Maine CDC Scientific Brief: 2025 PFOS Fish Consumption Advisory

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The Maine Center for Disease Control and Prevention (Maine CDC) is responsible for regularly assessing whether any health threats exist for persons consuming freshwater and anadromous fish caught in state waters by noncommercial anglers and issuing a consumption advisory if threats to public health are identified (MRSA 22 § 1696 I). This document presents recent analyses and recommendations regarding freshwater fish consumption in Maine. Specifically, it describes new and expanded waterbody-specific advisories based on data collected during the 2024 fishing season showing elevated levels of PFOS in fish tissue.

I. Approach to Fish Consumption Advisories

Maine CDC derives and uses chemical-specific fish tissue action levels (FTALs) as a guide to determine the need to develop a fish consumption advisory. FTALs are concentrations of a contaminant, in this case perfluorooctane sulfonic acid (PFOS) [1], in fish tissue below which there should be negligible risk of adverse health effects at a set fish consumption rate (e.g., one 8-ounce (oz) meal week, one 8-oz meal per month). These FTALs are derived following the U.S. Environmental Protection Agency (EPA) Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories (EPA 1996; EPA 2000a; EPA 2000b). FTALs are calculated using the following equation:

$$FTAL = \frac{(RfD \times BW)}{FC} X\ RSC \qquad (Eq. 1)$$

Where,

FTAL = Fish Tissue Action Level in nanograms per gram (ng/g)

RfD = Reference Dose in nanograms per kilogram body weight per day (ng/kg/day)

BW = Body Weight in kilograms (kg)

FC = Fish Consumption Rate in grams per day (g/day)

RSC = Relative Source Contribution (unitless)

The FTAL is a concentration of PFOS in fish tissue. The RfD is a toxicity value, or a measure of a daily dose of PFOS that results in minimal risk of any adverse health outcome. The body weight is an average adult body weight for the U.S. population. The fish consumption rate can be varied to compute an FTAL for different fish meal consumption frequencies, assuming a meal size of 8-oz, and expressed as a daily average consumption rate in grams per day (e.g., one 8-oz meal per week is 32.4 g/day, one 8-oz meal per month is 7.4 g/day). The RSC accounts for average background exposure to PFOS in the U.S.

[1] For PFAS action levels, Maine CDC follows the PFAS naming convention indicated by ATSDR, which follows the U.S. CDC's PFAS terminology in using the acid form when listing the compounds full name, e.g., perfluorooctane sulfonic acid versus perfluorooctane sulfonate (ATSDR 2021).

population. A detailed description of the derivation of each input in the FTAL equation can be found in the 2022 Scientific Brief.[2]

Maine CDC typically relies on toxicity values developed by federal agencies such as the U.S. EPA or the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). In 2022, Maine CDC began using the 2021 ATSDR toxicity value of 2 ng/kg/day for PFOS. Previously, Maine CDC had been using a U.S. EPA Office of Water toxicity value of 20 ng/kg/day derived in 2016. In March 2024, California's Office of Environmental Health Hazard Assessment (OEHHA) published a toxicity value of 0.6 ng/kg/day for PFOS in support of their Public Health Goals for drinking water (OEHHA 2024). On April 10, 2024, the U.S. EPA published an updated toxicity value for PFOS of 0.1 ng/kg/day used in the development of their finalized national drinking water standards. These toxicity values of 0.6 ng/kg/day and 0.1 ng/kg/day are based on human epidemiological data rather than laboratory animal data, which was the basis for the ATSDR 2021 toxicity value. Maine CDC is reviewing the toxicity values from U.S. EPA and OHHEA and their suitability for use in developing fish consumption advisories. In the interim Maine CDC is continuing to rely on the ATSDR toxicity value of 2 ng/kg/day for PFOS.

Using the ATSDR 2 ng/kg/day toxicity value (RfD), a body weight (BW) of 80 kg, and a relative source contribution (RSC) of 70% to account for average background exposure to PFOS in the U.S. population, Maine CDC calculates FTALs for PFOS that correspond to specified fish consumption rates (FC) expressed as 8-oz meal frequencies. Table 1 provides example meal frequences and the corresponding fish tissue PFOS concentrations.

Table 1. Example fish tissue PFOS concentrations and corresponding 8-ounce meal advice categories.

PFOS in fish (ng/g)	Meal advice
3.5	One meal per week
7.5	Two meals per month
15	One meal per month
30	Six meals per year
60	Three meals per year
> 60	Do Not Eat

To determine whether a fish consumption advisory is needed for a particular waterbody, the measured concentration of PFOS in fish tissue is compared to the FTALs. Maine CDC's preference is to estimate fish tissue concentrations for a waterbody based on five composite samples each consisting of five individual fish for a targeted species. In circumstances where contaminant levels are high enough to suggest the need for a very restrictive consumption advisory, Maine CDC will consider the development of advisories based on fewer than the desired five composite samples. To account for uncertainty in estimating fish tissue levels representative of an entire waterbody from the available

[2] https://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/documents/MainePFASDeerStudyReport2.8.22_FINAL.pdf

data, Maine CDC uses EPA's ProUCL software to compute a statistical upper confidence limit (UCL) on the estimated mean of the composite samples (EPA, 2022). Maine CDC compares the UCL of the mean to the maximum measured concentration and uses the lower of the two values as an upper-level estimate of fish tissue concentrations for a given waterbody.

Selection of appropriate indicator fish species for a given waterbody (e.g., brook trout, smallmouth bass, black crappie) can vary depending on the contaminant and fishery and are selected based on recommendations from the Maine DEP and the Maine Department of Inland Fisheries and Wildlife and the fish species able to be collected in a specific waterbody.

Maine CDC considers issuing a fish consumption advisory if fish cannot be safely consumed at a rate of at least one meal per week. Available data indicate that few anglers consume recreationally caught fish more frequently than one meal per week. Thresholds for issuing a Do Not Eat (DNE) advisory are evaluated on a contaminant-specific basis. For PFOS, Maine CDC will issue a DNE advisory when fish cannot be safely consumed at a rate of at least three meals per year. At lower consumption rates, and associated higher fish tissue levels, the impact on exposure to PFOS of eating just one additional fish meal per year becomes increasingly large. Maine CDC is aware of other states using 12 meals per year (New Jersey), six meals per year (Michigan), and one meal per year (Massachusetts) as the threshold for a DNE advisory for PFOS.

In considering whether to issue an advisory, Maine CDC also evaluates whether the resulting advisory would be more restrictive than any existing advisories[3], such as the statewide mercury fish consumption advisory (Table 2). The existing statewide mercury fish consumption advisory recommends anglers eat no more than two fish meals per month for most fish species and consumption of up to a meal per week is restricted to brook trout and landlocked salmon. For sensitive populations (children less than 8 years of age and women who are or who may become pregnant), the statewide mercury advisory is even more restrictive and recommends no consumption of freshwater fish from Maine's inland waters except for landlocked salmon and brook trout which can be consumed at a rate of one meal per month (Table 2). Thus, in determining whether a PFOS-specific advisory needs to be issued, Maine CDC will evaluate whether the concentrations of PFOS in fish tissue warrant an advisory that is more restrictive than the current statewide mercury advisory or any other waterbody-specific advisories.

[3] Current fish consumption advisories can be found under Maine CDC's Freshwater Fish Safe Eating Guidelines (https://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/2kfca.htm)

Table 2. Statewide mercury fish consumption advisory.

Sensitive populations (pregnant and nursing women, women of childbearing age, children under age 8)	
Brook trout and landlocked salmon	One meal per month
All other species	Do Not Eat
General population (all other adults and children aged 8 and older)	
Brook trout and landlocked salmon	One meal per week
All other species	Two meals per month

II. 2025 Recommended Waterbody-Specific Fish Consumption Advisories

Maine CDC is issuing freshwater fish consumption advisories on six waterbodies in Maine in response to data on PFOS levels in fish collected in 2024. Four of the advisories are for new waterbodies and two represent expansions of previously issued waterbody advisories as a result of additional sampling efforts. The new advisories come after testing of fish in these locations found elevated levels of per- and polyfluoroalkyl substances (PFAS) warranting fish consumption advisories more restrictive than the current Statewide mercury fish consumption advisory or other waterbody-specific advisories. The advisories recommend limiting consumption of either all fish or certain fish species from these waterbodies.

The new and expanded advisories are summarized in Table 3 and apply to Lovejoy Pond in Albion, Sebasticook River in Burnham and Benton, Collyer Brook in Gray, Androscoggin Lake in Leeds and Wayne, Annabessacook Lake in Monmouth and Winthrop, and Messalonskee Stream in Oakland and Waterville. The fish tissue data and basis for the consumption advisory are described for each of these waterbodies in Section III of this report.

Table 3. Recommended waterbody-specific fish consumption advisories.

Area	Waterbody	Consumption Advisory[1]
Albion	All of Lovejoy Pond.	Consume no more than six meals per year of any fish species.
Burnham to Benton	Sebasticook River from the confluence with Twentyfive Mile Stream in Burnham to Benton Falls in Benton.	Consume no more than five meals per year of any fish species.
Gray	All of Collyer Brook.	Consume no more than one meal per month of brook trout.
Leeds and Wayne	All of Androscoggin Lake.	Consume no more than one meal per month of black crappie.
Monmouth and Winthrop	All of Annabessacook Lake.	Consume no more than ten meals per year of any fish species.
Oakland and Waterville	Messalonskee Stream from the Rice Rips Dam in Oakland to the Kennebec River in Waterville	Consume no more than three fish meals per year of any fish species.

[1] define meals as 8-ounce serving

III. Basis for Waterbody-Specific Fish Consumption Advisories

A. Lovejoy Pond - Albion

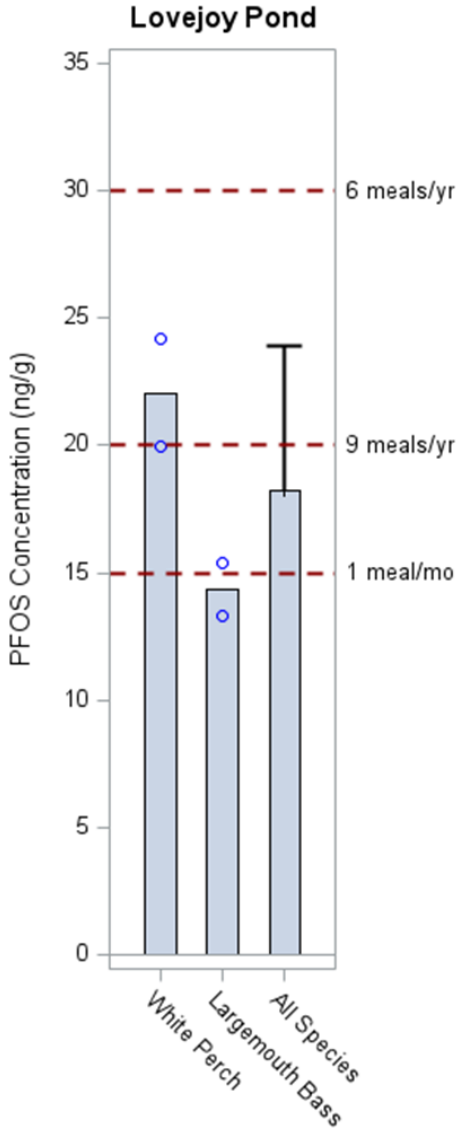


Figure 1. Fish tissue PFOS concentrations in Lovejoy Pond in Albion. *The bar corresponds to the mean PFOS tissue concentration in each species for Lovejoy Pond. The circles represent the concentration for individual composite samples, and the cap of the error bar corresponds to the upper confidence limit on the mean.*

Area: All of Lovejoy Pond.

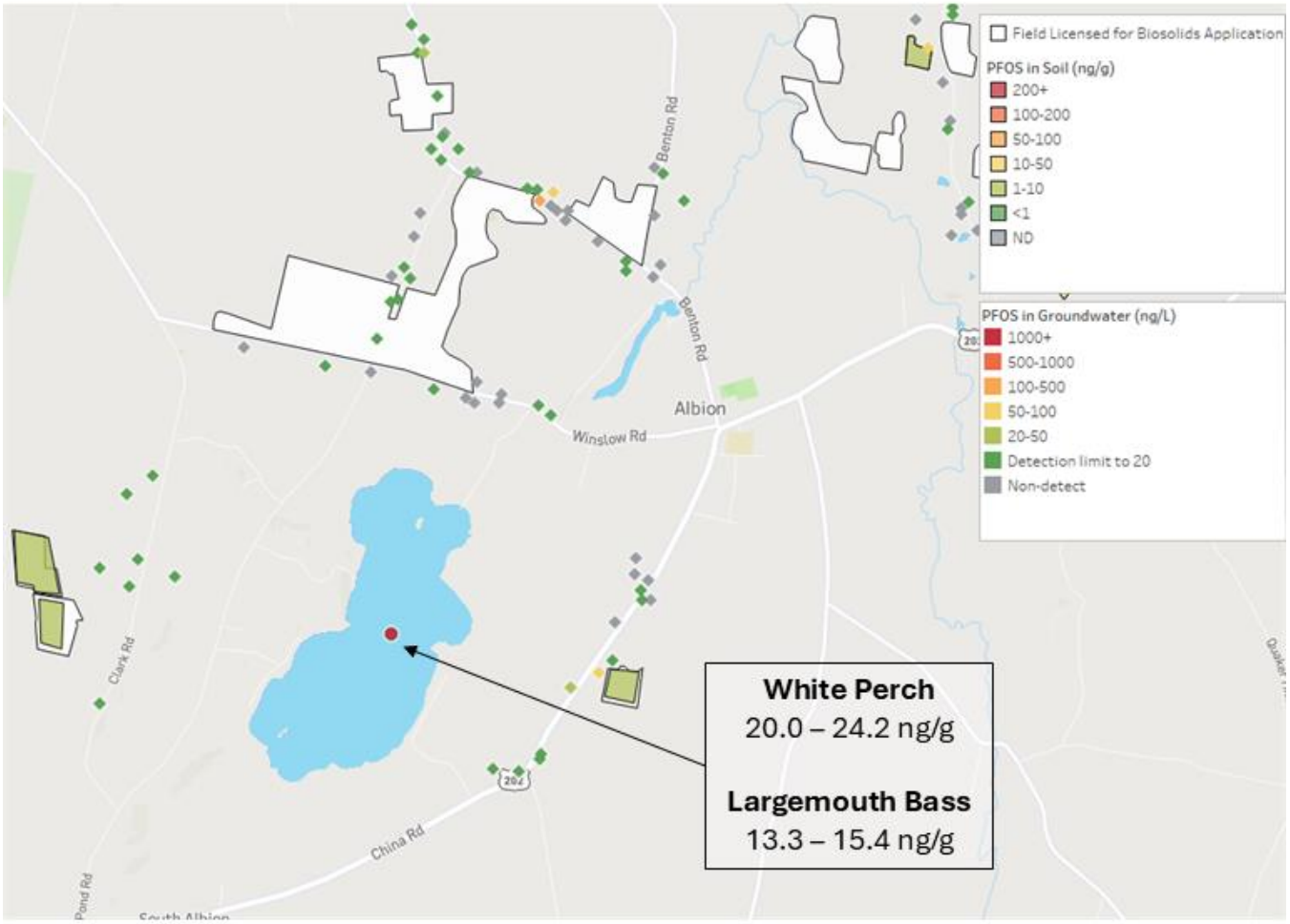
Advisory: Consume no more than six meals per year of any fish species.

Justification: In 2024 a total of two five-fish composite largemouth bass and two five-fish composite white perch samples were collected from Lovejoy Pond in Albion (Map 1). The white perch samples had PFOS concentrations of 20.0 and 24.2 ng/g. The largemouth bass samples had PFOS concentrations of 13.3 and 15.4 ng/g. Combining results from both species results in a mean (± SD) PFOS concentration of 18.2 ± 4.8 ng/g and an upper confidence limit on the mean of 23.9 ng/g. The 23.9 ng/g upper confidence limit PFOS concentration corresponds to a consumption rate of no more than six meals per year (Figure 1).

The decision to issue a consumption advisory based on four composites per sampled species is based on the high levels of PFOS in fish tissue and the resulting restrictive consumption advice. Additionally, a measured surface water concentration of 8.3 ng/L collected on Lovejoy Pond supports an expectation that fish will have elevated tissue concentrations based on estimates of a bioaccumulation factor (BAF) for PFOS.[4] It is also noted that Lovejoy Pond is located near multiple fields with a history of biosolids application. Nearby measured soil PFOS levels range from 6.2 to 7.1 ng/g and PFOS has been detected in nearby groundwater wells ranging from 5.8 to 239 ng/L (Map 1), which indicate a likely source for ongoing contamination of this waterbody.

[4] An estimated median BAF for muscle/fillet tissue of 1,500 L/kg has been reported for finned fish species (Burkhard, 2021) and a BAF of 1,700 L/kg for trophic level 3 fish was used by EPA in developing its proposed ambient water quality criteria for PFOS (EPA, 2024). Using a BAF of 1,500 – 1,700 L/kg and a surface water concentration of 8.3 ng/L would result in an estimated fish tissue PFOS concentration of 12.5 – 14.1 ng/g.

Map 1. Approximate locations of fish sampling for PFOS from Lovejoy Pond in Albion with range of PFOS concentrations in each species sampled.



B. Sebasticook River – Burnham to Benton

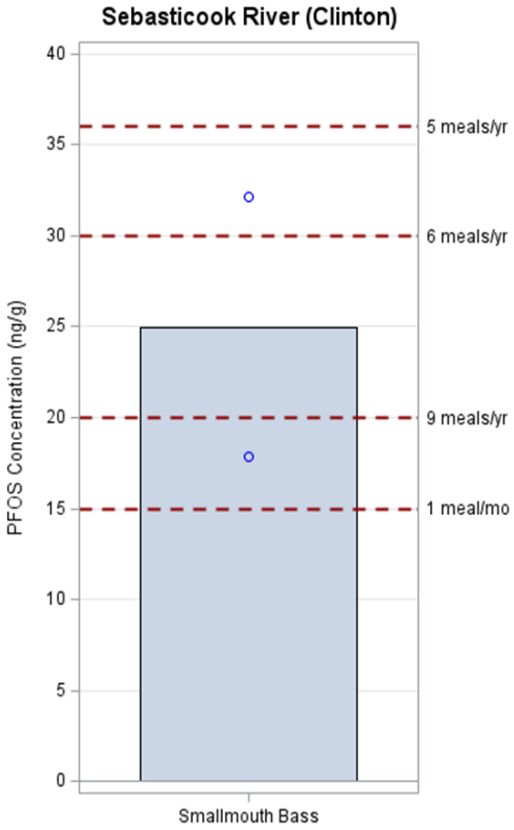


Figure 2. Fish tissue PFOS concentrations in the Sebasticook River in Clinton. *The bar corresponds to the mean PFOS tissue concentration in smallmouth bass in the Sebasticook River in Clinton. The circles represent the concentration for individual composite samples.*

Area: Sebasticook River from the confluence with Twentyfive Mile Stream in Burnham to Benton Falls in Benton.

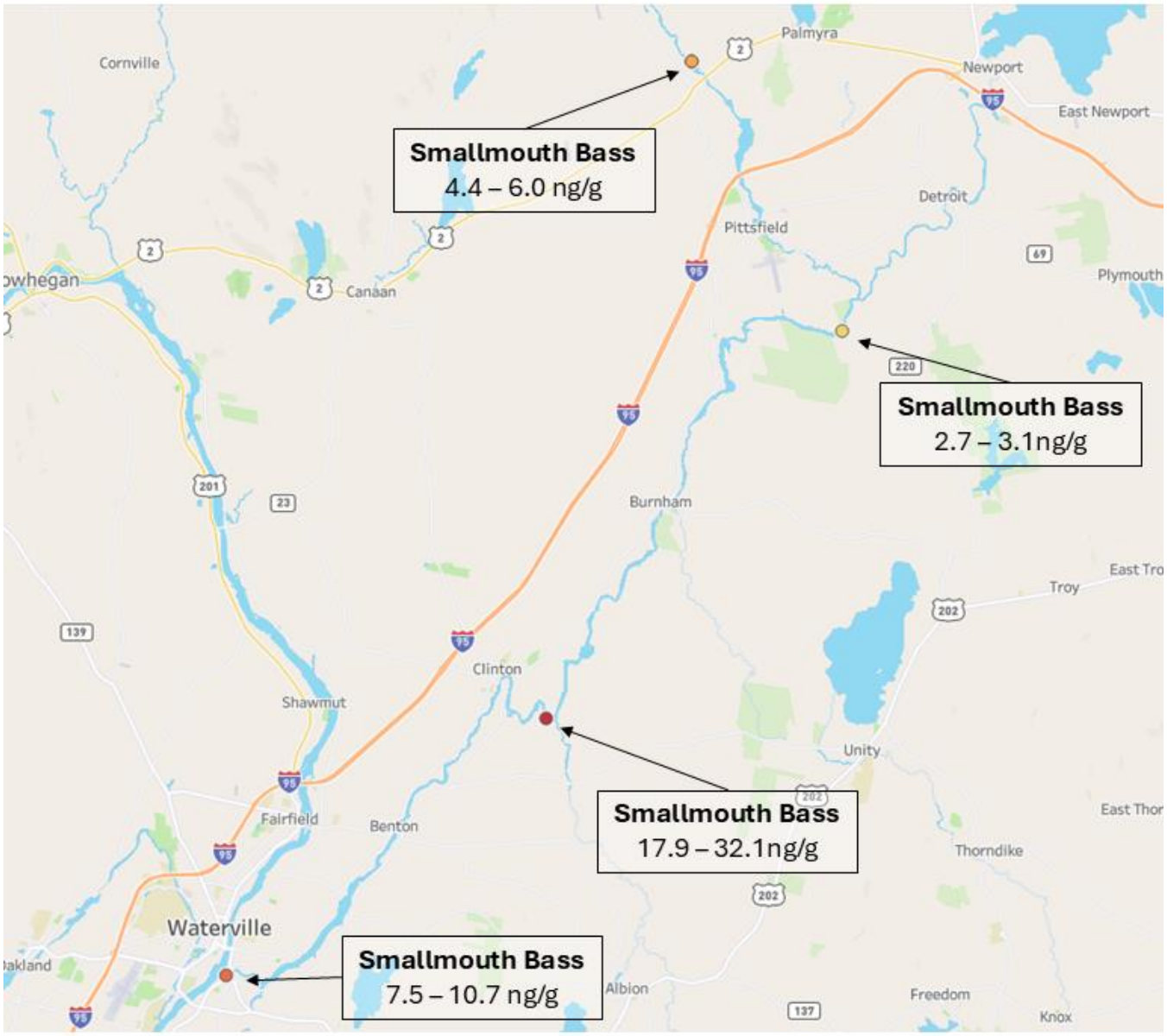
Advisory: Consume no more than five meals per year of any fish species.

Justification: Since 2021, there have been multiple locations sampled for PFOS in fish tissue along the Sebasticook River. Most recently, in 2024, two five-fish composite smallmouth bass samples were collected from the Sebasticook River in Clinton near the confluence with Fifteenmile Stream (Map 2). These two composite samples had PFOS concentrations of 17.9 and 32.1 ng/g (Figure 2). Prior fish tissue sampling downstream in Winslow, upstream in Burnham, and from the West Branch of the Sebasticook River in Palmyra found lower levels of PFOS in fish tissue that had not warranted consumption advisories (Map 2).

The mean PFOS concentration for the two composite smallmouth bass samples near Clinton is 25.0 ng/g with a maximum of 32.1 ng/g. While there is nearly a two-fold difference between the PFOS concentration in the two composite samples, a consumption advisory based on the mean of the two samples versus the maximum would be similar (six versus five meals per year). These consumption advisories are 4-fold lower than what would be allowable under the statewide mercury advisory (2 meals per month for the general population). As a precautionary public health measure, an advisory of five meals per year for all fish species based on the maximum result is being issued while awaiting additional data to be collected in the summer of 2025. Given the lower PFOS concentrations in fish tissue upstream in Burnham and Palmyra and downstream in Winslow, the boundaries of this advisory apply to the section of the Sebasticook River that runs from the confluence of Twentyfive Mile Stream in Burnham to Benton Falls in Benton.[5]

[5] Additionally, the surface water PFOS concentration in the Sebasticook River downstream of the confluence with Fifteenmile Stream was 10.6 ng/L. Using the 1,500 L/kg BAF from Burkhard (2021) would result in estimated fish tissue PFOS concentrations of 15.9 ng/g.

Map 2. Approximate location of fish sampling for PFOS from Sebasticook River from Palmyra to Winslow with range of PFOS concentrations in smallmouth bass at each location sampled.



C. Collyer Brook - Gray

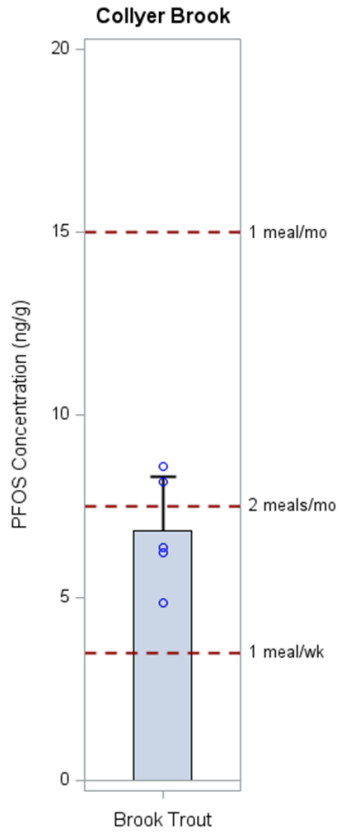


Figure 3. Fish tissue PFOS concentrations in Collyer Brook in Gray. *The bar corresponds to the mean PFOS tissue concentration in brook trout for Collyer Brook in Gray. The circles represent the concentration of each individual composite sample. The cap of the error bar corresponds to the upper confidence limit on the mean.*

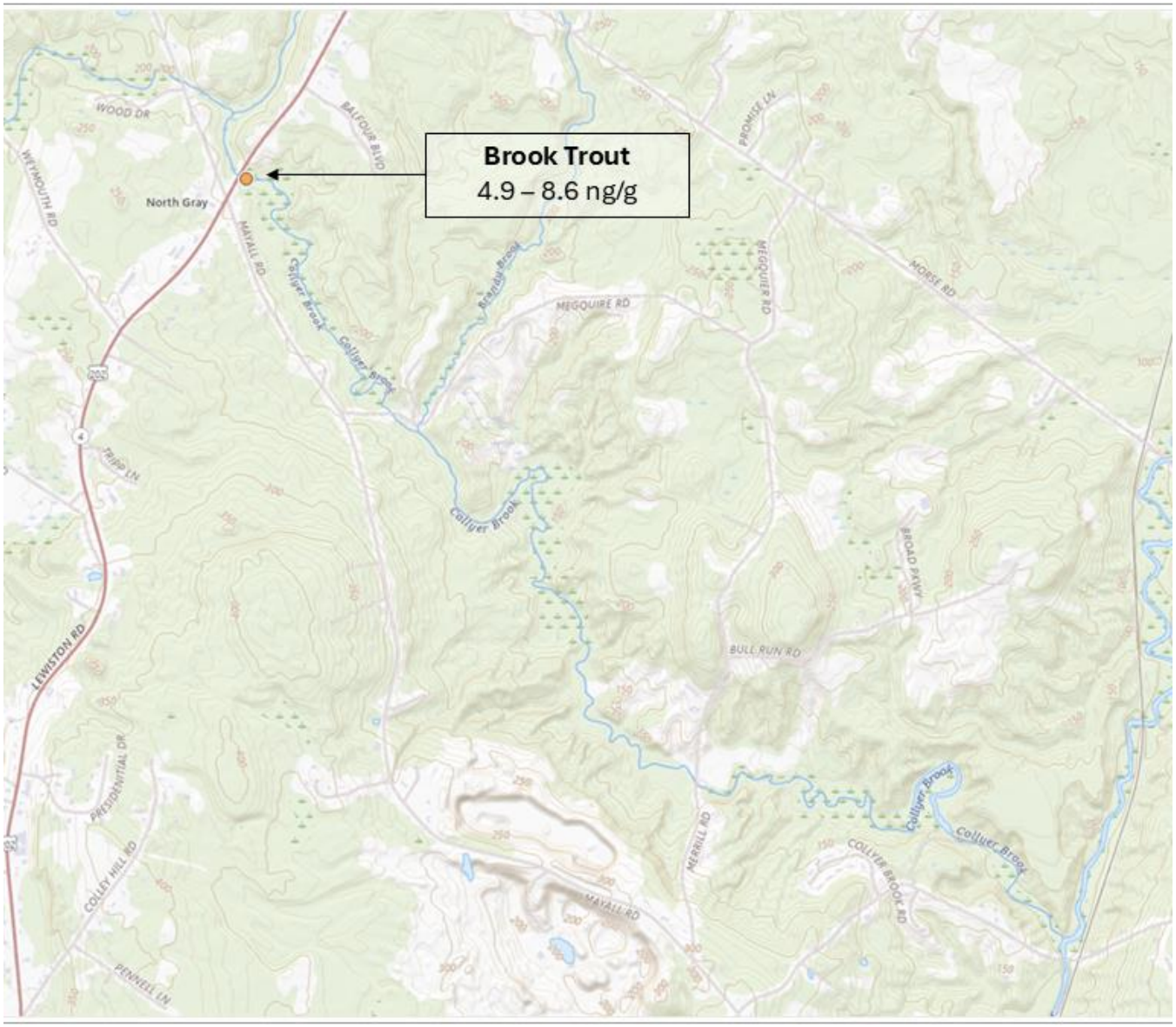
Area: All of Collyer Brook.

Advisory: Consume no more than one meal per month of brook trout.

Justification: In 2023 and 2024 a total of five five-fish composite brook trout samples were collected from Collyer Brook in Gray (Map 3). The brook trout samples had PFOS concentrations ranging from 4.9 to 8.6 ng/g with a mean concentration of 6.8 ± 1.5 ng/g. The upper confidence limit on the mean is 8.3 ng/g, which corresponds to a consumption rate of no more than one meal per month (Figure 3).

The brook trout samples for Collyer Brook were primarily collected between Eddy and Brandy Brooks. There are a few farm fields located downstream of Brandy Brook that have a history of land application of biosolids and may be a source of PFAS in the area. Collyer Brook then flows into the Royal River. Thus, a consumption advisory of no more than one meal per month of brook trout is recommended for the entirety of Collyer Brook.

Map 3. Approximate location of fish sampling for PFOS from Collyer Brook in Gray with range of PFOS concentrations in sampled brook trout.



D. Androscoggin Lake – Leeds and Wayne

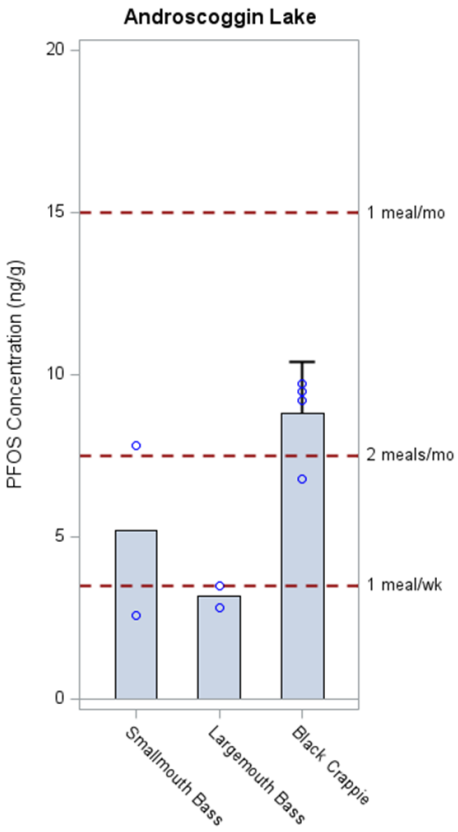


Figure 4. Fish tissue PFOS concentrations in Androscoggin Lake in Leeds and Wayne. *The bars correspond to the mean PFOS tissue concentration in each fish species sampled in Androscoggin Lake. The circles represent the concentration for individual composite samples, and the cap of the error bar corresponds to the upper confidence limit on the mean.*

Area: All of Androscoggin Lake.

Advisory: Consume no more than one meal per month of black crappie.

Justification: In 2023 and 2024 a total of four five-fish composite black crappie samples, two five-fish composite smallmouth bass samples, and two five-fish composite largemouth bass samples were collected from Androscoggin Lake (Map 4). The black crappie samples had PFOS tissue concentrations ranging from 6.8 to 9.7 ng/g with a mean concentration of 8.8 ± 1.4 ng/g. The smallmouth bass samples had PFOS tissue concentrations of 2.6 and 7.8 ng/g. The largemouth bass samples had PFOS tissue concentrations of 2.8 and 3.5 ng/g (Figure 4).

For black crappie, the mean fish tissue PFOS concentration was 8.8 ng/g with an upper confidence limit on the mean of 10.4 ng/g. The 10.4 ng/g upper confidence limit corresponds to a consumption rate of no more than one meal per month for black crappie (Figure 4).

The concentrations of PFOS in largemouth and smallmouth bass were generally lower than the concentrations of PFOS in black crappie, which is consistent with what has been seen at other waterbodies throughout the state. Additionally, the largemouth and smallmouth bass results were all below, or only slightly above, a recommended two meals per month consumption rate, which is the current limit for both bass species due to the presence of methylmercury in fish. For sensitive populations, the statewide mercury advisory recommendation is to not eat either bass species. Therefore, at this time, the fish consumption advisory for Androscoggin Lake is limited to black crappie only, but additional data will be collected in bass and other species to determine if further consumption advice is warranted.

Map 4. Approximate location of fish sampling for PFOS from Androscoggin Lake in Leeds and Wayne with range of PFOS concentrations in each species sampled.

E. Annabessacook Lake – Monmouth and Winthrop

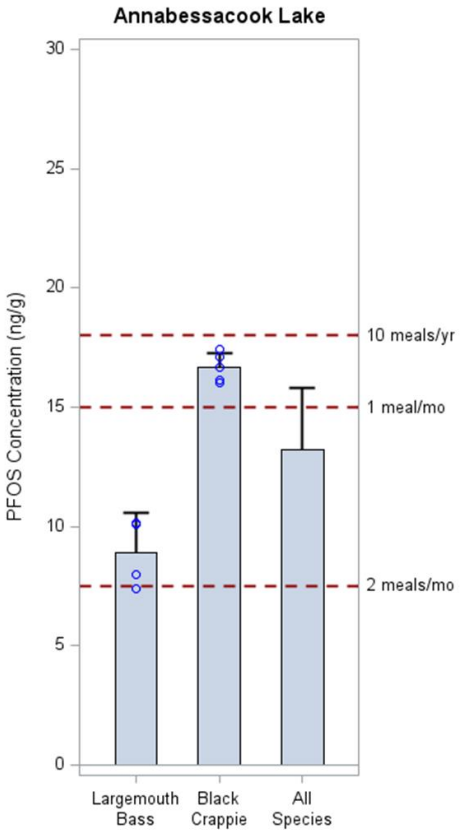


Figure 5. Fish tissue PFOS concentrations in Annabessacook Lake in Monmouth and Winthrop. *The bars correspond to the mean PFOS tissue concentration in each fish species sampled in Annabessacook Lake. The circles correspond to the concentration for individual composite samples, and the cap of the error bar corresponds to the upper confidence limit on the mean.*

Area: All of Annabessacook Lake.

Advisory: For the general population, consume no more than ten meals per year of any fish species.

Justification: In 2023 Maine CDC issued a fish consumption advisory of no more than ten meals per year for black crappie based on the results of two five-fish composite samples. In 2023 there were also two five-fish composite largemouth bass samples, but the PFOS concentrations were close to a recommended consumption rate of two meals per month, which is the current limit for largemouth bass due to the presence of methylmercury in fish (for sensitive populations, the recommendation is to not eat largemouth bass).

In 2024, an additional three five-fish composite black crappie samples and an additional two five-fish composite largemouth bass samples were collected from Annabessacook Lake (Map 5). Combining the data from 2023 and 2024 for black crappie, PFOS concentrations ranged from 16.0 to 17.5 ng/g, with a mean concentration of 17.3 ± 0.6 ng/g. Combining the data from 2023 and 2024 for largemouth bass, PFOS concentrations ranged from 7.4 to 10.12 ng/g, with a mean concentration of 10.6 ± 1.4 ng/g (Figure 5).

For black crappie the upper confidence limit on the mean is 17.3 ng/g, which corresponds to a consumption rate of no more than 10 meals per year. For largemouth bass the upper confidence limit on the mean is 10.6 ng/g, which corresponds to a consumption rate of no more than one meal per month or 12 meals per year (Figure 5). Combining both black crappie and largemouth bass results in a mean PFOS concentration of 12.3 ng/g with an upper confidence limit on the mean of 15.8 ng/g, which corresponds to an overall consumption rate of no more than 10 meals per year. To simplify the consumption advisory, and because the difference between 10 and 12 meals per year is minimal, the two species were combined for the purpose of issuing a fish consumption advisory. In the absence of data in other fish species, this consumption advisory applies to all fish species in Annabessacook Lake.

Map 5. Approximate location of fish sampling for PFOS from Annabessacook Lake in Monmouth and Winthrop with range of PFOS concentrations in each species sampled.

F. Messalonskee Stream – Oakland and Waterville

Area: Messalonskee Stream from the Rice Rips Dam in Oakland to the Kennebec River in Waterville.

Advisory: Consume no more than three meals per year of any fish species.

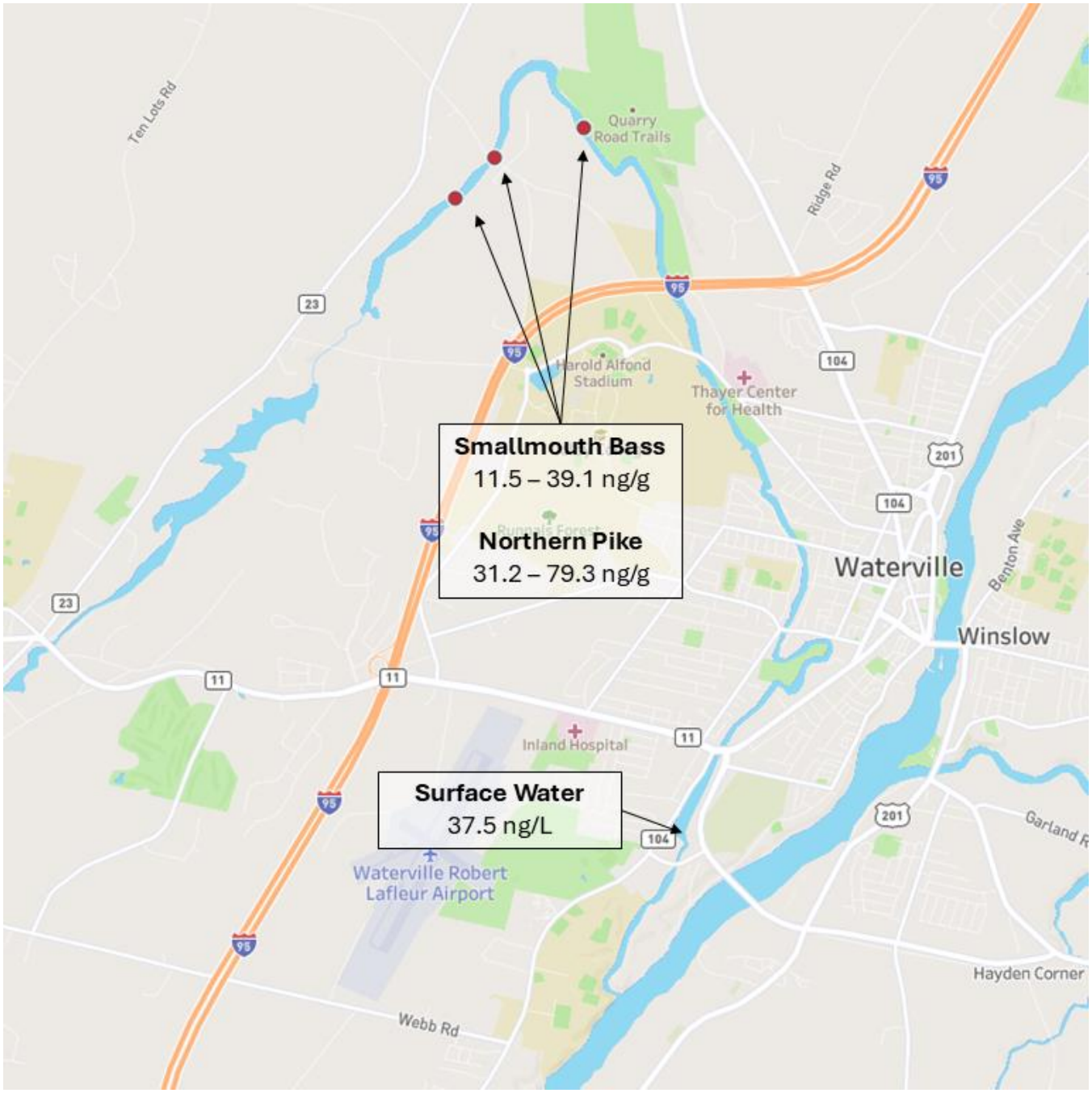
Justification: In 2022 a fish consumption advisory of no more than three meals per year of any fish species was issued for Messalonskee Stream from the Rice Rips Dam in Oakland to the Automatic Dam in Waterville. The boundaries for this advisory were set based on physical boundaries (i.e., dams) that would prevent fish movement between different sections of the stream.

Since 2022, experiences with waterbodies such as Limestone Stream in Limestone have demonstrated that physical boundaries that prevent fish movement are not necessarily sufficient for PFOS advisories (see 2023 and 2024 Scientific Briefs[6]), as the concentration of PFOS in fish appears to be more related to the concentration of PFOS in the water which is not impacted by physical boundaries such as dams. Thus, in 2024 an effort was made to collect additional fish tissue data from Messalonskee Stream below the Automatic Dam to evaluate the need for extending the 2022 advisory beyond the dam. While fish tissue sampling was unsuccessful, a surface water sample was collected near the Union Gas dam. The concentration of PFOS in the surface water at the Union Gas Dam was 37.5 ng/L (Map 6). At this water concentration, fish present in waters below the Union Gas Dam would be expected to have fish tissue concentrations warranting a consumption rate of 3 meals per year.[7] Based on the elevated surface water concentrations below the Automatic Dam and estimated fish tissue concentrations, the existing consumption advisory of no more than three meals per year for any fish species is extended all the way to the Kennebec River.

[6] https://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/documents/pfas-fish-scientific-brief-04202023.pdf https://www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/documents/pfas-fish-scientific-brief-06182024.pdf

[7] An estimated median BAF for muscle/fillet tissue of 1,500 L/kg has been reported for finned fish species (Burkhard, 2021) and a BAF of 1,700 L/kg for trophic level 3 fish was used by EPA in developing its proposed ambient water quality criteria for PFOS (EPA, 2024). Using a BAF of 1,500 – 1,700 L/kg and a surface water concentration of 37.5ng/L would result in an estimated fish tissue PFOS concentration of 56.3 – 63.8 ng/g.

Map 6. Approximate location of fish and surface water sampling for PFOS from Messalonskee Stream in Oakland and Waterville with range of PFOS concentrations in each fish species sampled.



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