

STATE OF CONNECTICUT

DEPARTMENT OF PUBLIC HEALTH

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TO: Lisa Morrissey, Deputy Commissioner

THRU: Jim Vannoy, Section Chief
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FROM: Sharee Rusnak, Epidemiologist, Toxic Hazards Health Assessment Unit

SUBJ: PFOS IN FISH CONSUMPTION LIMITS

DATE: March 23, 2023

RE: PFOS IN FISH CONSUMPTION LIMITS

This memo updates fish consumption advisory guidelines based on an updated reference dose for perfluorooctane sulfonic acid (PFOS) of 0.0029 $\mu\text{g}/\text{kg}\cdot\text{day}$ (CT DPH 2022) and an updated average body weight of 80 kg (US EPA 2011).

Connecticut's previous consumption limits for PFOS in fish tissue were based on the United States Environmental Protection Agency's (US EPA) reference dose of 0.02 $\mu\text{g}/\text{kg}/\text{day}$ which is described in Rusnak (2019). Connecticut's updated reference dose is an order of magnitude lower than US EPA's reference dose that was used in 2019. This memo describes Connecticut's fish consumption guidance methodology, updated toxicology and exposure assumptions, new consumption limits and how the new limits compare with other states.

Consumption Guidance Methodology

Connecticut, like most states and tribal governments, develops risk-based fish consumption guidance following the *US EPA Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories Volume 2 Risk Assessment and Fish Consumption Limits (USEPA, 2000)*. The method uses species-specific data on concentrations of a contaminant in fish tissue to determine how often it is safe to eat a particular fish species.



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The maximum number of recommended meals of fish per month is calculated using a health-based reference dose (RfD) and the measured concentration of contaminant in micrograms per gram (µg/g) using a form of the equation below:

$$\#Meals/month = \frac{RfD (\mu g/kg/-day) \times 80 kg_{bw} \times 30.44 days/month}{Concentration\ in\ fish\ (\mu g/g) \times 227 g_{fish/meal}}$$

Where:

µg/kg/-day= micrograms per kilogram per day

bw= body weight

g fish/meal= grams of fish per meal

Body Weight and Meal Size

When deriving fish consumption guidance for PFOS exposure, Connecticut uses the US EPA's 2011 guidance which recommends an average fish meal size of 227 grams (8 oz) for an 80 kg person (USEPA, 2011). The average meal size can be scaled to the body weight for specific populations.

Reference Dose Rationale

Health-based guidance values for PFOS, such as a reference dose, have been developed by federal, state and international agencies using a variety of critical studies, endpoints, and methods. In general, these guidance values are estimates of a daily exposure dose that is not expected to lead to a non-cancer health risk over a set period of time, usually a lifetime. These guidance values are used to identify exposures that could potentially be hazardous to human health. However, exposure above a guidance value does not mean that health problems will occur. CT DPH has recently developed health-based oral reference doses for PFOS, perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) (CTDPH 2022). PFOS is by far the most abundant per- and polyfluoroalkyl substance (PFAS) found in fish tissue in Connecticut and is the most toxic of the four above listed PFAS.

CT DPH developed its updated reference dose of 0.0029 µg/kg-day (CT DPH 2022) for PFOS by first conducting a comprehensive literature review to identify the most sensitive adverse health effect observed in animal studies that is biologically relevant and plausible to humans. As noted in Table 1, the most sensitive effect/critical endpoint in animal testing which forms the basis of the Connecticut reference dose is immune suppression, as determined from an immune system function assay that measured decreased plaque forming cell response in adult male mice (Dong *et al* 2009). This reference dose was used to develop the Connecticut Action Level (AL) for PFOS in drinking water. This endpoint (Dong *et al* 2009 study) was also used to develop the drinking water regulations derived by the states of Michigan, New York and New Jersey (CT DPH 2022). It is important to note that Minnesota, Washington, and New Hampshire have also referenced immune system effects as the critical effect for PFOS, based on findings reported in Dong *et al* (2009) (CT DPH 2022).

The 2016 US EPA reference dose for PFOS of 0.02 µg/kg/day (US EPA 2016), used to develop previous consumption limits in fish (Rusnak 2019) was based on developmental effects and was considered to be protective of subgroups, including children and women of childbearing age. Additionally, the uncertainty factor¹ applied to the Human Equivalent Dose² (HED) of 0.51 µg/kg/day for the derivation of the US EPA

¹ An uncertainty factor is applied to add additional safety to a RfD. In this case, the study used for establishing the RfD is an animal study and there is much uncertainty going from an animal study to inferring the same effects in humans. Also, since the same exposure can have varying degrees of injury in different humans, an additional safety factor is needed.

² A human equivalent dose refers to the quantity of a chemical that, when administered to humans, produces an effect equal to that produced in test animals, by a lower dose.

reference dose is 30 (3 for animal-to human toxicodynamic differences x 10 for human-to-human variability) which provides a reasonable margin of protection. The Connecticut reference dose of 0.0029 ug/kg/day- an order of magnitude lower than the US EPA reference dose of 0.02 ug/kg/day- incorporates the same uncertainty factors in its derivation, and thus, is considered to be protective of sensitive groups.

Table 1. CT DPH's Health-Based Guidance Values for PFOS

Study	Critical Endpoints	Point of Departure (HED) [^] (mg/L)	Uncertainty Factors	CT Reference Dose* (µg/kg/day)
Dong (2009)	Immune Suppression	0.67	Total uncertainty factor of 30 (3 for toxicodynamic differences between animals and humans and 10 for human to human variability)	0.0029

[^]Human Equivalent Dose

*(CT DPH 2022)

Calculation of Consumption Limits

Using the equation above, the CT DPH reference dose, a body weight of 80 kg and an assumed meal size of 227 grams, CT DPH has derived updated fish consumption limits for PFOS. CT DPH's PFOS fish concentration cutoffs equating to a Hazard Index³ of one for different meal frequencies are shown in Table 2 below. The cutoff limits are for both low and high-risk consumers.

Table 2. CT DPH Updated 2022 Fish Consumption Limits for PFOS

Fish Consumption	Calculated Meals	Fish Concentration (ppb)
Unlimited	> 2/week	< 4
1 meal/week	1 to 2/week	≥ 4 to < 8
1 meal/month	< 1/week	≥ 8 to < 31
Do not eat	< 1/month	≥ 31

Comparison to Previous Fish Consumption Limits

After using the updated health-based reference dose for PFOS and an updated body weight of 80 kg, the new cutoff limits for fish consumption are approximately 5 times lower than the previous limits for PFOS (Table 3). These more restrictive limits are protective for exposure to PFOS, given the new, more stringent toxicity value while still allowing for the general population to benefit from consumption of Omega 3 fatty acids in fish.

³ A hazard index or hazard quotient (HI) is the ratio of potential exposure to a substance and the level at which no adverse health effects are expected. If the HI is calculated to be less than 1, then no adverse health effects are expected. If the HI is calculated to be greater than 1, then adverse health effects can not be ruled out. However, it is important to note that a HI greater than 1 does not necessarily mean that adverse health effects will occur.

Table 3. CT DPH Updated and Previous Fish Consumption Limits for PFOS

Fish Consumption	Previous Cutoff Limits (ppb)	2022 Updated Cutoff Limits (ppb)
Unlimited	<20	< 4
1 meal/wk	≥ 20 to <40	≥ 4 to < 8
1 meal/month	≥ 40 to < 159	≥ 8 to < 31
Do not eat	≥ 159	≥ 31

Comparison to Other States' Fish Consumption Limits

The table in the Appendix illustrates PFOS fish consumption limits in Connecticut compared with other states. The main differences are that other states are using a different reference dose, body weight, and/or a fish meal size to develop fish consumption limits. It is important to note that each state has their own definition for allowing for some consumption of fish or none at all. For example, some states like Maine allow for one fish meal per year and PFOS concentrations higher than that allowable limit for one fish meal per year are placed in the “Do Not Eat” category, whereas in Connecticut, a PFOS concentration that does not allow for less than 1 fish meal per month is placed in the ‘Do Not Eat’ category. Therefore, it can be very complicated to compare each state’s consumption limits.

Comparison of PFOS Exposure from Fish Consumption With Background Levels

To provide perspective regarding the magnitude PFOS exposure reduction that we achieve with our fish consumption advisory, we used the geometric mean PFOS serum level for the general population in the US, to calculate a background PFOS dose in ng/kg/day. The background PFOS dose on a ng/kg/day basis using the geometric serum level of 4.25 ng/ml for the total population ages 12 years and older based on the 2017-2018 NHANES survey (USCDC 2021) is 0.55 ng/kg/day and is trending downward. The geometric mean was selected to represent the central tendency PFOS serum level. Connecticut’s PFOS reference dose of 2.9 ng/kg/day (i.e. the dose above when CT DPH would issue a consumption advisory) is over 5 times the estimated background level. Therefore, our recommended fish consumption limits can achieve an important reduction in PFOS exposures, as compared with background levels.

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Appendix

Fish Consumption Limits for PFOS in Connecticut Compared With Other States¹

State	Cutoff Limits for Sensitive Populations	Unlimited	2 Meals per Week	1 Meal Per Week	2 Meals Per Month	1 Meal Per Month	Do Not Eat
		PFOS Conc. ² (ppb ³)	PFOS Conc. (ppb)	PFOS Conc. (ppb)	PFOS Conc. (ppb)	PFOS Conc. (ppb)	PFOS Conc. (ppb)
Connecticut⁴	No	<4.0	NA ⁵	≥ 4 to < 8	NA	≥ 8 to < 31	≥ 31
Massachusetts⁶	Yes	≤0.5	>0.5-≤1.76	>1.76 to ≤3.52	>3.52 to ≤7.62	>15.2 to ≤30.5	>183 ppb
Illinois	No	≤10	NA	>10 to ≤50	NA	>50 to ≤200	>200
Maine⁷	No	≤0.3.5	NA	>3.5 to ≤7.5	>7.5 to ≤15	7.5 to ≤15	>60
Great Lakes Consortium⁸	No	≤10	>10 to ≤20	>20 to ≤50	NA	>50 to ≤200	>200
Michigan⁹	Yes	NA	>13 to ≤19	>19 to ≤38	>38 to ≤75	>150 to ≤300	>300
New York	Yes	NA	NA	<50	NA	>50 to ≤200	>200
Wisconsin⁸	No	≤	>10 to ≤20	>20 to ≤50	NA	>50 to ≤200	>200
New Jersey¹⁰	Yes	0.56	NA	≥3.9 to >17	NA	≥17 to > 51	≥226

¹It is important to note that states differ in the type of consumption advisories that they issue, what assumptions are made for meal size, body weight, sensitive groups, and what is considered a safe or unsafe consumption rate.

²Concentration.

³parts per billion.

⁴Connecticut does not issue an advisory if fish can be safely consumed at a rate of more than 2 fish meals per week.

⁵Not Available.

⁶Massachusetts does not issue an advisory if fish can be safely consumed at a rate of 7 fish meals per week (MADPH 2021).

⁷Maine does not issue an advisory if fish can be safely consumed at a rate of at least one fish meal per week (Maine CDC 2022).

⁸Includes Pennsylvania, Michigan, New York, Illinois, Minnesota, Wisconsin, and Ohio (Great Lakes Consortium 2019).

⁹(Michigan 2016).

¹⁰(Goodrow, S., Ruppel, B. *et al.* 2019).

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