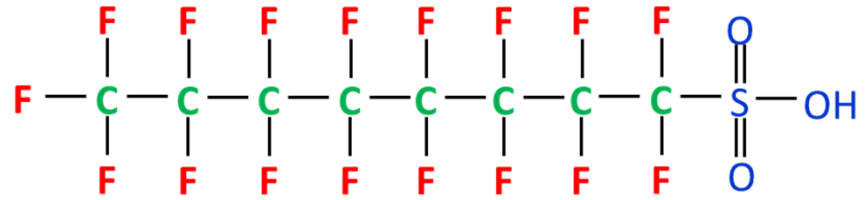


Perfluorooctanoic acid (PFOA)
8 carbons

Perfluoroheptanoic acid (PFHpA)
7 carbons

Perfluorononanoic acid (PFNA)
9 carbons

Perfluorodecanoic acid (PFDA)
10 carbons

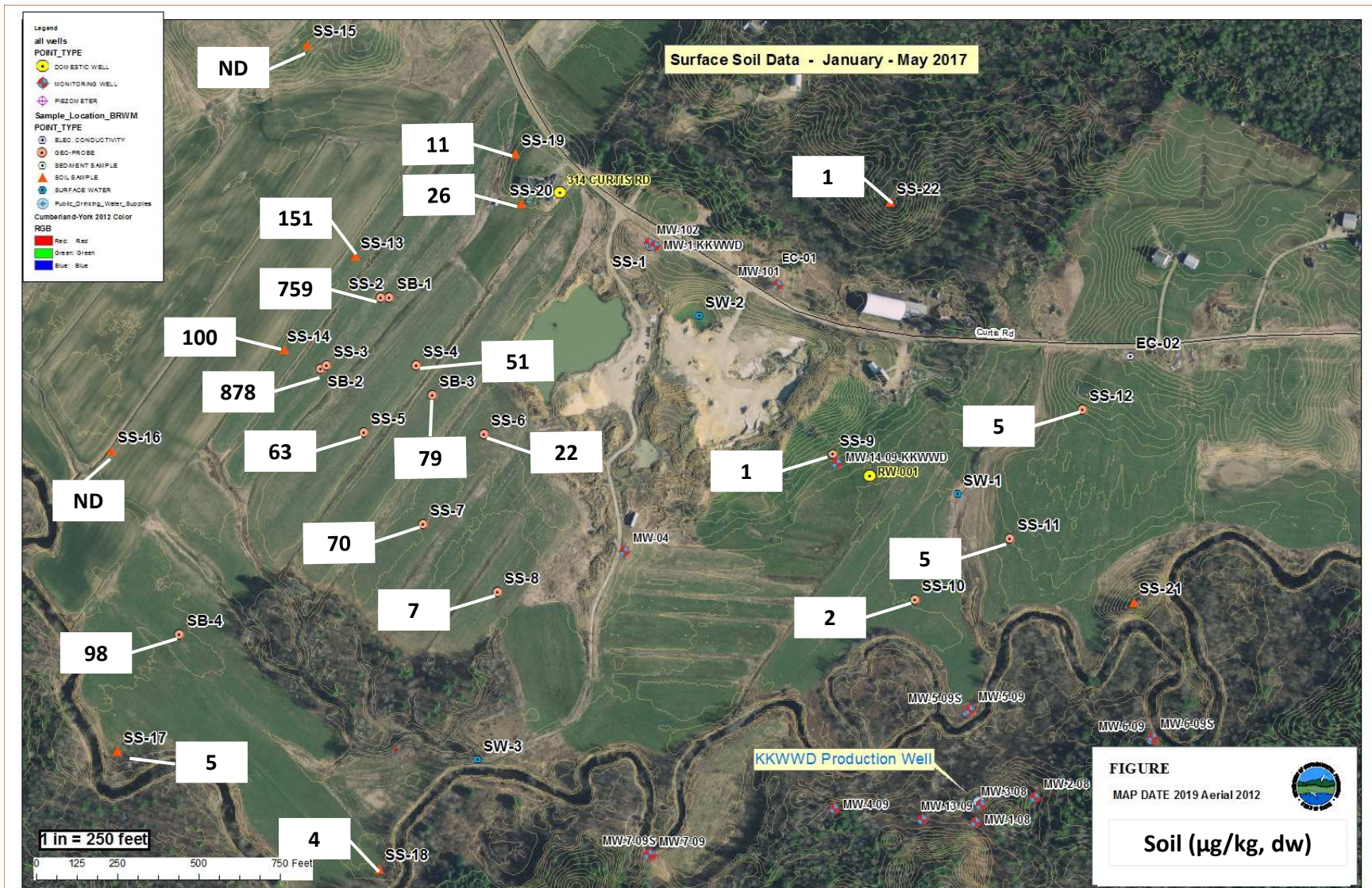


Perfluorooctanesulfonic acid (PFOS)
8 carbons

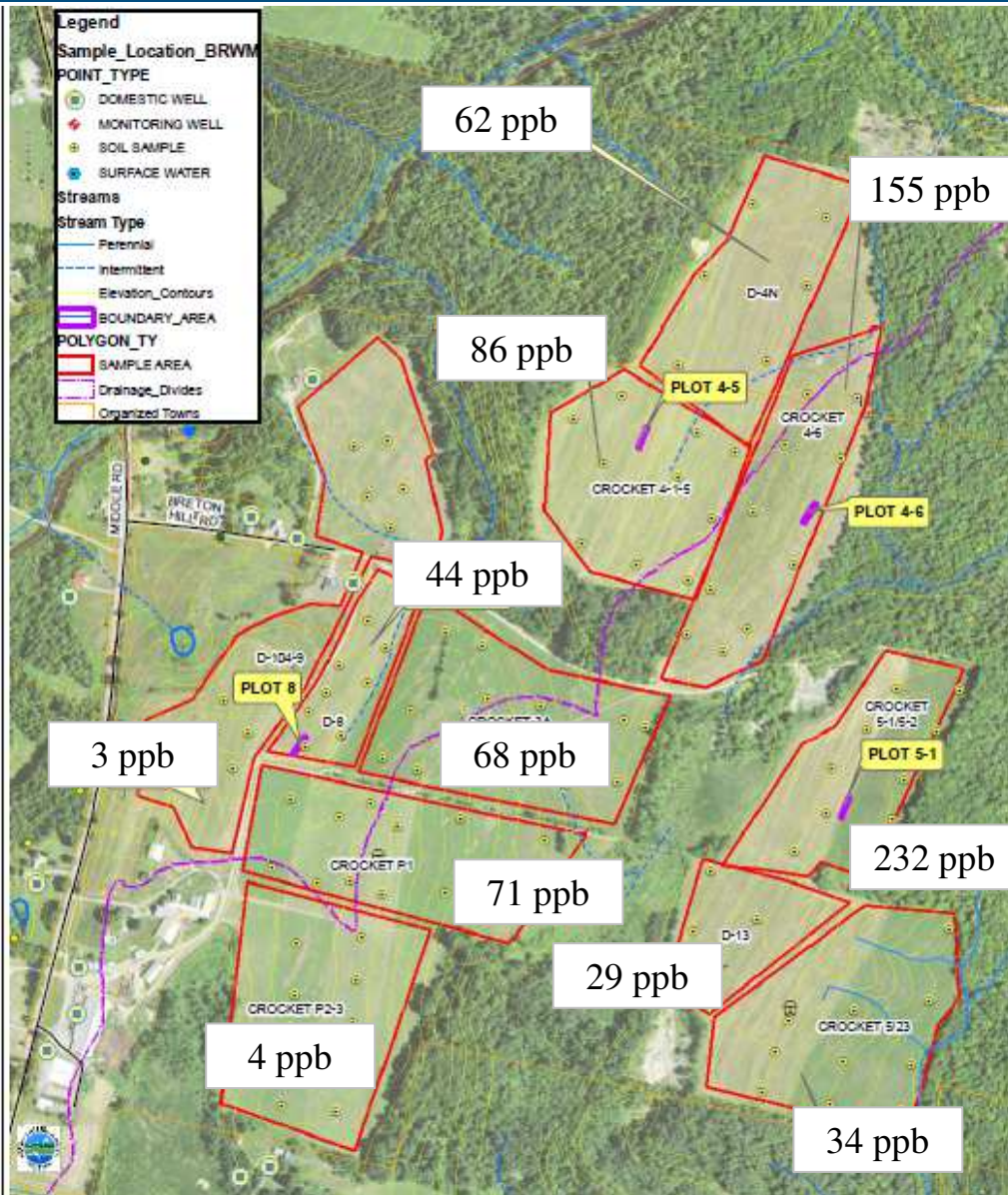
Perfluorohexanesulfonic acid (PFHxS)
6 carbons

Perfluorobutanesulfonic acid (PFBS)
4 carbons

PFAS soil levels can vary a lot within a field



PFAS soil levels can vary a lot between fields



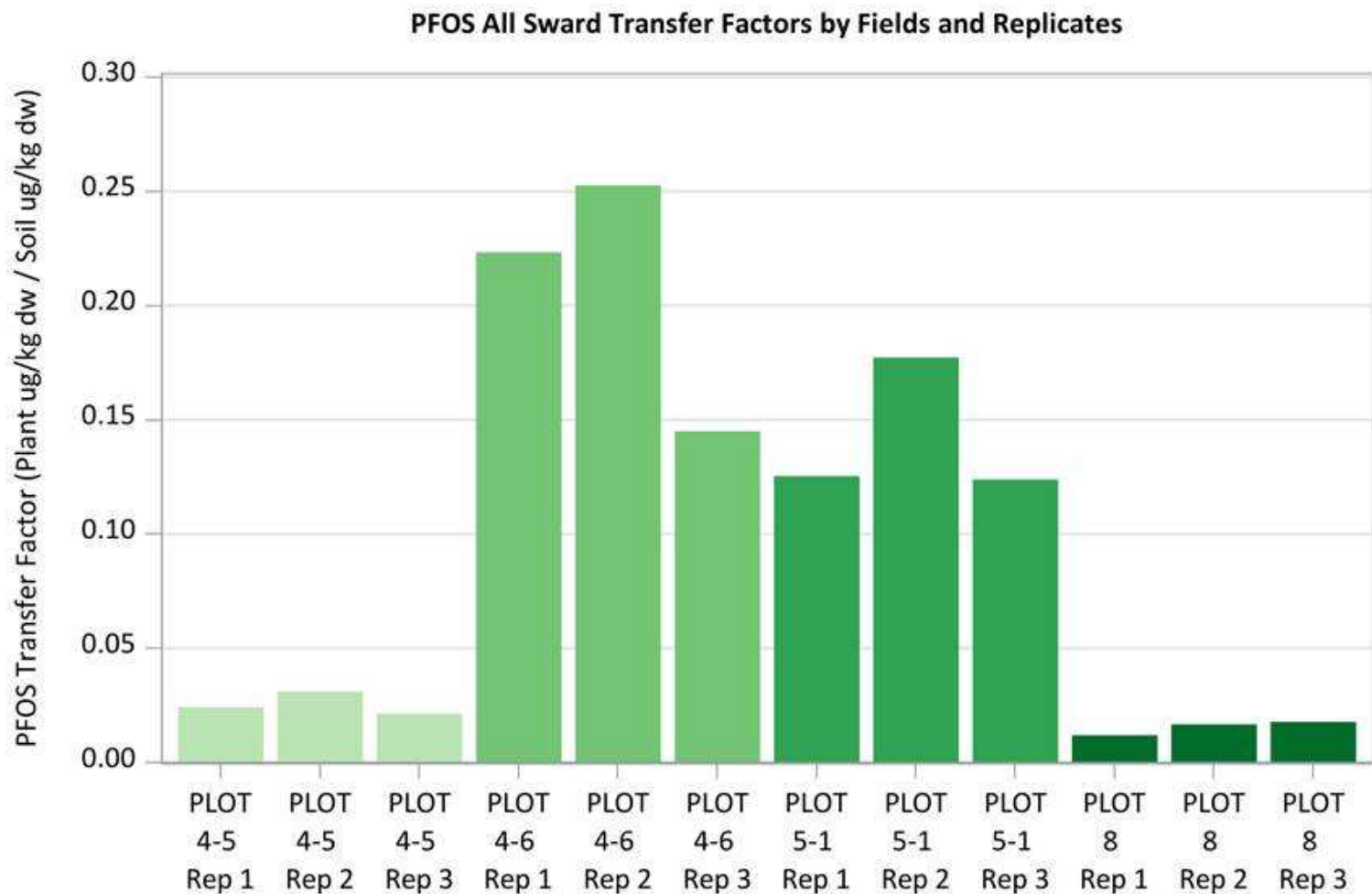
- *Average* PFOS levels in fields range from low of 29 ppb to high of 232 ppb.

Hay PFOS Uptake Study



Uptake of PFOS by hay can vary by field

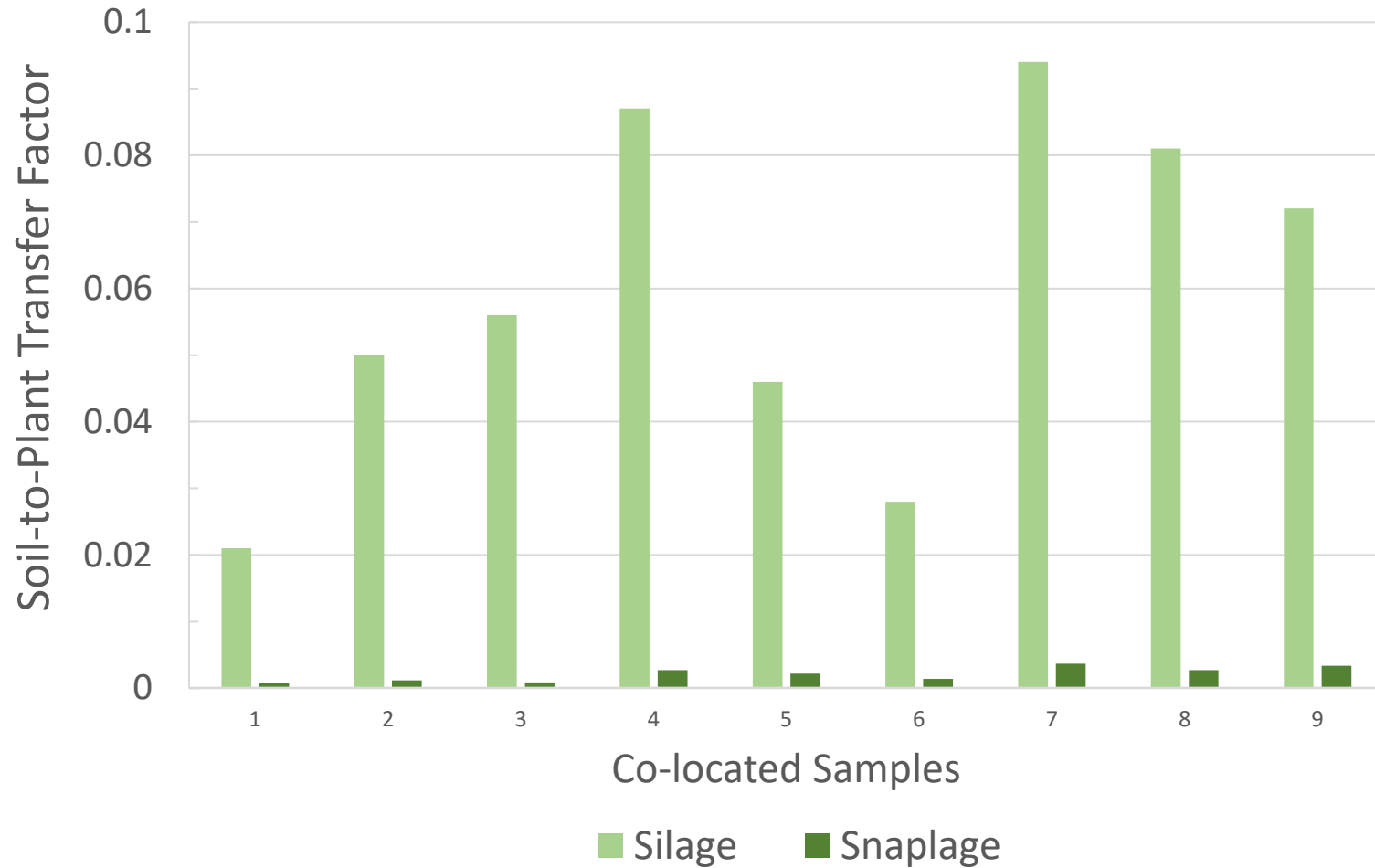
Preliminary Results



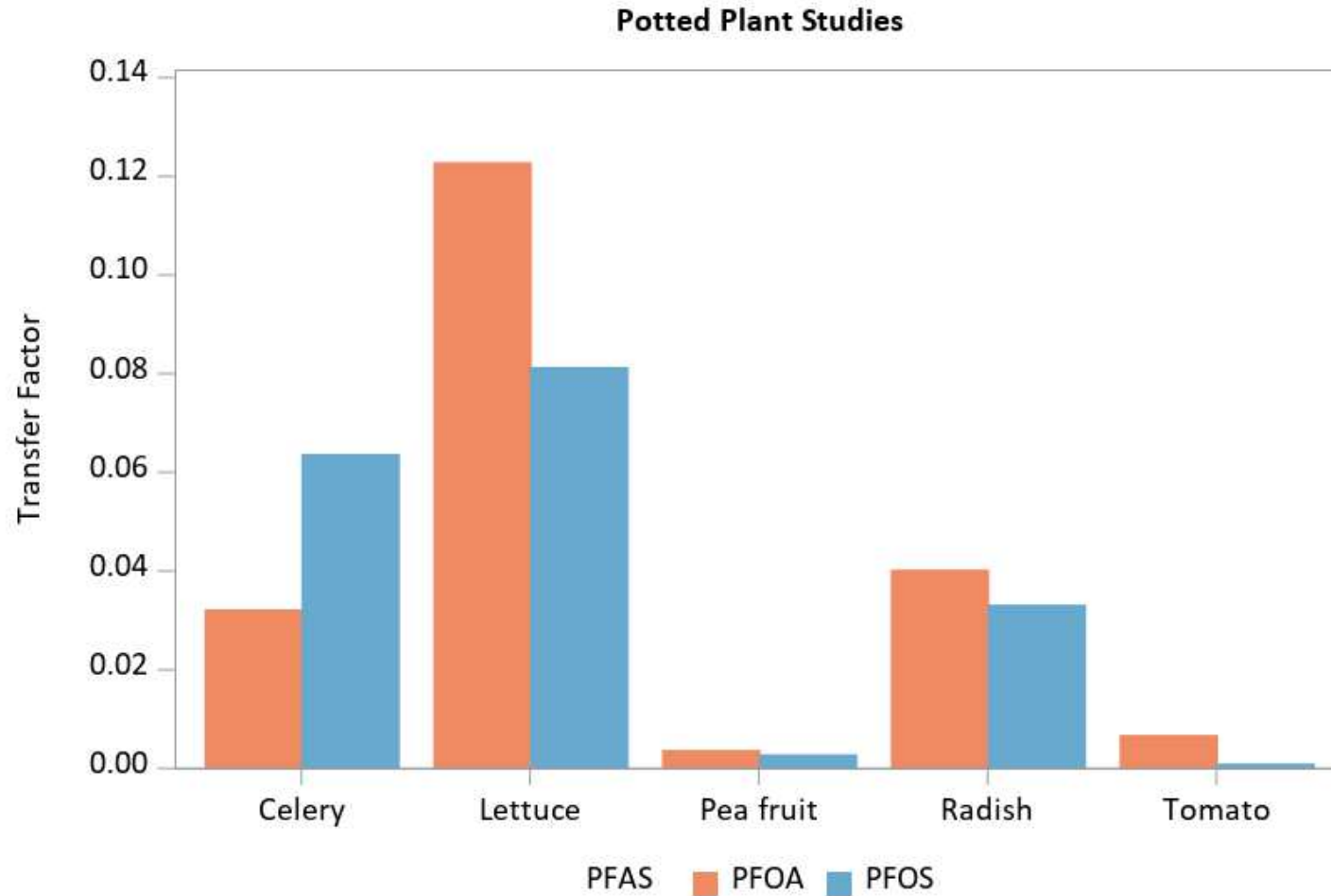
Corn Silage PFOS Uptake Study



Uptake of PFOS can vary by plant tissue

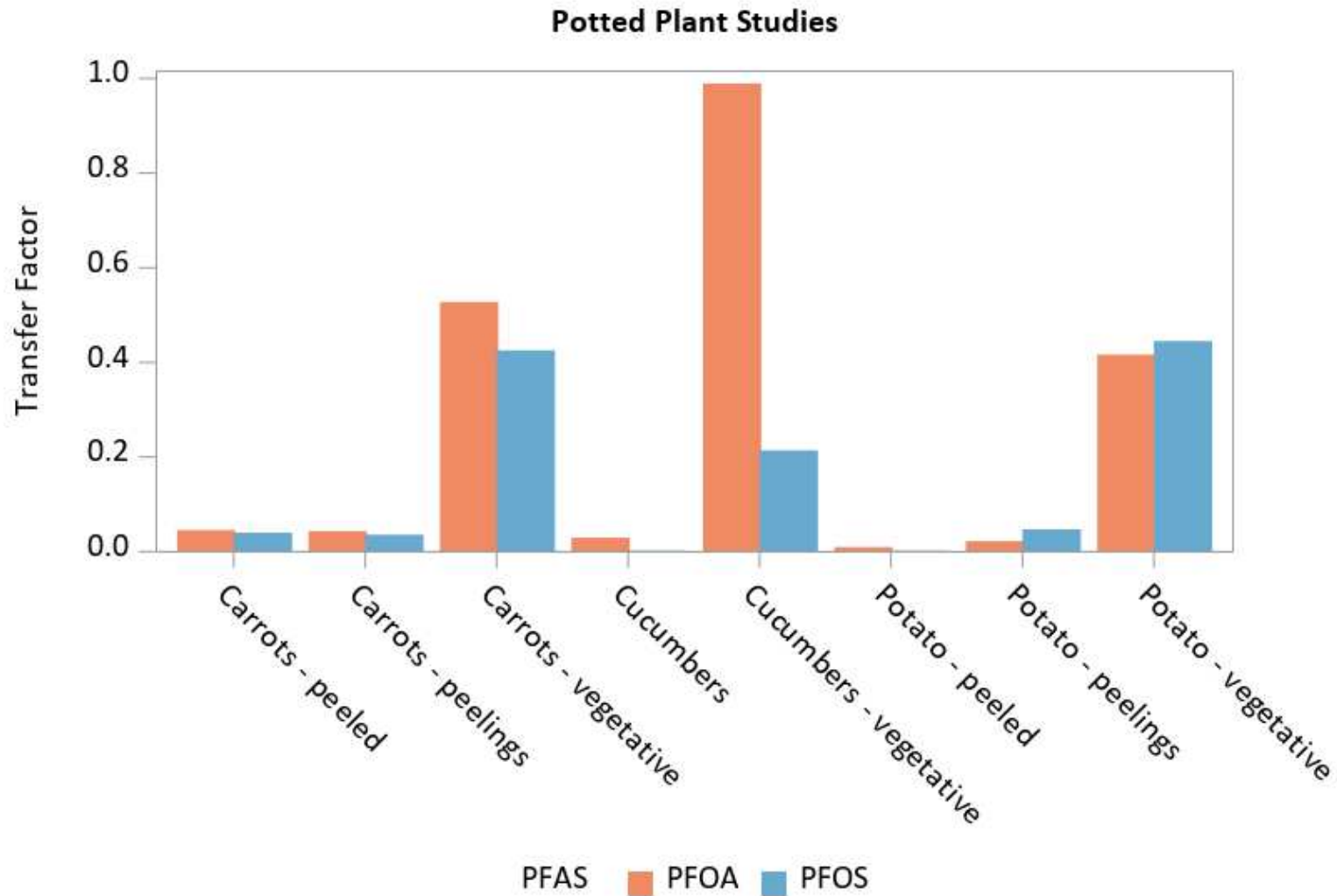


Uptake of PFAS can vary by plant tissue



Source: Blaine et al. 2013 <https://pubs.acs.org/doi/abs/10.1021/es403094g> and Blaine et al. 2014 <https://pubs.acs.org/doi/abs/10.1021/es500016s>

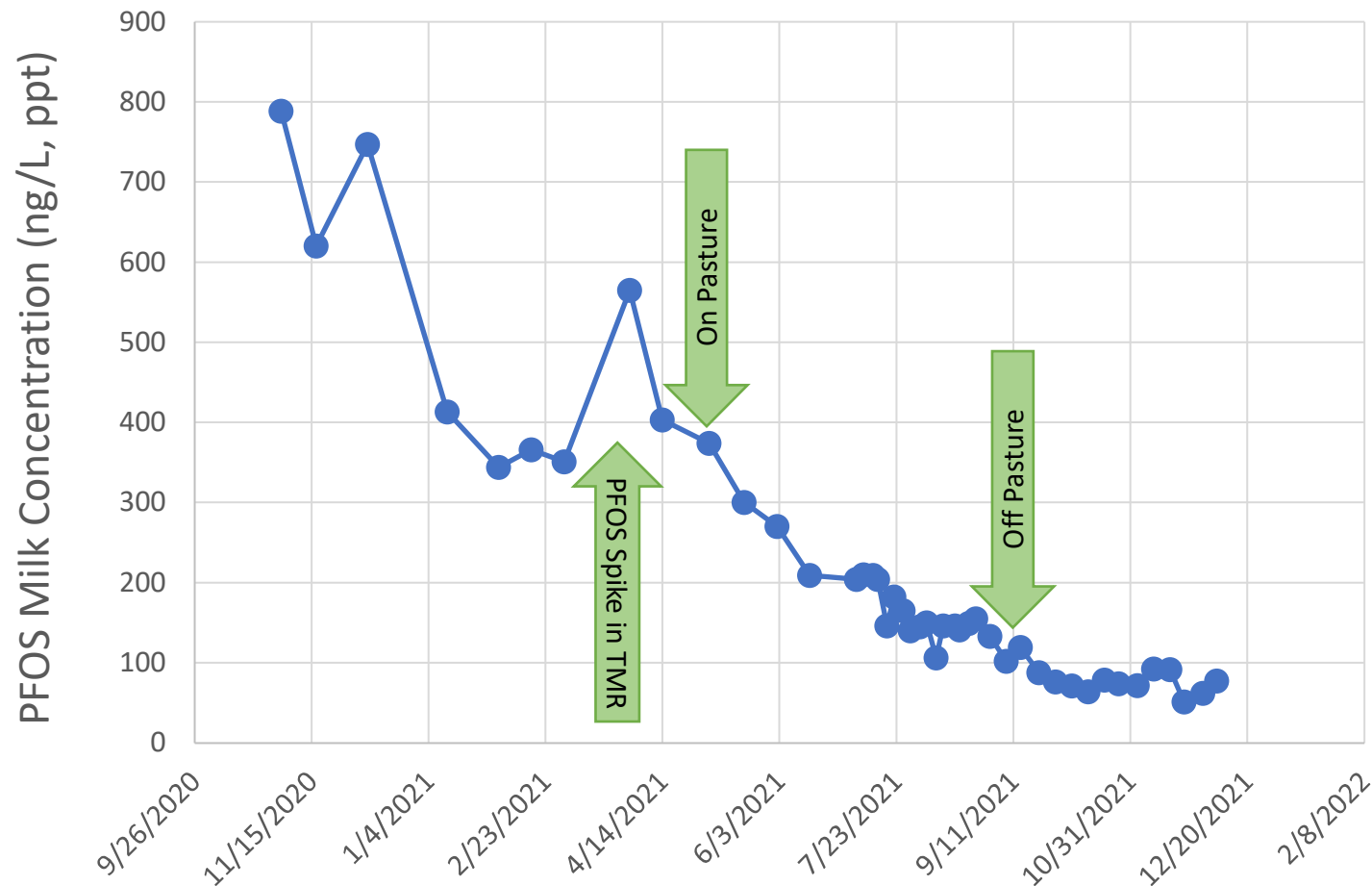
Uptake of PFAS can vary by plant tissue



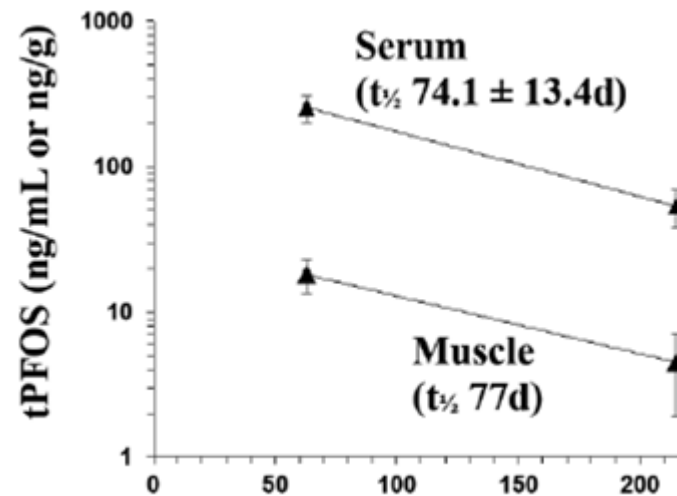
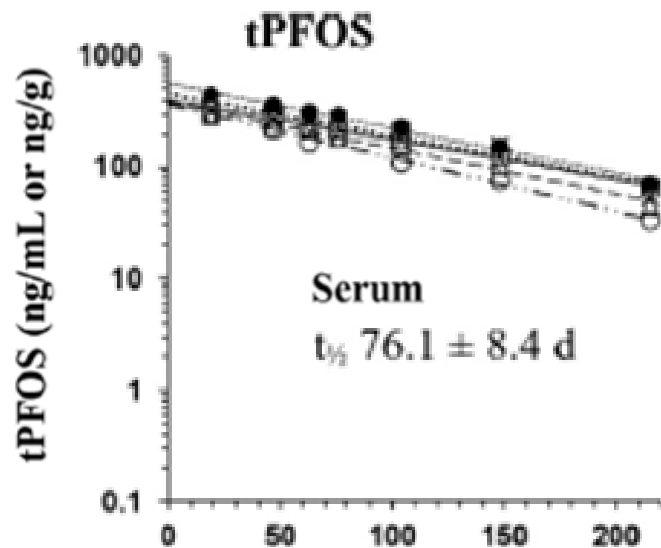
Source: Lechner and Knapp. 2011. <https://pubs.acs.org/doi/10.1021/jf201355y>

The “Forever Chemicals” are not forever in milk

PFOS Milk levels at a Dairy Farm Nov 2020 – Dec 2021



The “Forever Chemicals” are not forever in beef



Source: Drew et al., 2021. <https://doi.org/10.1080/19440049.2021.1991004>

Can we develop a live animal test for PFAS in muscle?



Need to have cow in a chute to restrain



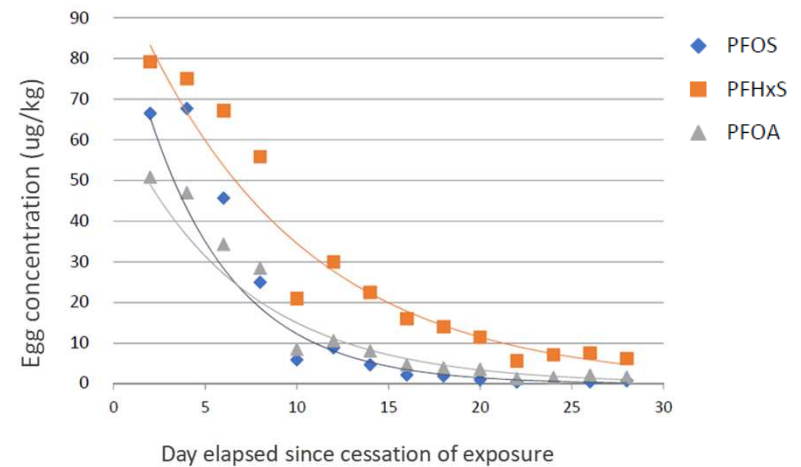
Sampling tail vein for blood

The “Forever Chemicals” are not forever in eggs



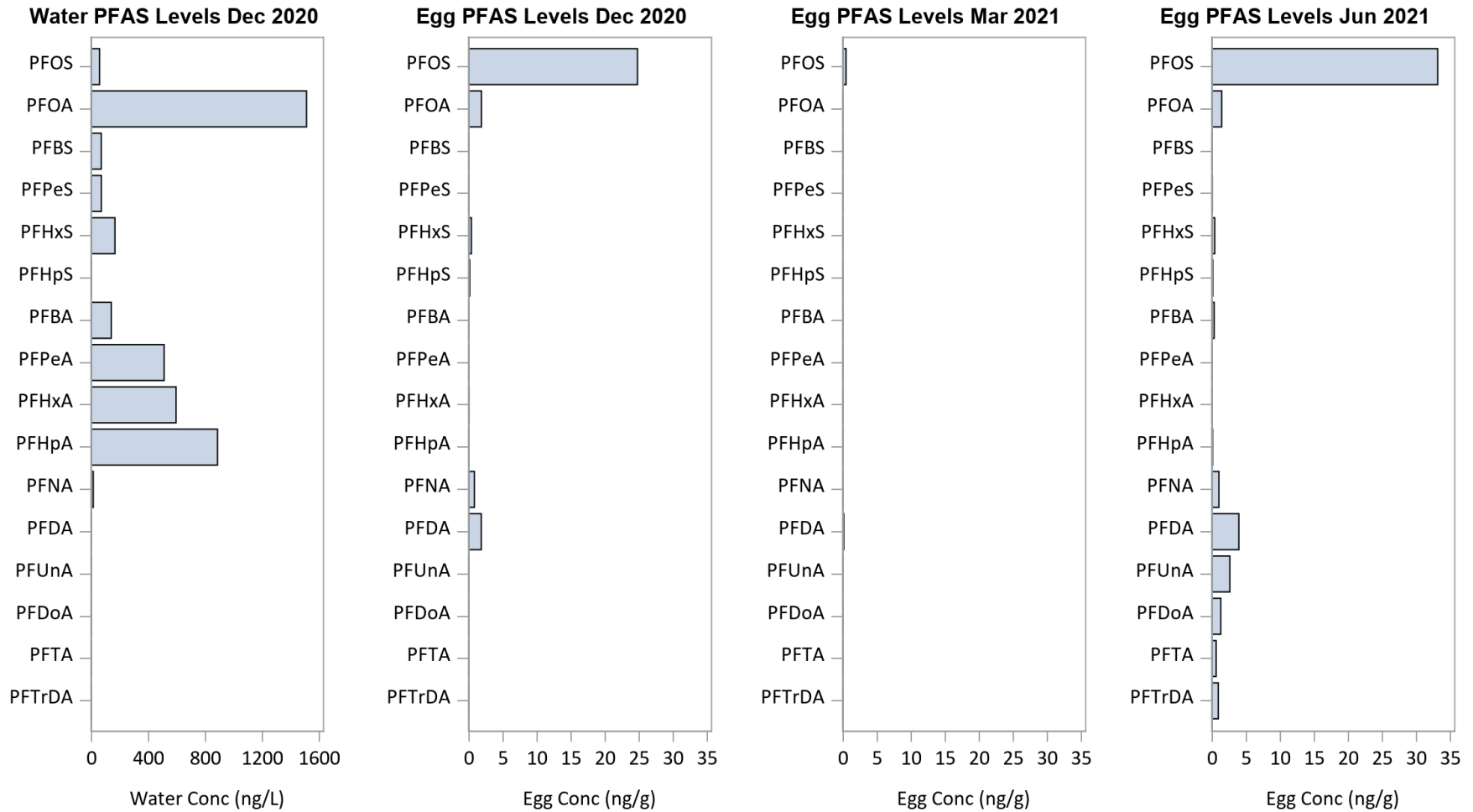
Australian PFAS water chicken egg study

	Half-life
PFOS	3.5 days
PFOA	5.4 days

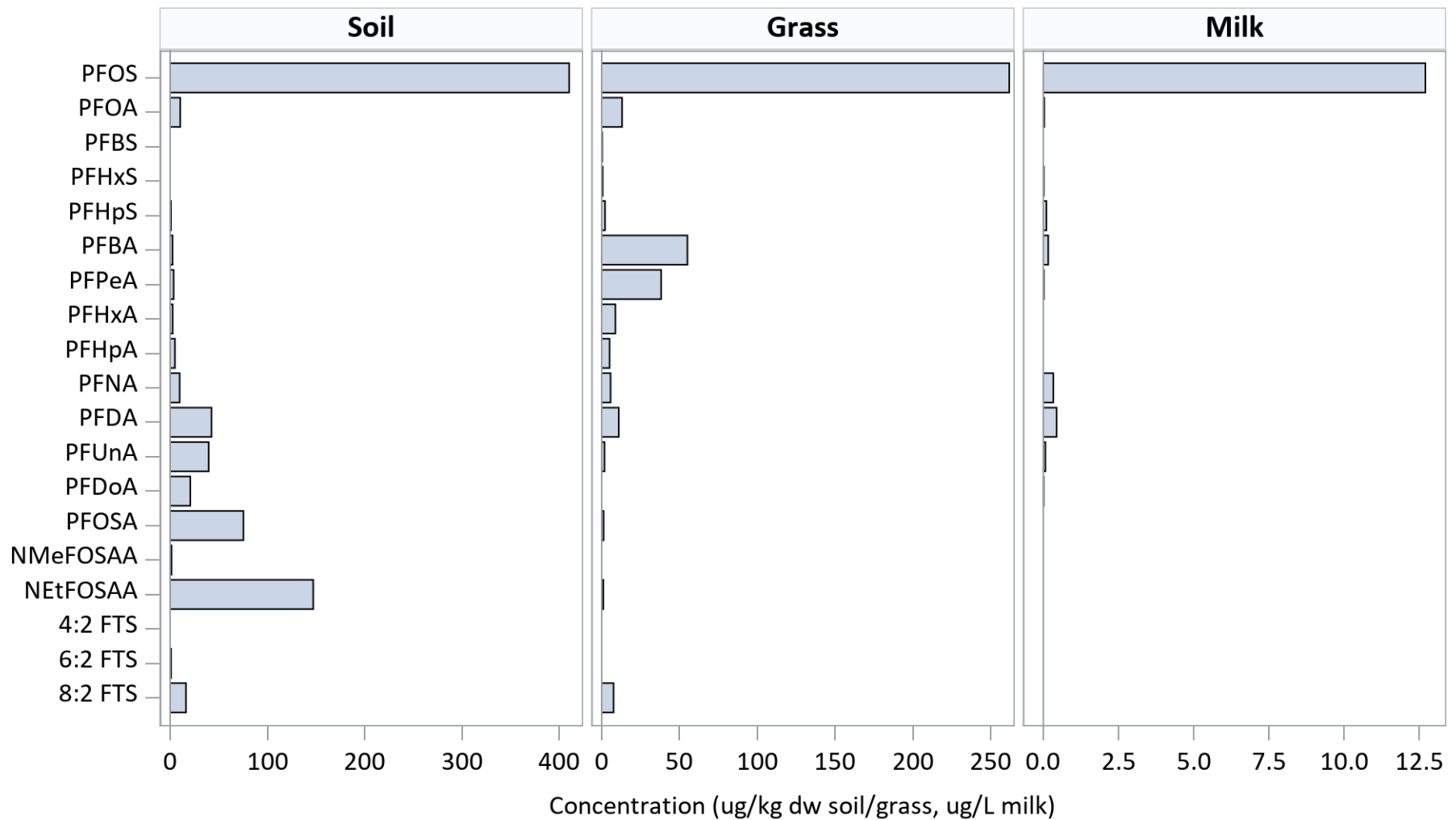


Source: AECOM. 2017. Off-Site Human Health Risk Assessment
<https://www.defence.gov.au/environment/pfas/williamtown/publications.asp>

Soil Pathway for Free Range Chickens?



PFAS move differently between media



How much is too much PFOS in soil

$$SL_{soil} = \frac{C_{milk} \times (D_{milk})^{-1}}{TF_{milk} \times \left[(I_{fodder} \times F_{land-f} \times F_{year-f} \times (TF_{plant} + MLF)) + (I_{soil} \times F_{land-g} \times F_{year-g}) \right]}$$

Milk Action Level
"adulterated" Milk density
 ↓ ↓
 $C_{milk} \times (D_{milk})^{-1}$

Transfer factor intake to milk Feed ingestion rate Fraction of time exposed to contaminated feed Plant transfer factor Soil mass loading factor Soil ingestion rate Fraction of time exposed to contaminated soil

Source: Modified equation from U.S. EPA Preliminary Remediation Goals for Radionuclides, consumption of milk back calculated to soil
https://epa-prgs.ornl.gov/radionuclides/users_guide.html

How much is too much PFOS in soil

Grass-based Dairy Farm



Pasture Fodder Only

SSL = 6.8 $\mu\text{g}/\text{kg}$, *dw* *



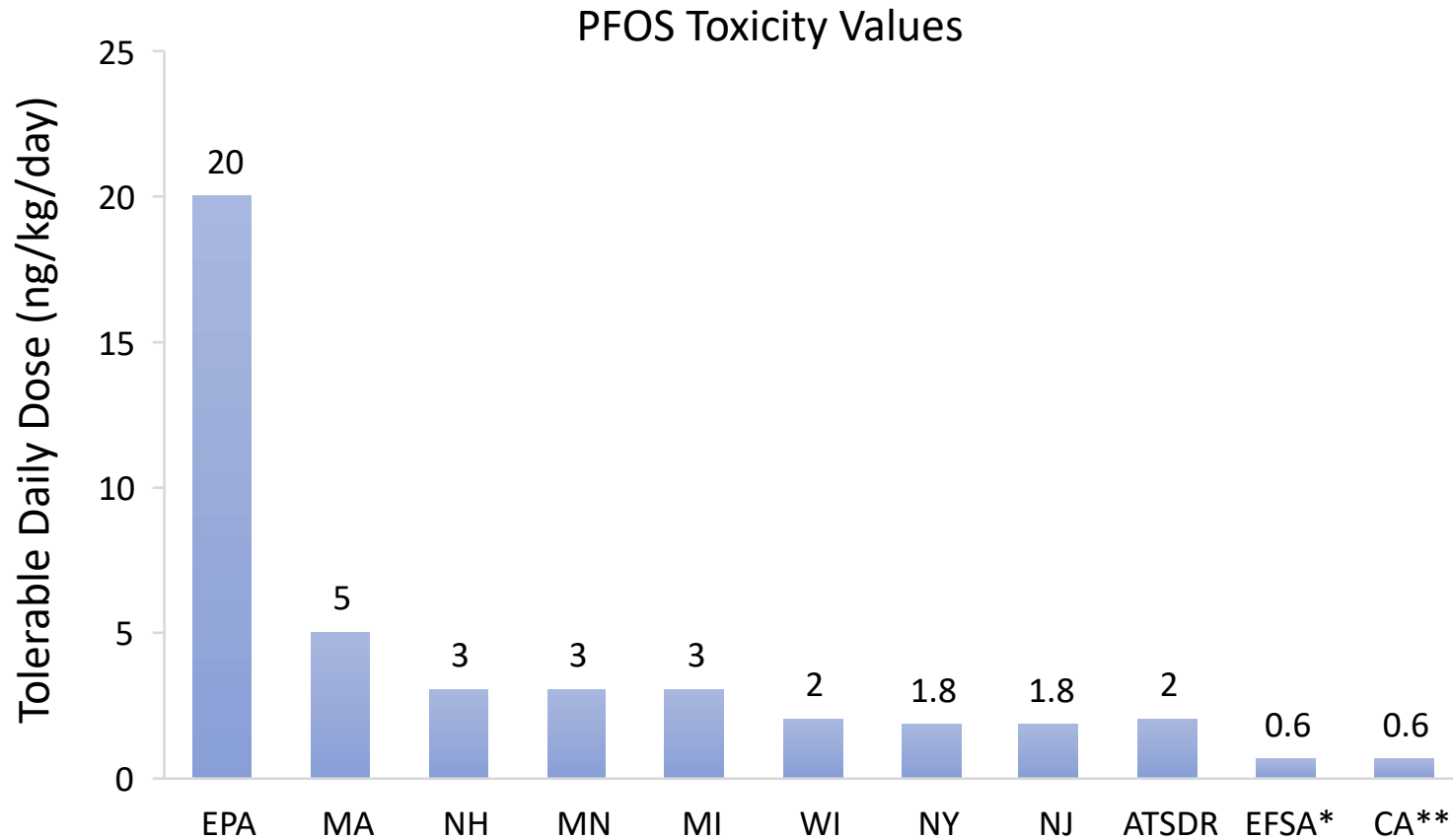
Corn-Silage Fodder Only

SSL = 120 $\mu\text{g}/\text{kg}$, *dw* *

* Based on 210 ng/L milk action level

Source: <https://www.maine.gov/dep/spills/topics/pfas/Agronomic-Pathway-Soil-Screening-Levels-Soil-Fodder-Cows-Milk-09.16.20.pdf>

Changing thinking on the toxicity of PFAS



EFSA* - Human data, immune system toxicity, sum of PFOA, PFOS, PFNA, PFHxS

CA** - Human data, changes in cholesterol, proposed

For more information

Andrew Smith, SM, ScD

State Toxicologist

Maine Center for Disease Control and Prevention

andy.e.smith@maine.gov

Thomas Simones, PhD

Toxicologist

Maine Center for Disease Control and Prevention

Thomas.simones@maine.gov

