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Surface Water Ambient Toxics Monitoring Program Report 2023-2024

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Table of Contents

Page

Introduction 2
Acronyms 3
Executive Summary 4
Contaminants in Marine Fish and Shellfish 5
Contaminants in Freshwater Fish 6
Cyanotoxins in Lakes 7
Biological Monitoring 7
2. Contaminants in Freshwater Fish 50
2.1 Background 50
2.2 PFAS in 2023 Fish & Water Samples 56
Methods 56
Results: 2023 Fish Samples 60
Results: 2023 Water Samples 69
2.3 PFAS in 2024 Fish & Water Samples 71
Methods 71
Results: 2024 Fish Samples 76
2.4 Overview of PFAS in Fish Samples (2014-2024) and Water Samples (2021-2024). 87
2.5 DDT in 2023 Fish Samples 91
2.6 PCBs in 2023 and 2024 Fish Samples 95
2.8 References 97
3. Cyanotoxins in Lakes 99
3.1 Introduction 99
Health Advisory Levels. 99
3.2 Results 100
Discussions Regarding Advisories 103
4. Biological Monitoring 104
4.1 Introduction 104
4.2 2023 Results 106
4.3 2024 Results 128

Introduction

This 2023-2024 Surface Water Ambient Toxic (SWAT) monitoring program final report is organized into an Executive Summary, Introduction and the following four sections:

1. Contaminants in Marine Fish and Shellfish (*Jim Stahlnecker, Marine Unit*, *james.stahlnecker@maine.gov)*
2. Contaminants in Freshwater Fish (*Tom Danielson, Aquatic Toxicology Unit, thomas.j.danielson@maine.gov*)
3. Cyanotoxins in Lakes (*Linda Bacon, Lake Assessment Unit, linda.bacon@maine.gov*)
4. Biological Monitoring (*Jeanne DiFranco, Biological Monitoring Unit, jeanne.l.difranco@maine.gov*)

The full report is available on the DEP website at http://www.maine.gov/dep/water/monitoring/toxics/swat/index.htm

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Academic:	Dr. Rebecca Van Beneden, School of Marine Sciences, UM Dr. Dianne Kopec, Senator George J. Mitchell Center for Sustainability Solutions, UM
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Public Health:	Breana Bennett, CDC Dan Kusnierz, Penobscot Indian Nation
Legislators:	Senate – Sen. Stacy Brenner House of Representatives – Rep. Allison Hepler

Acronyms

AFFF	aqueous film-forming foam
BKT	brook trout
BRWM	Bureau of Remediation and Waste Management
CDC	Maine Center for Disease Control and Prevention
DEP	Maine Department of Environmental Protection
DMR	Maine Department of Marine Resources
DO	dissolved oxygen
ELISA	enzyme-linked immunosorbent assay
EPA	US Environmental Protection Agency
EPT	sum of mayflies, stoneflies and caddisflies
FTAL	fish tissue action level
HA	health advisory
HAB	harmful algal bloom
IFW	Maine Department of Inland Fisheries & Wildlife
LAFB	Loring Airforce Base
LMZ	lobster management zone
MC	microcystin
NA	non-attainment
NCCA	National Coastal Condition Assessment
NPS	nonpoint source pollution
NRSA	National River and Stream Assessment
PCB	polychlorinated biphenyl
PFAS	per- and polyfluoroalkyl substances
PFOS	perfluorooctane sulfonate
PFOSA	perfluorooctane sulfonamide
RAG	remedial action guidelines
RL	reporting limit
SWAT	Surface Water Ambient Toxics
TAG	Technical Advisory Group
TEF	toxic equivalent factor
TEQ	toxic equivalency value
WHO	World Health Organization
WWTP	wastewater treatment plant

Executive Summary

Maine's Surface Water Ambient Toxics (SWAT) monitoring program was established in 1993 (38 MRSA §420-B) and administered by the Department of Environmental Protection (DEP) to determine the nature, scope and severity of toxic contamination in the surface waters and fisheries of the State. The authorizing statute states that the program must be designed to comprehensively monitor the lakes, rivers and streams, and marine and estuarine waters of the State on an ongoing basis. The program must incorporate testing for suspected toxic contamination in biological tissue and sediment; may include testing of the water column; and must include biomonitoring and the monitoring of the health of individual organisms that may serve as indicators of toxic contamination. The program must collect data sufficient to support assessment of the risks to human and ecological health posed by the direct and indirect discharge of toxic contaminants.

The Commissioner of the DEP must prepare a five-year conceptual work plan in addition to annual work plans which are each reviewed by a Technical Advisory Group (TAG). The TAG is composed of 12 individuals, including two representatives with scientific backgrounds representing each of five various interests (business, municipal, conservation, public health and academic), and two legislators.

The SWAT program is divided into four sections: 1) Contaminants in Marine and Estuarine Fish and Shellfish, 2) Contaminants in Freshwater Fish, 3) Cyanotoxins in Lakes, and 4) Biological Monitoring. This biennial report follows the goals of the 2019-2023 five-year conceptual plan, including:

- monitor contaminants in marine and anadromous fish and shellfish and provide information to the Department of Marine Resources (DMR),
- monitor contaminants in freshwater fish and provide data to the Maine Center for Disease Control and Prevention (CDC) for use in revising fish consumption advisories,
- investigate cyanotoxins in lakes, and
- evaluate the condition of aquatic life assemblages in rivers and streams to determine if they attain aquatic life criteria.

This report more specifically presents the findings of the 2023 and 2024 annual work plans recommended by the SWAT Technical Advisory Group. Highlights of the 2023 and 2024 sampling for each of the four sections are provided below. Most sampling was funded by the Maine State Legislature. Some sampling was funded by additional money from the U.S. Environmental Protection Agency. SWAT program activities described in this report were funded by the Maine Legislature and the U.S. Environmental Protection Agency.

Contaminants in Marine Fish and Shellfish

- American lobster hepatopancreas (tomalley) was analyzed for per- and polyfluoroalkyl substances (PFAS) compounds from 16 sites across the coast of Maine in 2023. Perfluorooctane sulfonate (PFOS) was detected in hepatopancreas tissue at all stations analyzed, with even the highest concentrations below the Maine Center for Disease Control (MCDC) fish tissue action level (FTAL) for PFOS in recreationally caught freshwater finfish. In contrast, previous analyses of PFOS in lobster meat showed non-detects at about half of sites tested and very low concentrations of PFOS in muscle from the remaining sites that should not pose risk in human consumption of lobster meat. In hepatopancreas, twelve other PFAS compounds were detected in samples.
- American lobster hepatopancreas (tomalley) was analyzed for dioxins, furans, coplanar polychlorinated biphenyls (PCBs), and total PCBs (to update 2018 results). New 2023 data support retaining the do not eat recommendation for hepatopancreas due to elevated levels of both total PCBs and calculated "toxic equivalents" (a measure of both toxicity and detected concentration for coplanar PCBs and dioxins/furans).
- American lobster muscle was analyzed for dioxins, furans, coplanar polychlorinated biphenyls (PCBs), and total PCBs (to update 2018 results). New 2023 data demonstrates that Maine lobster meat remains low in both total PCBs and the calculated "toxic equivalents" (a measure of both toxicity and detected concentration for coplanar PCBs and dioxins/furans). Neither of these measures approach CDC FTAL, indicating lobster meat is edible without any consumption advisory.
- American lobster hepatopancreas and muscle tissues were analyzed for ten metals. Metals concentrations support consumption of lobster muscle tissue without any consumption advisory. Cadmium concentrations in hepatopancreas support a continued do not eat recommendation for lobster tomalley.
- Atlantic silverside, a minnow species, were analyzed for PFAS compounds from 3 sites in 2023 and 26 sites in 2024. PFOS was present in silverside tissue from 26 of 29 sites tested, with the highest concentrations found in Fore River and East End, Portland, and Harpswell Cove (Mare Brook), Brunswick. Fourteen additional PFAS compounds were found in low levels in Atlantic silverside tissue.
- Pollock (small, "harbor" pollock) were analyzed for PFAS compounds from 3 sites in 2024: Two in Casco Bay and one in Penobscot Bay. All pollock tested had PFOS concentrations in tissue well below (at most, one seventh) of CDC PFOS FTAL for recreationally caught freshwater fish. Pollock in Casco Bay had slightly higher PFOS concentrations than Penobscot Bay pollock.
- Softshell clams were analyzed for PFAS compounds from two sites in the lower Kennebec River estuary in 2024. Clam tissue at the two 2024 sites contained PFOS at low concentrations, like 2022 sampling nearby at a third site. PFOS concentrations in clam tissue were well below (at most, one seventh) of CDC PFOS FTAL for recreationally caught freshwater fish. Clam tissue showed low concentrations of ten other PFAS compounds of the 40 compounds for which testing was conducted. PFAS

testing of softshell clams indicates PFAS compound concentrations are low in clam tissue and support human consumption without advisories.

Contaminants in Freshwater Fish

- Similar to previous samples, the most common PFAS in freshwater fish collected in 2023 and 2024 was PFOS. Currently, PFOS is the only kind of PFAS that is used by CDC to determine if fish consumption advisories are necessary for PFAS. The fish tissue action level (FTAL) for PFOS is 3.5 ng/g or parts per billion (ppb).
- In 2023, fish from the following waterbodies had average concentrations of PFOS that **exceeded** the 3.5 ng/g FTAL: Androscoggin Lake (Wayne), Androscoggin River (Brunswick), Annabessacook Lake (Winthrop), Aroostook River (Caribou), Collyer Brook (Gray), Fairfield PAL Pond (Fairfield), Great Works River (Berwick), Halfmoon Stream (Thorndike), Kenduskeag Stream (Bangor, Corinth), Kennebec River (Hinkley and Fairfield), McGrath Pond (Oakland), Messalonskee Stream (Waterville), North Branch Presque Ise Stream (Mapleton), Pearce Brook (Houlton), Presumpscot River (Westbook, Windham), Salmon Falls River (North Berwick), Salmon Lake (Oakland), Sandy Stream (Unity), Togus Pond (Augusta), West Branch Sebasticook River (Palmyra).
- In 2023, fish from the following waterbodies had average concentrations of PFOS that were **less than** the 3.5 ng/g FTAL: Aroostook River (Fort Fairfield), Auburn Lake (Auburn), B Stream (Houlton), East Pond (Smithfield), Kennebec River (Norridgewock), Mattanawcook Pond (Lincoln), Meduxnekeag River (Houlton), North Pond (Smithfield), Prestile Stream (Mars Hill), Pushaw Lake (Glenburn), Sabattus Pond (Sabattus), and Silve Lake (Bucksport).
- In 2024, fish from the following waterbodies had average PFOS concentrations that **exceeded** the 3.5 ng/g FTAL: Androscoggin Lake (Wayne), Androscoggin River (Brunswick), Annabessacook Lake (Winthrop), Cobbosseecontee Lake (Manchester), Collyer Brook (Gray), Great Works River (Berwick), Kennebec River (Sidney), Little Madawaska River (Caribou), Maranacook Lake (Readfield), Mare Brook (Brunswick), Merriconeag Stream (Brunswick), Long Lake (Belgrade), Lovejoy Pond (Albion), Saco River (Biddeford), Sandy Stream (Unity), Sebago Lake (Raymond), Sebasticook River (Clinton), West Branch Sebasticook River (Palmyra), and Wilson Pond (Monmouth).
- In 2024, fish from the following waterbodies had average concentrations of PFOS that were **less than** the 3.5 ng/g FTAL: Aroostook River (Fort Fairfield), Big Lake (Big Lake TWP), Clary Lake (Jefferson), Damariscotta Lake (Damariscotta), Gagnon Brook (Frenchville), Grand Falls Flowage (Princeton), Great Pond (Belgrade), Highland Lake (Bridgton), Kennebec River (Norridgewock), Long Pond (Belgrade), Meduxnekeag River (Houlton), North Branch Presque Isle Stream (Mapleton), Pearce Brook (Houlton), Presque Isle Stream (Presque Isle), Quiggle Brook (Union), Sebasticook Lake (Newport), Seven Tree Pond (Union), and Stantial Brook (Brooks).
- In 2023 and 2024, samples of brook trout from the Meduxnekeag River (Houlton), North Branch Presque Isle Stream (Mapleton), and Prestile Stream (Mars Hill) were analyzed for the pesticide, dichloro-diphenyl-trichloroethane (DDT). All of those sites

currently have fish consumption advisories for DDT. The FTAL for the sum of 6 forms of DDT and its metabolites is 64 ng/g (ppb). The average concentration of DDT was less than the FTAL in all of those waterbodies.

- In 2023 and 2024, samples of smallmouth bass from the Androscoggin River (Brunswick), Kennebec River (Augusta, Norridgewock, Richmond, and Sidney) and Presumpscot River (Gorham) were analyzed for total PCBs. All of those waterbodies have fish consumption advisories for total PCBs. The FTAL for total PCBs is 11 ng/g (ppb). The mean concentration of total PCBs was greater than the FTAL in the Androscoggin River (Brunswick), Kennebec River (Augusta and Richmond), and Presumpscot River (Gorham). The mean concentration of total PCBs was less than the FTAL in the Kennebec River (Norridgewock and Sidney).

Cyanotoxins in Lakes

- Previous SWAT-funded cyanotoxin research revealed that most Maine lakes do not produce the cyanotoxin microcystin. Microcystin concentrations in lakes that support annual, severe algal blooms rarely have open water levels that exceed EPA's 10-day drinking water health advisory for adults and school-aged children. However, algal scums that accumulate on downwind shores may have concentrations orders of magnitude above both drinking water and recreational EPA levels.
- In 2019 DEP invested in an Abraxis Strip Reader to obtain timely cyanotoxin results. The strip reader was used in 2023 and 2024 to evaluate samples submitted by concerned citizens.
- Results from 100 samples obtained between 2020 and 2023 and submitted to EPA Region I under their BloomWatch Program, were received in 2024 and are included in this report.
- DEP collaborated with Bigelow Labs by collecting samples for eDNA analysis to determine which algal populations have the genetic capacity to produce microcystin. Samples were collected from the same locations as the 2023 and 2024 BloomWatch samples in 2023 and 2024; no results from Bigelow have been received yet.
- DEP considered adopting EPA's recommended swimming criteria for microcystin as part of the current Triennial Review of Maine's Water Quality Standards, but because EPA guidance requires that not only magnitude, but also duration and frequency be addressed in an advisory, this will be reconsidered at a later time.
- DEP sponsored a 2024 MOHF grant to explore public messaging regarding algal blooms.
- An emerging priority throughout the country is evaluation of toxin production from benthic species of algae. The Lake Assessment Section hopes to explore the use of Gold Standard's test kits to begin evaluating the extent to which benthic HABs exist in Maine's lakes.

Biological Monitoring

- In 2023 the Biological Monitoring Unit sampled macroinvertebrate communities at 43 stations focusing in the Androscoggin River basin to determine attainment of

Maine's aquatic life use criteria. Thirty stations met the aquatic life criteria for their legislatively-assigned water quality class, but 13 stations did not attain criteria for their assigned class.

- In 2024, the Biological Monitoring Unit focused macroinvertebrate sampling in the St. John and Aroostook basins. A total of 35 stations were sampled. Taxonomic analysis of the 2024 data is still ongoing, and additional results will be added to this report as data are received back from DEP contractors. Results for 15 stations are currently available and are summarized in Table 1b. Of these 15 stations, 3 did not attain criteria for their assigned class.

1. Contaminants in Marine Fish and Shellfish

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1.1 Introduction

Maine's coastline lies within and lends its name to the larger Gulf of Maine, a diverse and productive ecosystem. The Maine coast and the Gulf of Maine provide economic opportunities including commercial fisheries, aquaculture, recreational fisheries, commerce via shipping, and a wide variety of tourism activities. Maine includes the urbanized areas of Portland, Lewiston/Auburn, and Bangor and has experienced growth and increased development in recent years, especially in the southwestern portion of the state's coastline. With development, increases in chemical contaminants discharged to the marine environment may occur. Some contaminants can also become concentrated as they move through the food chain, bioaccumulating at higher trophic levels and potentially impacting the viability of marine species and ecosystem health and causing concern about potential consequences to human health. All these factors suggest that the monitoring of chemical contaminants is an important component of assessing the health of the marine environment in Maine.

This report explores analysis of marine tissues, including finfish, softshell clams, and American lobster hepatopancreas samples for perfluorinated alkylated compounds (PFAS). PFAS are organofluorinated compounds that have fluorine substituted for all hydrogens where C-H bonds otherwise would occur in organic compounds. PFAS also have a functional group derived from the parent organic compound such that PFAS have properties of both fluorocarbons and the parent compound. The dual properties of PFAS make them useful in water, grease, and stain repellants (paper, fabric, and carpet treatments, notably Scotchgard by 3M), in the semiconductor industry, in firefighting foams, and as paint and other coating additives where flow is critical. Production of perfluorooctonatesulfonyl fluoride related compounds, notably PFOSA (a sulfonamide), was terminated by 3M by 2003 but production overseas has continued or increased. While PFOSA was synthesized for use by industry, it is also created as a degradation byproduct of alkylated-perfluorooctanesulfonamides (which were used to treat paper, carpet, and fabric) through conversion into acetates and eventually to PFOSA.

In addition to PFAS, analyses of total polychlorinated biphenyl (PCBs), coplanar PCBs and dioxins/furans, heavy metals, and mercury, were completed in samples of American lobster muscle and hepatopancreas tissues to update previous work. These results support the do not eat fish tissue consumption advisory in place for lobster hepatopancreas and confirm safe consumption of lobster muscle tissue.

American Lobster

This report presents data from American lobster (*Homarus americanus*) tissues collected in 2023 from the DMR lobster management zones statewide. Lobster hepatopancreas was analyzed for PCBs, coplanar PCB/dioxin/furan, PFAS and metals. Lobster muscle was analyzed for PCBs, coplanar PCBs/dioxins/furans, and metals. Lobsters were collected by DMR via traps and provided to DEP frozen whole for dissection by DEP staff. The DEP SWAT program sampled lobster previously in 2021, with muscle tissue analyzed for PFAS compounds. In 2018, lobster muscle and hepatopancreas (tomalley) were analyzed for PCBs, including coplanar PCBs, and dioxins/furans. The 2018 PCB/coplanar PCB/dioxins/furans data combined with prior 2016 metals data have been useful in confirming low concentrations of contaminants in lobster as seafood, particularly when foreign buyers in emerging markets inquire about lobster contaminant concentrations.

Lobster was also analyzed to provide information concerning the quality of the benthic environment and because Maine has a fish consumption advisory on lobster hepatopancreas (tomalley) tissue. As predators and scavengers of benthic infauna and detritus on the sea bottom, lobsters ingest toxic contaminants and bioaccumulate those contaminants in their body tissues. Lobsters are ubiquitous along the Maine coast, allowing collections to take place along the entire coast and facilitating geographic comparisons. The lobster fishery is Maine's premier fishery, with the highest landed value of any commercial fishery in the state. In addition, Maine lobstermen strive to provide the highest quality product and determining and assuring the quality of this product is of importance to the future sustainability of the fishery. This project builds upon early work done by DEP in 1994-1996 on contaminants in lobster tissues, previous sampling of lobster by National Coastal Condition Assessment (NCCA) in 2005-06 and 2010 at additional locations, 2016 SWAT metals analyses, 2018 SWAT PCB analyses, and 2021 muscle PFAS analysis.

Marine Minnow and Sport Finfish Species

This report presents PFAS data from Atlantic silversides (*Menidia menidia*) collected by DEP SWAT at three sites in 2023 and twenty-six sites in 2024. These data can be compared to previous PFAS data from silversides and banded killifish (*Fundulus diaphanous*) taken at other locations. Prior PFAS analyses by the SWAT program in blue mussel and softshell clams have shown low concentrations of PFAS in bivalve tissues, prompting interest in examining nearshore finfish to better understand PFAS contaminant concentrations in the Maine marine environment. Freshwater fish show uptake of PFAS compounds and little data exists for marine finfish species on the Maine coast.

Atlantic silverside were chosen for their limited migratory habits and small size, allowing a large composite sample size and a comparison between spatial sites, while minimizing the chance of fish moving large distances from where they took up PFAS contaminants. In 2023, silverside were collected from two sites in the Fore River and one site off East End Beach, Portland. Silverside collections in 2024 included 26 sites from York River in southern Maine, across Casco Bay and the mid-coast, and multiple sites in Penobscot Bay.

Softshell Clams

Softshell clams were collected at two sites in the lower Kennebec River estuary in 2024. In 2022, softshell clams obtained from Atkins Bay in the Kennebec estuary had detectable concentrations of PFOS. Subsequent sampling was planned for 2024 to obtain more spatial information on PFAS contaminant concentrations in nearby areas of the Kennebec estuary. Clams were collected at two sites in 2024, near Bald Head and Parker Head.

Marine Finfish from Trawl Survey

This report presents PFAS data from winter flounder (*Pseudopleuronectes americanus*) and white hake (*Urophycis tenuis*), which were obtained from the Maine Dept. of Marine Resources and were collected through the Maine – New Hampshire Inshore Trawl Survey conducted in autumn, 2024. Winter flounder and white hake were chosen for analysis due to their popularity as commonly caught recreational fish, their suitability as food, and the frequency of their occurrence in DMR trawl samples. Trawl samples included winter flounder from 11 stations and white hake from 5 stations.

Anadromous Rainbow Smelt

As part of the marine SWAT PFAS tissue sampling, anadromous rainbow smelt (*Osmerus mordax*) were collected by DEP staff in winter and spring of 2025. Smelt were, and are being, collected from four rivers in the Androscoggin/Kennebec River drainage. Due to the timing of sampling, which is ongoing, and completion of lab analysis, smelt results will be presented in a subsequent SWAT report.

1.2 Methods

American Lobster

In 2023, lobsters were sampled from 16 areas across the coast of Maine, with samples distributed among the DMR lobster management zones (LMZs), which run west to east from G to A (Figure 1). Two zones with large areas and with high lobster landings, A and C, were collected in a western, midzone, and eastern location. In the remaining five LMZs, samples from two areas (west and east) were collected. Five lobsters were collected from each area sampled, with all five lobsters used to construct one composite sample for analysis. Lobsters were trapped by DMR and frozen individually in plastic bags.

In the laboratory, DEP SWAT staff dissected each partially frozen lobster, removing claw and tail meat to provide a muscle tissue sample. A biopsy punch was used to remove tissue plugs of tail (3 plugs/lobster) and claw meat (2 plugs/lobster). Hepatopancreas was removed by dissecting partially frozen tissue. Tissues from five lobsters were combined into a composite sample for each of the tissue types and spatial sites sampled. Tissue composites were immediately placed in pre-cleaned jars furnished by the lab and capped. Jars were pre-labeled and filled jars were stored at -80^{o} C for up to one month until samples could be shipped, and analyses could be completed. Frozen tissue was shipped overnight to the laboratory for analysis. Lobster hepatopancreas tissue was analyzed for total PCBs, coplanar PCBs/dioxin/furan, and 40 PFAS compounds by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using methods E1668A, E1613B, and EPA 1633. Lobster muscle tissue was analyzed for total PCBs, and coplanar PCBs/dioxin/furan by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using methods E1668A, and E1613B. Both lobster hepatopancreas and muscle tissues were analyzed for 11 metals and mercury by Brooks Applied Labs, Seattle, Washington, using methods EPA 3050B, and ICP-QQQ-MS.

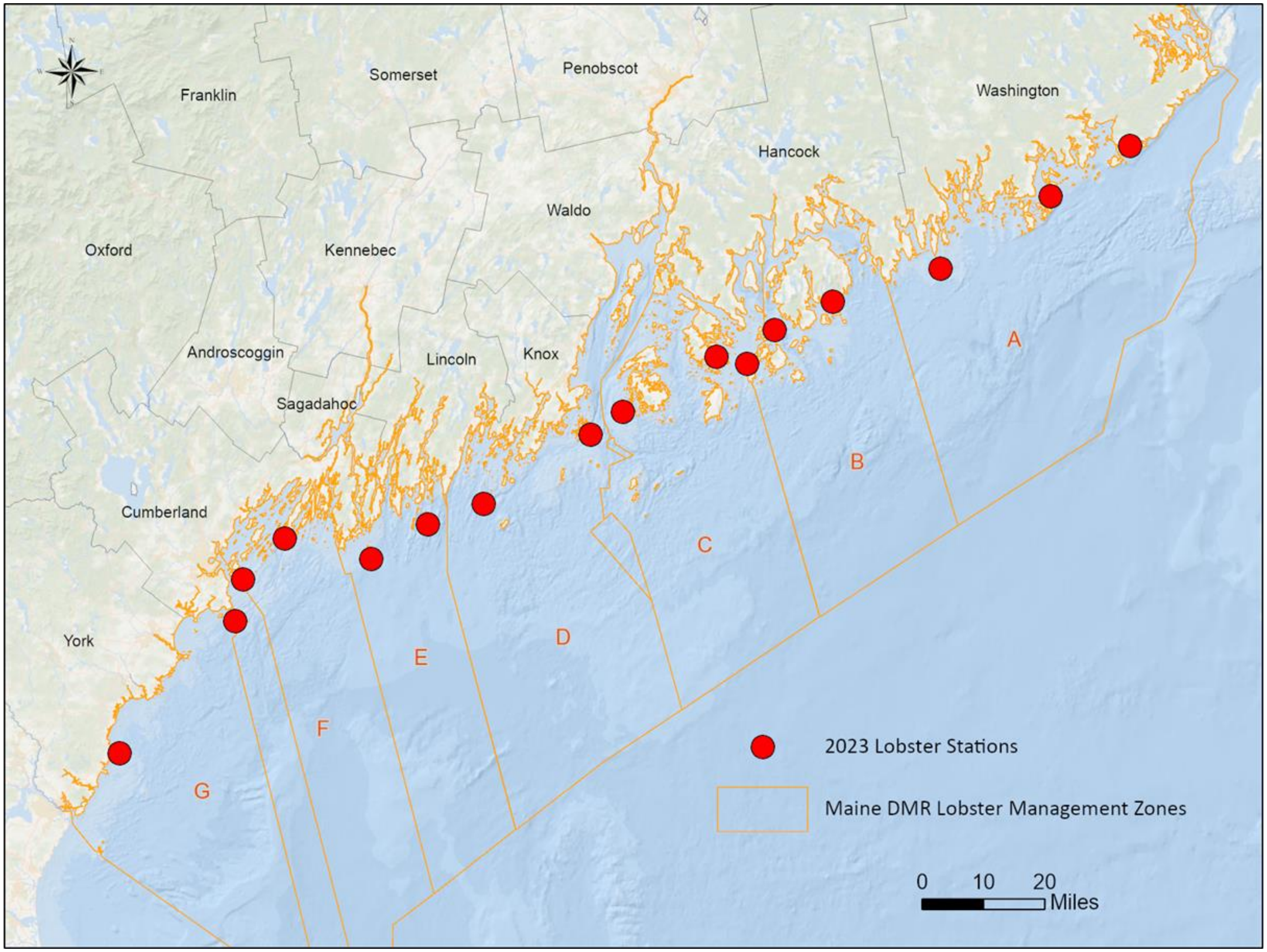

Figure 1. DMR lobster management zones and locations of 2023 SWAT lobster stations

Marine Minnow and Sport Finfish Species

Atlantic silverside (*Menidia menidia*) were collected by beach seine along shore. DEP staff weighed and measured minnow samples in the lab and created composites containing 25 fish. Composite samples consisted of whole fish. Tissue composites were immediately placed in pre-labeled Ziploc bags and filled bags were stored at -5° C for up to one month until samples could be shipped, and analyses could be completed. Frozen tissue was shipped overnight to the laboratory for analysis. Minnow tissue was analyzed for a suite of 40 PFAS compounds by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using Method EPA 1633. See Table 1 and 2 and Figure 2.

Table 1. 2023 marine finfish sites

Atlantic Silverside					
Site Name	Municipality	Date Sampled	West Longitude	North Latitude	# Fish / Composite
Inner Fore River West of 1-295	S Portland	9/22/2023	-70.29367	43.64560	25
Middle Fore River West of Rte. 77	S Portland	9/22/2023	-70.25857	43.64248	25
East End Beach Casco Bay	Portland	9/22/2023	-70.23996	43.66864	25

Table 2. 2024 marine finfish sites

Atlantic Silverside					
Site Name	Municipality	Date Sampled	West Longitude	North Latitude	# Fish / Composite
York R.	York	8/14/2024	-70.67355	43.13514	25
Mousam R.	Kennebunkport	8/21/2024	-70.50979	43.34513	25
Saco R.	Saco	9/19/2024	-70.38333	43.46409	25
Goosefare Brook	Old Orchard Beach	9/19/2024	-70.38712	43.498	25
Nonesuch R.	Scarborough	8/1/2024	-70.33543	43.54468	25
Presumpscot R.	Falmouth	7/30/2024	-70.24724	43.70839	25
Presumpscot R. Upper	Falmouth	8/20/2024	-70.25859	43.71561	25
Falmouth	Falmouth	7/30/2024	-70.21765	43.72007	25
Royal R.	Yarmouth	7/31/2024	-70.16382	43.79246	25
Harraseeket R.	Freeport	7/31/2024	-70.09935	43.82855	25
Harpswell Ctr.	Harpswell	8/19/2024	-69.97849	43.79933	25
N. Harpswell	Harpswell	8/19/2024	-69.94955	43.8342	25

Mare Brook	Brunswick	8/19/2024	-69.93267	43.86366	25
New Meadows R.	Brunswick	8/13/2024	-69.87371	43.90557	25
Small Pt. Harbor	Phippsburg	8/13/2024	-69.84759	43.73535	25
Owls Head	Owls Head	9/4/2024	-69.07966	44.06296	25
Rockland	Rockland	9/4/2024	-69.10637	44.10245	25
Camden	Camden	9/12/2024	-69.0523	44.21547	25
Northport	Northport	9/12/2024	-68.95304	44.33943	25
Belfast	Belfast	9/12/2024	-69.0108	44.43712	25
Searsport	Searsport	9/6/2024	-68.89677	44.46862	25
Stockton Springs	Stockton Springs	9/6/2024	-68.85685	44.47943	25
Sandy Pt.	Stockton Springs	9/6/2024	-68.8095	44.51379	25
Frankfort	Frankfort	9/18/2024	-68.86085	44.59264	25
Winterport	Winterport	9/18/2024	-68.82202	44.67099	25
N. Winterport	Winterport	9/18/2024	-68.84222	44.69851	25
Pollock					
Site Name	**Municipality**	**Date Sampled**	**West Longitude**	**North Latitude**	**# Fish / Composite**
CB Stepping Stones	Long Island	10/9/2024	-70.13559	43.69376	5
E. CB Pond Is.	Harpswell	8/27/2024	-69.96783	43.73526	5
W PB Monroe Is.	Owls Head	9/4/2024	-69.03174	44.08027	5

Pollock (*Pollachius virens*), smaller, “harbor” pollock were collected by DEP staff by angling in shallow water adjacent to rocky areas near shore. DEP staff dissected samples of skinless fillet from fresh pollock, placed equal mass tissue samples from five pollock per replicate in Ziploc bags, two replicates per site sampled, and froze the filled bags at -80^{o} C for up to one month until shipping could be completed. Frozen tissue composites were shipped overnight to the laboratory for analysis. SGS AXYS completed homogenization of pollock composites. Pollock skinless fillet composites were analyzed for a suite of 40 PFAS compounds by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using Method EPA 1633. See Table 1 and 2 and Figure 2.

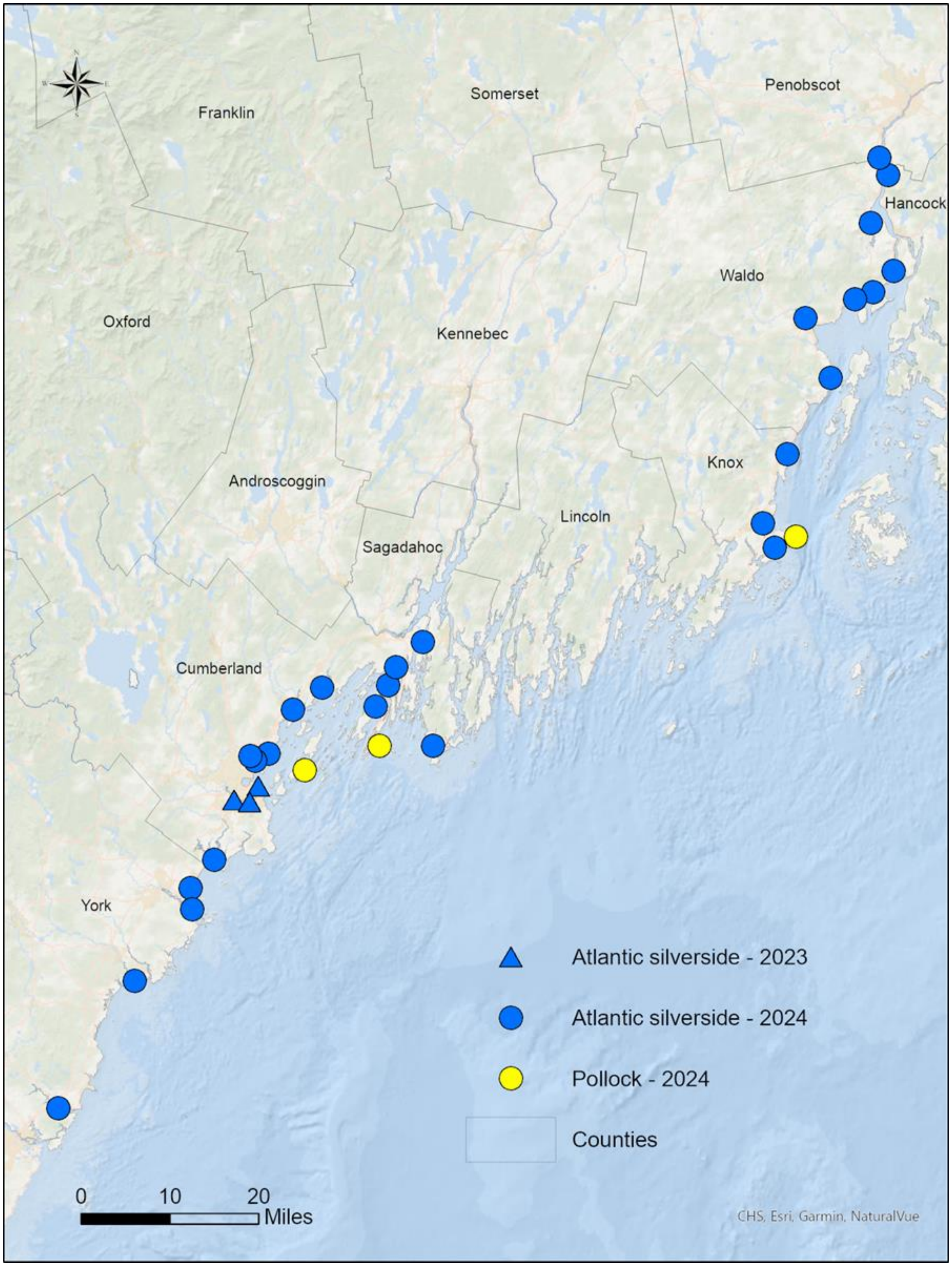

Figure 2. 2023 - 2024 marine finfish sampling stations

Softshell Clam

Softshell clams were collected by digging clams in the intertidal zone along the shore. In 2024, DEP staff collected softshell clams at two sites in the lower Kennebec River estuary to expand spatial coverage of PFAS data in clam tissue in the estuary. Samples of softshell clam tissue taken in 2022 at Atkins Bay showed detectable concentrations of PFOS, which was a new finding in SWAT softshell clam tissue. Additional data were sought to determine if nearby flats also contained clams with detectable PFOS in their tissue and to determine any discernable spatial patterns. Each site sampled in 2024 was represented by four spatial subsamples, analyzed separately. Each subsample was a composite of ten softshell clams, including the skin or membrane portion of each clam. DEP staff dissected clam samples and placed tissues from ten clams into a composite for each of the four spatial subsamples. Upon dissection, clam tissue composites were immediately placed in Zip-lock bags and were stored at -80^{o} C for up to one month until analyses could be completed. Frozen tissue was shipped overnight to the laboratory for analysis. Softshell clam edible tissue was analyzed for a suite of 40 PFAS compounds by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using Method 1633. Softshell clam sampling location dates and coordinates are presented in Table 3. Sampling locations are shown in Figure 3.

Table 3. Softshell clam sampling locations 2022, 2024

Site Name	Municipality	Station Code	West Longitude	North Latitude	Date Sampled
Bald Head	Arrowsic	MCKNBH	-69.791440	43.812610	9/10/2024
Kennebec R.					
Parker Head	Phippsburg	MCKNPH	-69.801210	43.790360	9/10/2024
Kennebec R.					
Atkins Bay	Phippsburg	MCKNAT	-69.798844	43.742764	9/19/2022
Kennebec R.					

Marine Finfish from Trawl Survey

Prior to the October DMR fall trawl survey, DEP selected planned DMR trawl locations from which to request winter flounder and white hake samples from areas of interest or adjacent to potential PFAS sources. Trawl locations selected were from the shallowest stratum of trawl locations, typically those most nearshore. DMR collected winter flounder and white hake fished at targeted trawl locations and bagged and froze whole specimens aboard the research vessel. DEP collected frozen specimens from DMR, dissected individual fish to obtain skinless fillet samples of equal mass, placed equal mass tissue samples from five fish per replicate in Ziploc bags, two replicates per site sampled, and froze the filled bags at -80^{o} C for up to one month until shipping could be completed.

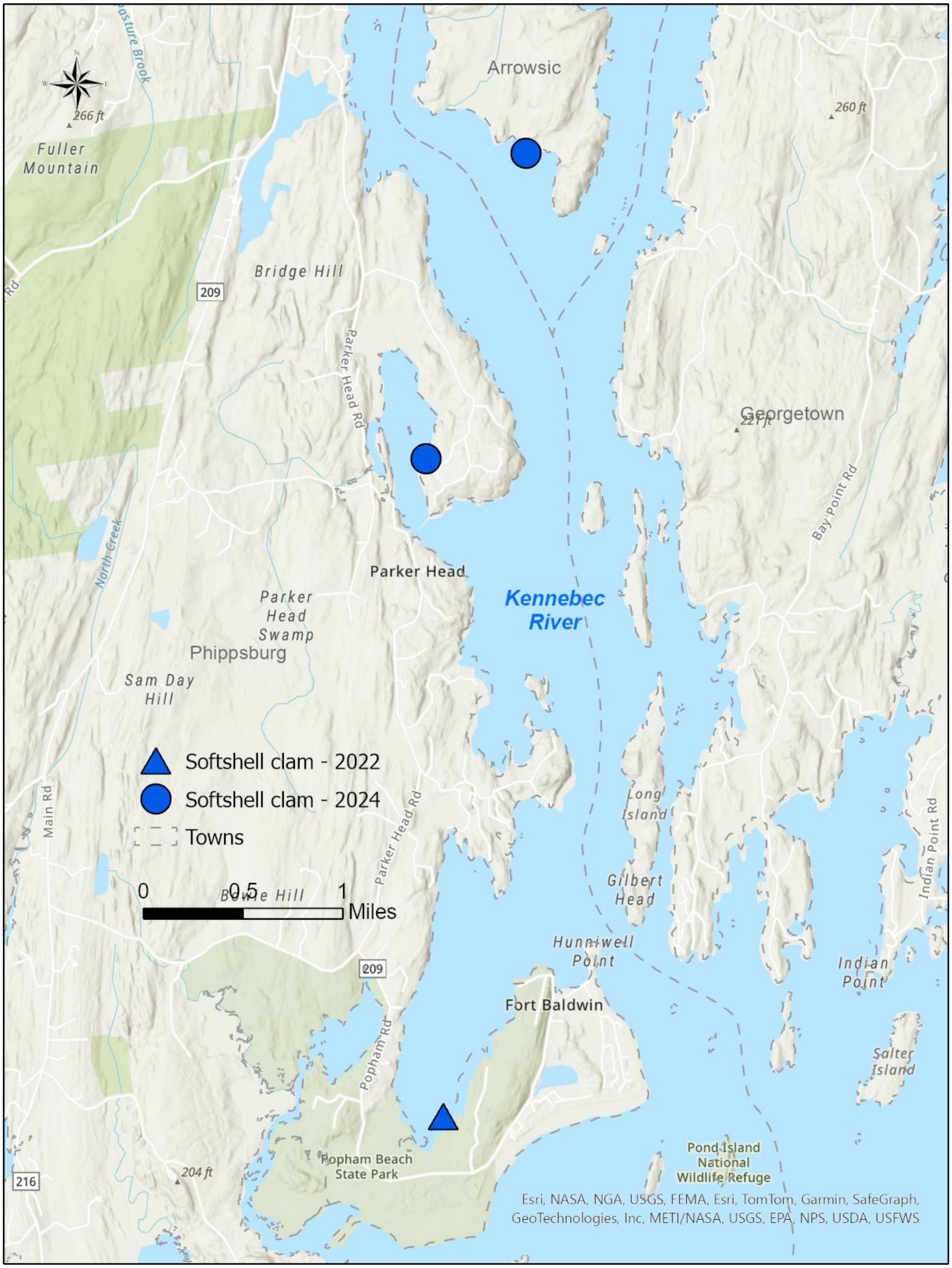

Figure 3. Softshell clam sampling locations 2022, 2024

Frozen tissue composites were shipped overnight to the laboratory for analysis. SGS AXYS completed homogenization of winter flounder and white hake composites. Winter flounder and white hake skinless fillet composites were analyzed for a suite of 40 PFAS compounds by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using Method EPA 1633. Laboratory results are still pending and will be included in the subsequent report after they become available.

Anadromous Rainbow Smelt

Rainbow smelt were sampled by DEP staff from four rivers within the Kennebec River basin in winter and spring, 2025. Smelt were chosen for analysis for PFAS since they are a target for recreational anglers and are consumed as food fish. PFAS tissue concentrations in other fish species examined by DEP SWAT in the Kennebec basin were elevated and so concentrations in smelt tissue are of interest and warranted examination.

Smelt were collected by DEP staff by angling through the ice at known smelt colony locations in the Androscoggin, Kennebec, Abagadasset, and Eastern rivers. DEP staff dissected samples of smelt, removing heads and entrails to replicate how smelts are typically consumed by anglers. Composites were constructed by placing five headless, gutted smelts per composite in Ziploc bags, two replicates per site sampled, and filled bags were frozen at -80^{o} C for up to one month until shipping could be completed. Frozen tissue composites will be shipped overnight to the laboratory for analysis. SGS AXYS will complete homogenization of smelt composites and analyze them for a suite of 40 PFAS compounds by SGS AXYS Analytical Services Ltd. Sidney, British Columbia, Canada, using Method EPA 1633. Laboratory results are still pending and will be included in the subsequent report after they become available.

1.3 Results

American Lobster – PFAS

American lobster hepatopancreas tissue collected in 2023 was analyzed for 40 PFAS compounds, which are listed in table 4.

Table 4: SWAT PFAS Compounds (40)

PERFLUOROBUTANOATE
PERFLUOROPENTANOATE
PERFLUOROHEXANOATE
PERFLUOROHEPTANOATE
PERFLUOROOCTANOATE
PERFLUORONONANOATE
PERFLUORODECANOATE
PERFLUOROUNDECANOATE
PERFLUORODODECANOATE
PERFLUOROTRIDECANOATE
PERFLUOROTETRADECANOATE
PERFLUOROBUTANE SULFONATE
PERFLUOROPENTANE SULFONATE
PERFLUOROHEXANE SULFONATE
PERFLUOROHEPTANE SULFONATE
PERFLUOROOCTANE SULFONATE
PERFLUORONONANE SULFONATE
PERFLUORODECANE SULFONATE
PERFLUORODODECANE SULFONATE
4:2 FLUOROTELOMER SULFONATE
6:2 FLUOROTELOMER SULFONATE
8:2 FLUOROTELOMER SULFONATE
PERFLUOROOCTANE SULFONAMIDE
N-METHYL PERFLUOROOCTANE SULFONAMIDE
N-ETHYL PERFLUOROOCTANE SULFONAMIDE
N-METHYL PERFLUOROOCTANE SULFONAMIDOACETIC ACID
N-ETHYL PERFLUOROOCTANE SULFONAMIDOACETIC ACID
N-METHYL PERFLUOROOCTANE SULFONAMIDOETHANOL
N-ETHYL PERFLUOROOCTANE SULFONAMIDOETHANOL
HEXAFLUOROPROPYLENE OXIDE DIMER ACID
4,8-DIOXA-3H-PERFLUORONONANOATE
9-CHOLOROHEXADECAFLUORO-3-OXANONANE-1-SULFONATE
11-CHLOROEICOSAFLUORO-3-OXAUNDECANE-1-SULFONATE
3:3 FTCA
5:3 FTCA
7:3 FTCA
PFEESA
PFMPA
PFMBA
NFDHA

Figure 6 shows the PFOS concentrations in lobster hepatopancreas tissue at the 16 lobster stations sampled in 2023. The stations run from left to right in west to east order with station G West located closest to the New Hampshire border and station A East located closest to the New Brunswick border. Each of the 16 sites tested represents the concentration in one five lobster composite sample, with the detected PFOS concentration shown in blue on the left. All 16 hepatopancreas composites had detectible concentrations of PFOS. The gray bars represent the reporting limit for each sample, shown to the right of and adjacent to each concentration. Samples E West (just east of Casco Bay) through D East (eastern Penobscot Bay), and sites B East and A East appear to have somewhat lower concentrations of PFOS in hepatopancreas than the other sites tested.

Maine does not have a fish tissue action level (FTAL) for PFOS in marine fish and shellfish to protect people that consume seafood. In the absence of a marine-specific FTAL for PFOS, the data were compared to Maine’s FTAL for PFOS for freshwater and anadromous fish, which is 3.5 ng/g ww (ppb).

Figure 7 compares the PFOS concentrations in lobster hepatopancreas (2023) and lobster muscle tissue (2021). It is important to recognize that these are not truly paired samples, as they come from somewhat different exact locations but are within the same general region. Concentrations from 2021 muscle tissue are means of two replicates. Muscle tissue PFOS concentrations are represented by the green bars and hepatopancreas concentrations by the blue bars. Some muscle tissue concentrations were non-detect, while all hepatopancreas concentrations were above reporting limits. Hepatopancreas concentrations were much higher than muscle concentrations overall. The lobster hepatopancreas PFOS concentrations were below the FTAL, with the highest at 2.5 ng/g wet wt. at F West being approximately 71% of the FTAL for PFOS. As outlined in the 2021-2022 SWAT report, the highest muscle concentration of PFOS in 2021 at 0.157 ng/g wet wt. at G West being approximately 4.5% of the FTAL for PFOS.

Figure 8 shows the ratios of all PFAS compounds detected in 2023 lobster hepatopancreas samples. PFOSA (8 carbons) is the dominant PFAS detected in G West through E East, from the New Hampshire border through Casco Bay to approximately Pemaquid Point. Similarly, PFHxA (6 carbons) is present from G West to D West but absent in hepatopancreas to the east. The concentration of PFTrDA (13 carbons) appears to be somewhat more consistent across sites, appearing in all 16 samples of hepatopancreas. In all, 13 PFAS compounds were detected in lobster hepatopancreas. In 2021, ten PFAS compounds were detected in lobster muscle tissue. Perfluorooctanoate (or perfluorooctanoic acid - PFOA) was not detected in any of the 36 lobster meat samples tested in 2021. Perfluorooctanoate (or perfluorooctanoic acid - PFOA) was detected in low concentrations in 15 of 16 hepatopancreas samples in 2023, while PFOA was not detected in any of the 18 lobster meat sites tested in 2021.

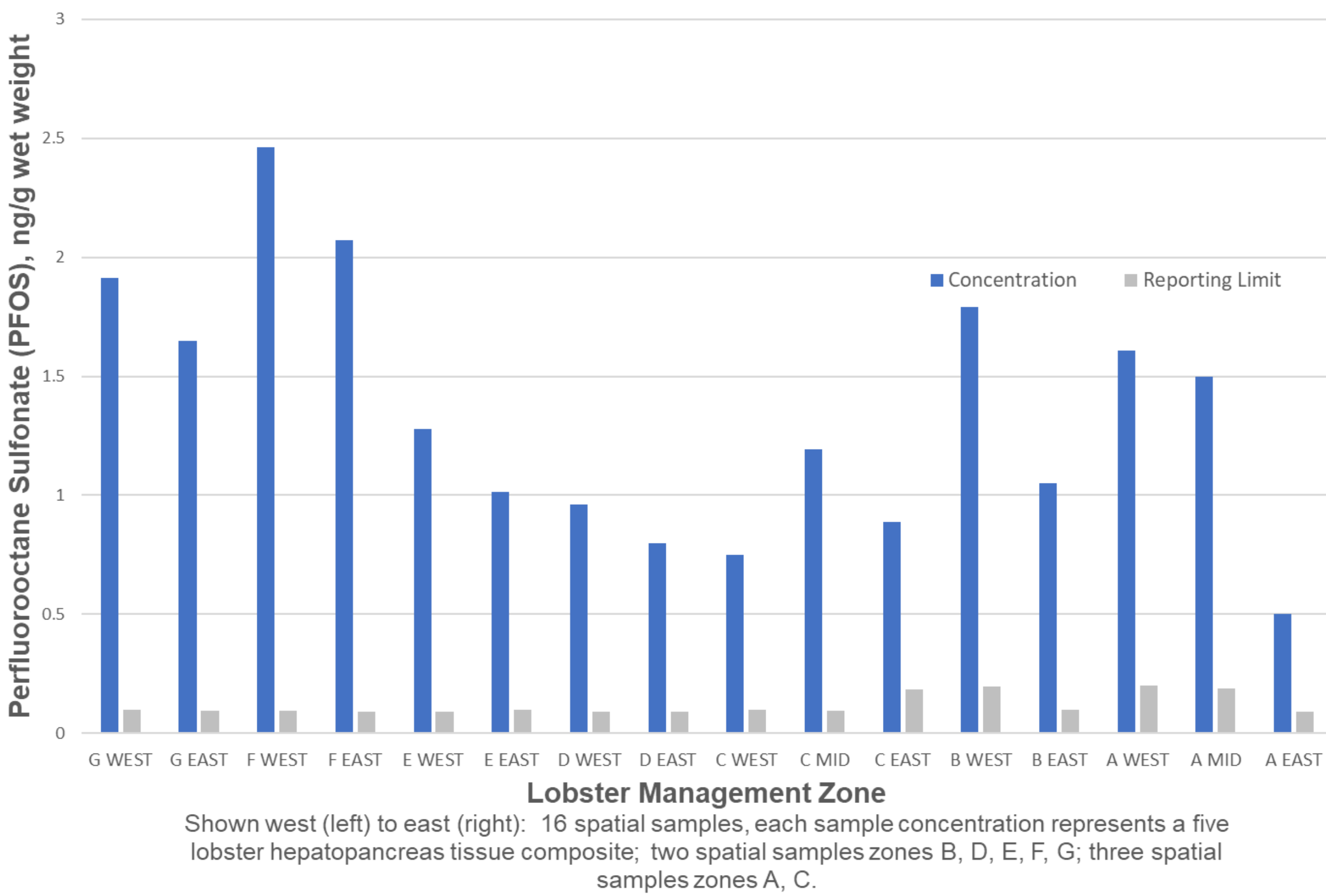

Figure 6. PFOS in 2023 American lobster hepatopancreas tissue

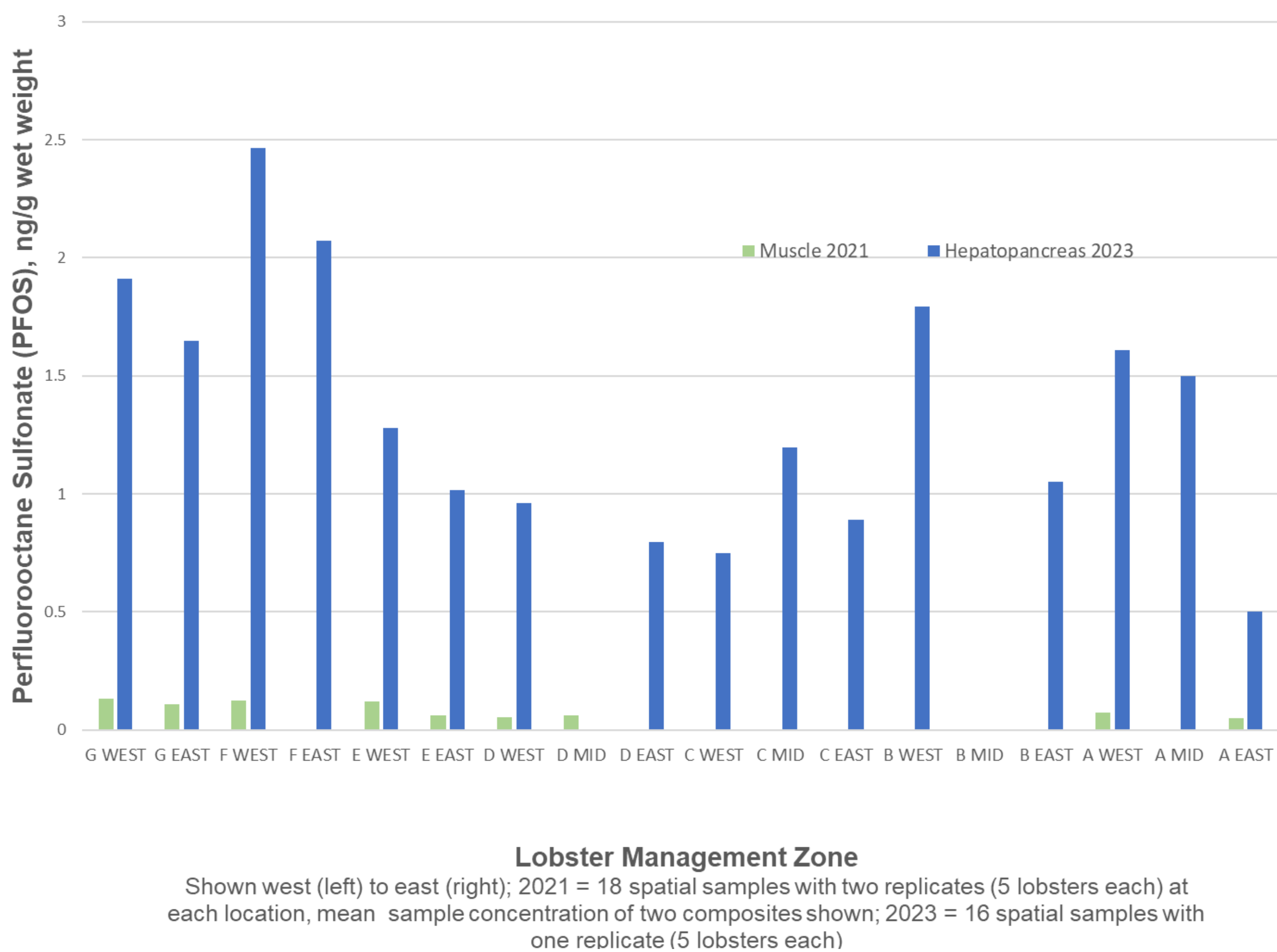

Figure 7. PFOS in American lobster hepatopancreas (2023) and muscle (2021) tissues

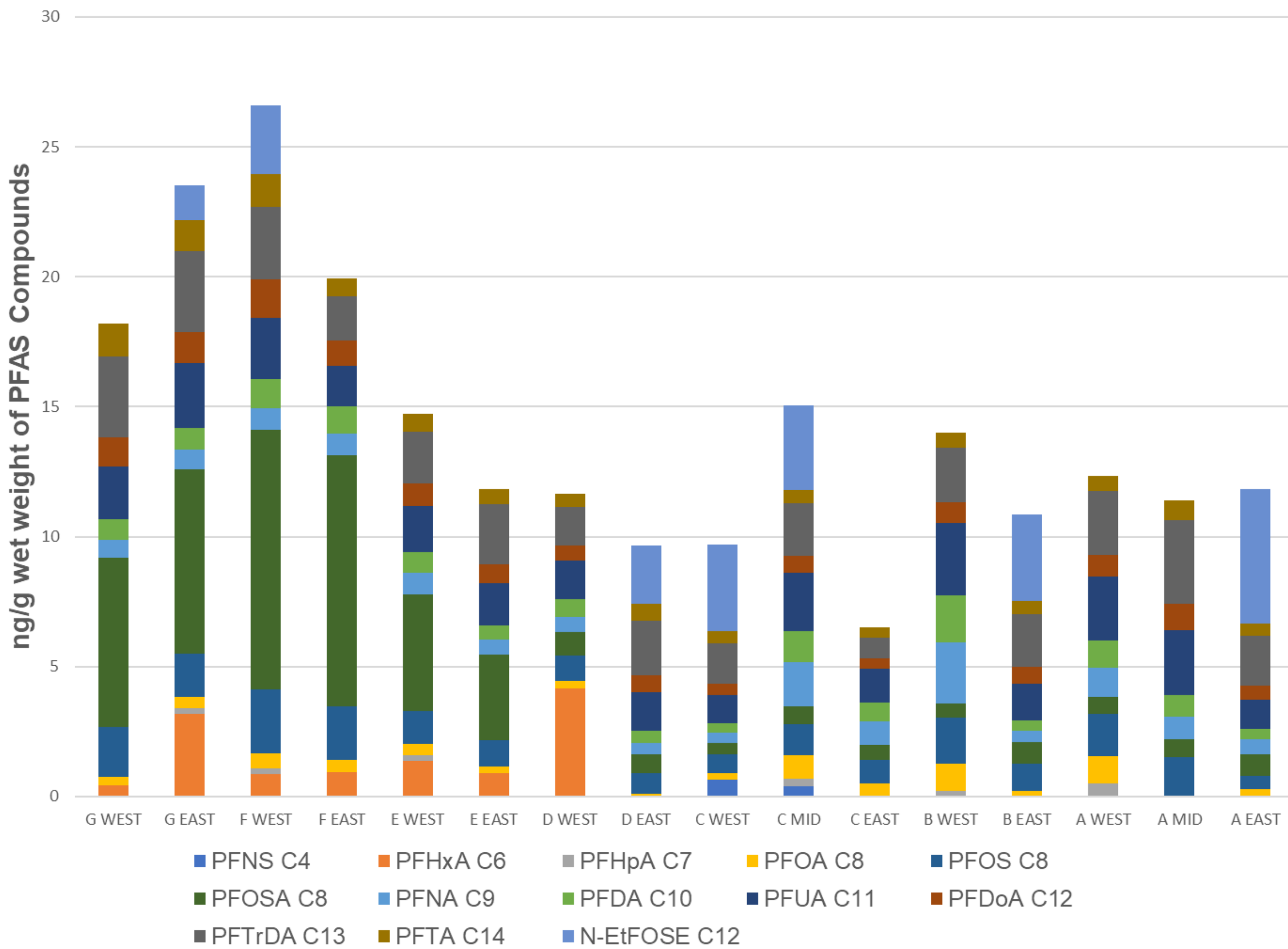

Figure 8. Ratio of all PFAS compounds detected in 2023 lobster hepatopancreas tissue

American Lobster - Total PCBs, Dioxin, Furan

Table 5. The dioxins, furans, and coplanar PCBs for which analysis was completed for American Lobster samples.

Furans and Dioxins	Coplanar PCBs
2,3,7,8-TCDF	PCB-77
1,2,3,7,8-PECDF	PCB-81
2,3,4,7,8-PECDF	PCB-126
1,2,3,4,7,8-HXCDF	PCB-105
1,2,3,6,7,8-HXCDF	PCB-114
2,3,4,6,7,8-HXCDF	PCB-118
1,2,3,7,8,9-HXCDF	PCB-123
1,2,3,4,6,7,8-HPCDF	PCB-156/157
1,2,3,4,7,8,9-HPCDF	PCB-167
OCDF	PCB-169
2,3,7,8-TCDD	PCB-189
1,2,3,7,8-PECDD	
1,2,3,4,7,8-HXCDD	
1,2,3,6,7,8-HXCDD	
1,2,3,7,8,9-HXCDD	
1,2,3,4,6,7,8-HPCDD	
OCDD	

From a human health perspective, CDC cancer FTAL for total PCBs for non-commercially caught finfish is 11 ng/g wet wt. (ppb), while CDC non-cancer FTAL for total PCBs is 43 ng/g wet wt. (ppb).

The ΣTotal PCBs (assuming non-detects equal half the detection limit, wet wt.) in hepatopancreas at all 16 sites exceeded CDC cancer FTAL of 11 ng/g wet wt. The ΣTotal PCBs (assuming non-detects equal half the detection limit, wet wt.) in hepatopancreas at 15 of 16 sites exceeded the higher CDC non-cancer FTAL of 43 ng/g wet wt. (Figure 9).

The ΣTotal PCBs (assuming non-detects equal half the detection limit, wet wt.) in muscle tissue at all 18 sites were well below CDC cancer FTAL of 11 ng/g wet wt., with the highest summation only around 23% of that FTAL value. Thus, all 18 sites were below the higher CDC non-cancer FTAL (Figure 10).

Concentrations in tissues of the individual compounds determined in the laboratory were multiplied by their toxic equivalencies and summed to construct CTEs and DTEs, coplanar and dioxin toxic equivalencies. Compounds with non-detects were assigned a concentration value at half the detection limit, which were then used to calculate the CTEs and DTEs. CTEs and DTEs were calculated on a wet weight basis for the lobster tissues, as they are principally used from a human health perspective to assess risk associated with human dietary intake of these compounds in food. Since the food, lobster meat, is eaten in a wet weight form, the CTEs and DTEs were calculated in the wet weight format to provide the best prediction of CTE and DTE intake.

Figure 11 shows CTEs and DTEs calculated for lobster hepatopancreas tissue at the 16 lobster stations sampled in 2023. The stations run from left to right in west to east order along the Maine coast (from DMR LMZs G – A, with G near the New Hampshire border). Summed (coplanar PCBs) CTEs comprise the base of each bar (shown in blue), with the top of each bar comprised of the summed (dioxins/furans) DTEs (shown in orange). Since the toxicities of the coplanar PCBs and dioxins and furans are additive, the CTEs and DTEs are shown in one bar that adds their toxicity for comparison to the fish tissue action level.

CDC has produced a fish tissue action level (FTAL) for dioxins, furans and coplanar PCBs (DTEs/CTEs) for recreationally caught finfish fillet. CDC has recommended that this 0.4 pg/g (or parts per trillion) FTAL be utilized to compare lobster tissues to determine acceptability for human consumption. Consistent with prior hepatopancreas data (most recent in 2018), the 2023 data confirms that consumption of hepatopancreas should be avoided as all stations sampled had DTEs/CTEs well above the 0.4 pg/g FTAL.

Figure 12 shows CTEs and DTEs calculated for lobster muscle tissue at the 16 lobster stations

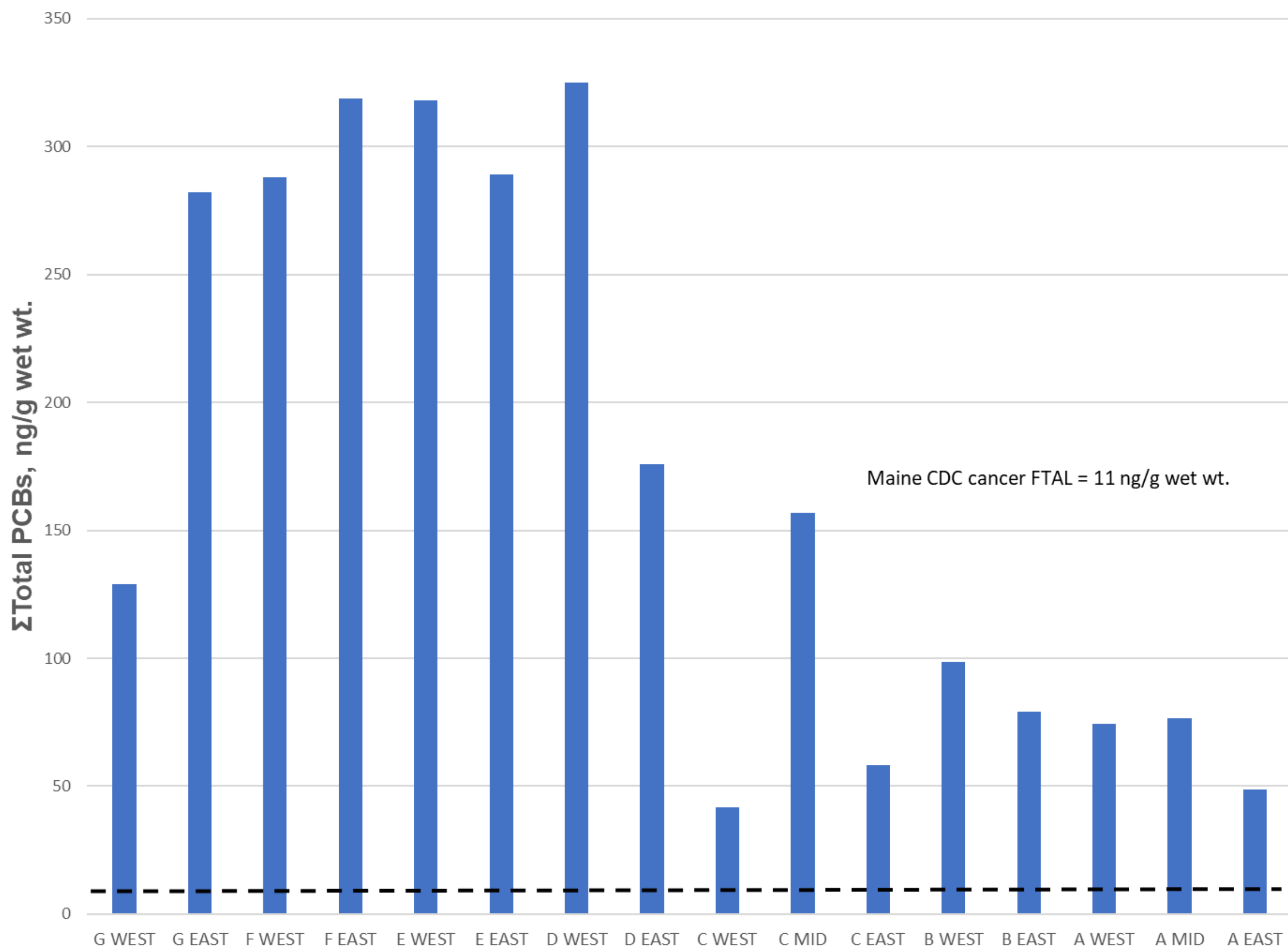

Figure 9. ∑Total PCBs in 2023 lobster hepatopancreas

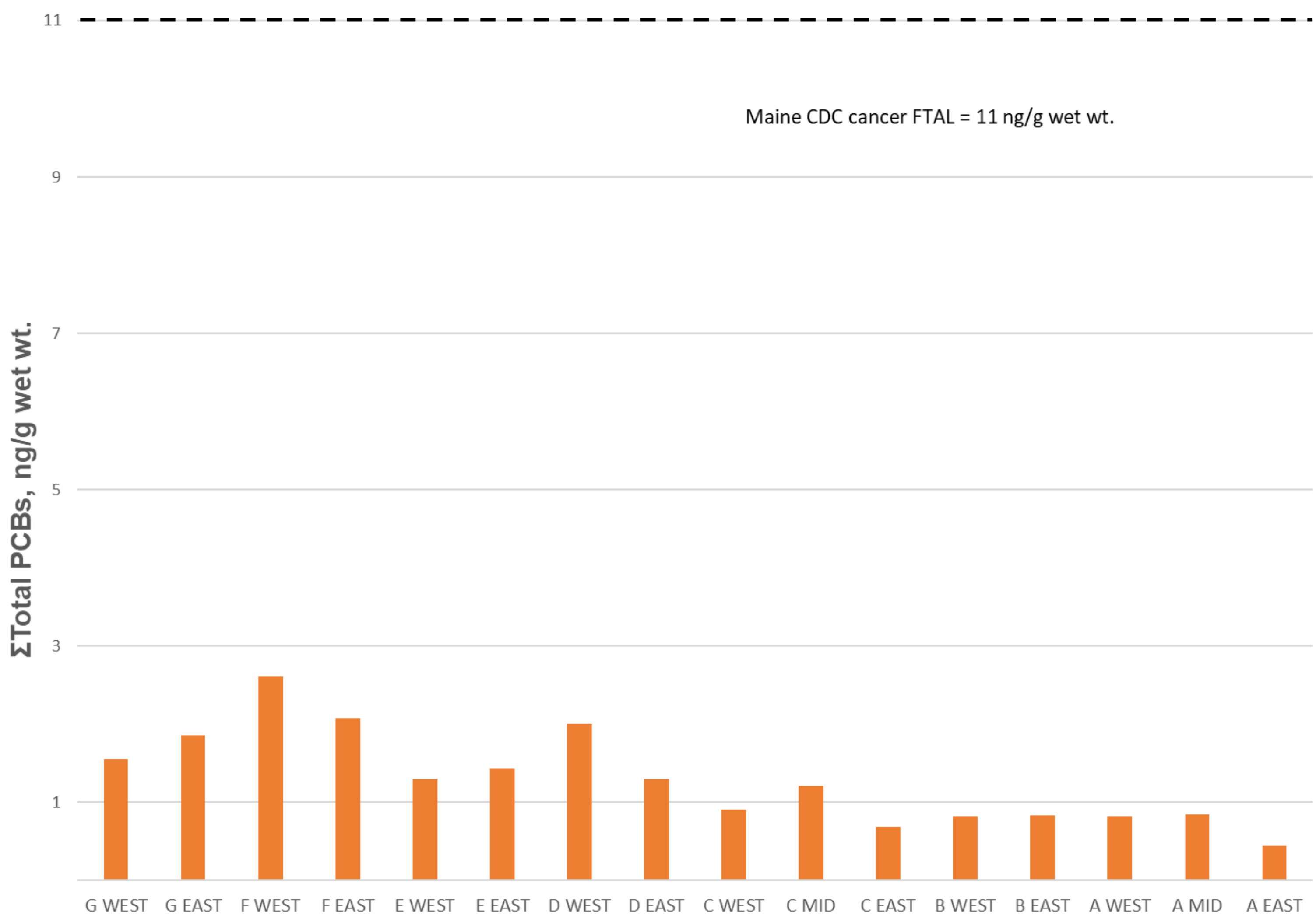

Figure 10. ∑Total PCBs in 2023 lobster muscle

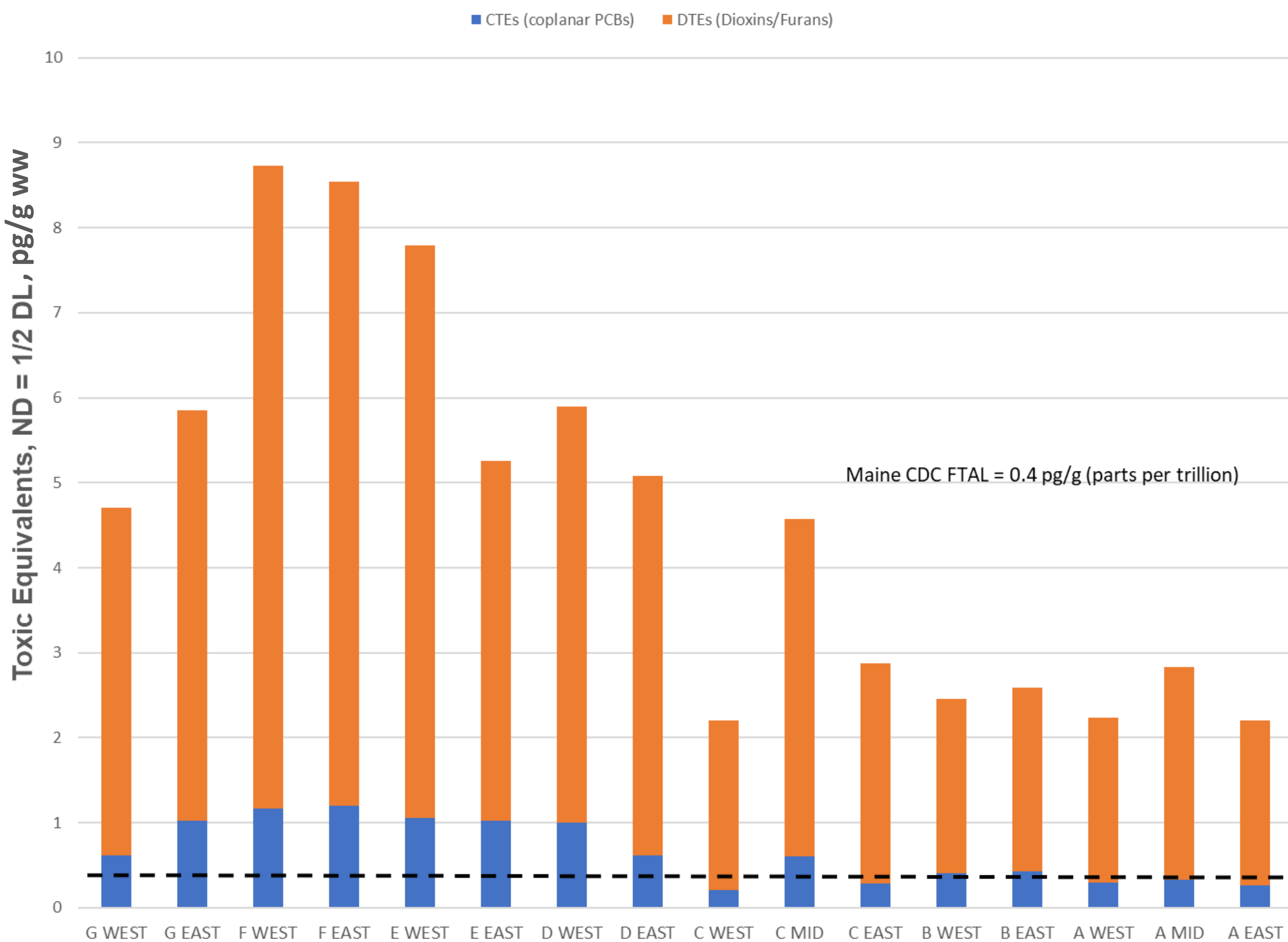

Figure 11. Coplanar PCB and dioxin/furan toxic equivalents in 2023 lobster hepatopancreas tissue

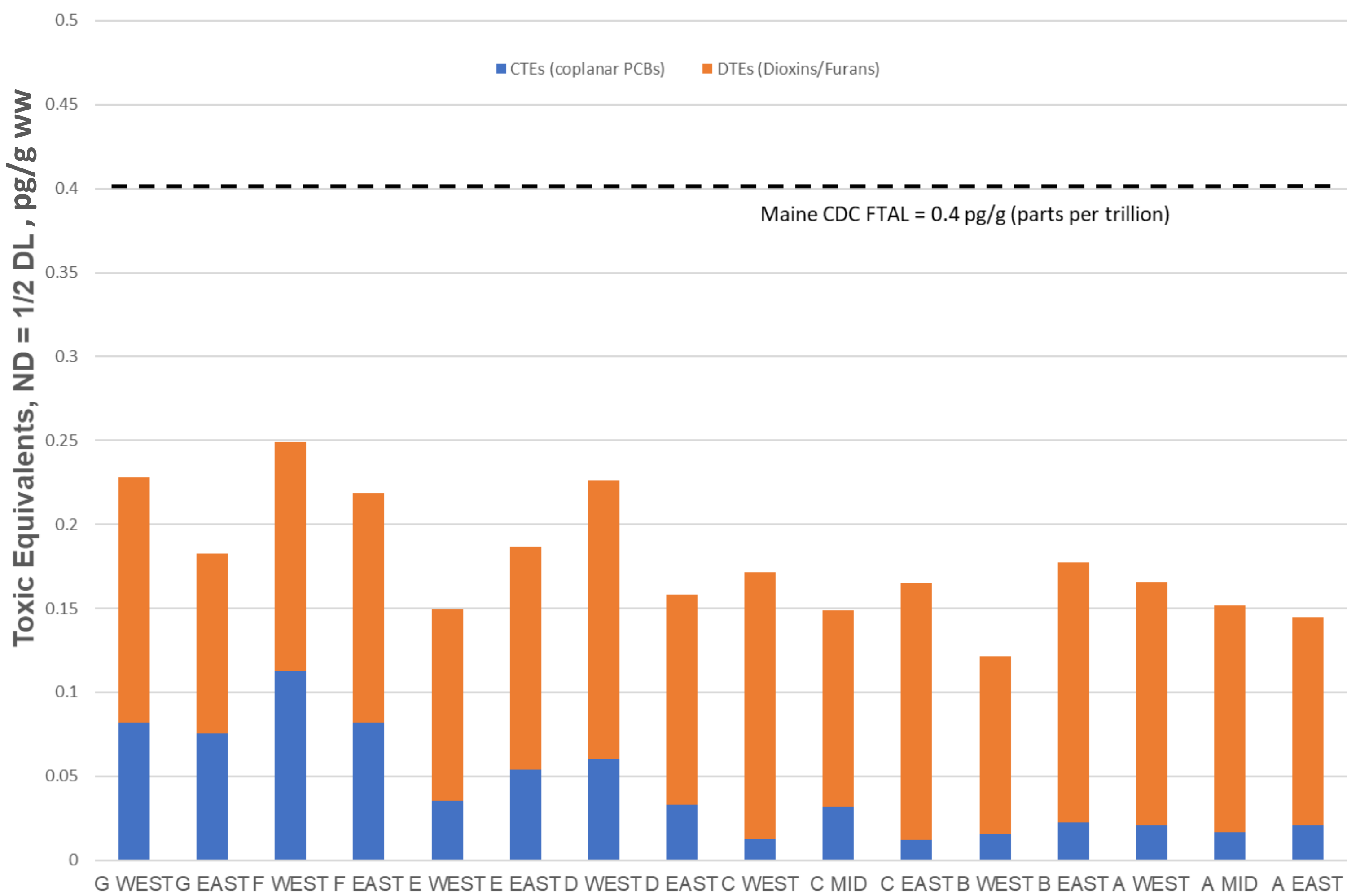

Figure 12. Coplanar PCB and dioxin/furan toxic equivalents in 2023 lobster muscle tissue

sampled in 2023. The stations run from left to right in west to east order along the Maine coast from DMR LMZs G – A, with G near the New Hampshire border). Summed (coplanar PCBs) CTEs comprise the base of each bar (shown in blue), with the top of each bar comprised of the summed (dioxin/furan) DTEs (shown in orange). Since the toxicities of the dioxins and furans and the coplanar PCBs are additive, the DTEs and CTEs are shown in one bar that adds their toxicity for comparison to the fish tissue action level.

The highest DTE/CTE level is well below the 0.4 pg/g FTAL, indicating that calculated DTEs/CTEs in lobster muscle tissue are much lower than those from hepatopancreas and that lobster muscle tissue is safe to consume based on concentration of coplanar PCBs, dioxin, and furan. Of the 16 stations sampled in 2023, the highest muscle tissue DTEs/CTEs was 63% of CDC FTAL while the rest of the samples were lower.

Hepatopancreas tissue appears to have a higher percentage of its overall toxicity contributed by CTEs (from coplanar PCBs) than does the muscle tissue. This is most readily observed at the western Maine sites, which have higher relative DTEs to CTEs in muscle tissue. Sites with higher concentrations of CTEs and DTEs in muscle tissue appear to have a more even composition of CTEs and DTEs. This may be due to sequestration of the coplanar PCBs in the hepatopancreas. Both DTEs and CTEs in hepatopancreas appeared to be higher in western Maine stations (western Penobscot Bay and further west) than in other areas of the coast. In muscle tissue, there was less variability than in hepatopancreas tissue across the coast.

PCB and dioxin/furan data in lobster hepatopancreas and muscle tissues can be compared to some extent from 2018 to 2023. Since the general regions are the same but not the individual sites, fine scale differences are of little meaning. Figures 13 and 14 show ∑total PCBs in lobster hepatopancreas and muscle tissues, respectively, for both 2018 and 2023. Little apparent trend can be observed in these data as some concentrations are higher in 2018 and some in 2023.

Figures 15 and 16 show PCB CTEs in lobster hepatopancreas and muscle tissues, respectively, for both 2018 and 2023. PCB CTEs in hepatopancreas appear similar between years in western Maine, but PCB CTEs appear lower in the 2023 data than in 2018 from C West to the east to A East, and also at G West and D West. In contrast, muscle PCB CTEs appear to be somewhat higher at most sites in 2023 than in 2018, excepting site A MID.

Figures 17 and 18 show dioxin DTEs in lobster hepatopancreas and muscle tissues, respectively, for both 2018 and 2023. Dioxin DTEs in hepatopancreas showed no trend, with half of the 16 sites showing higher DTEs in 2018 and half higher DTEs in 2023. Dioxin DTEs in muscle tissue appear slightly higher in 2023 than 2018 at 15 of 16 sites.

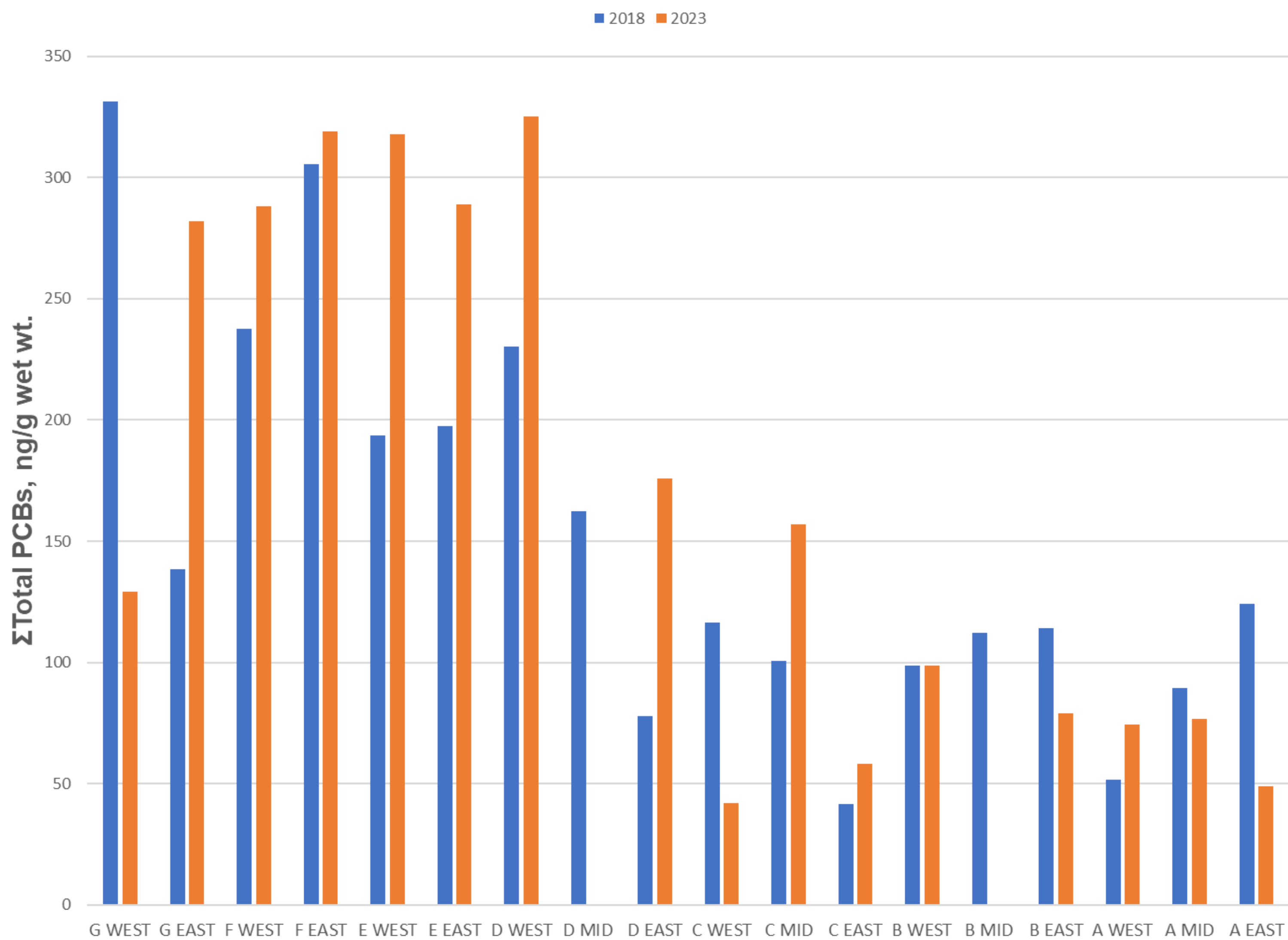

Figure 13. ∑Total PCBs in 2018 and 2023 lobster hepatopancreas tissue

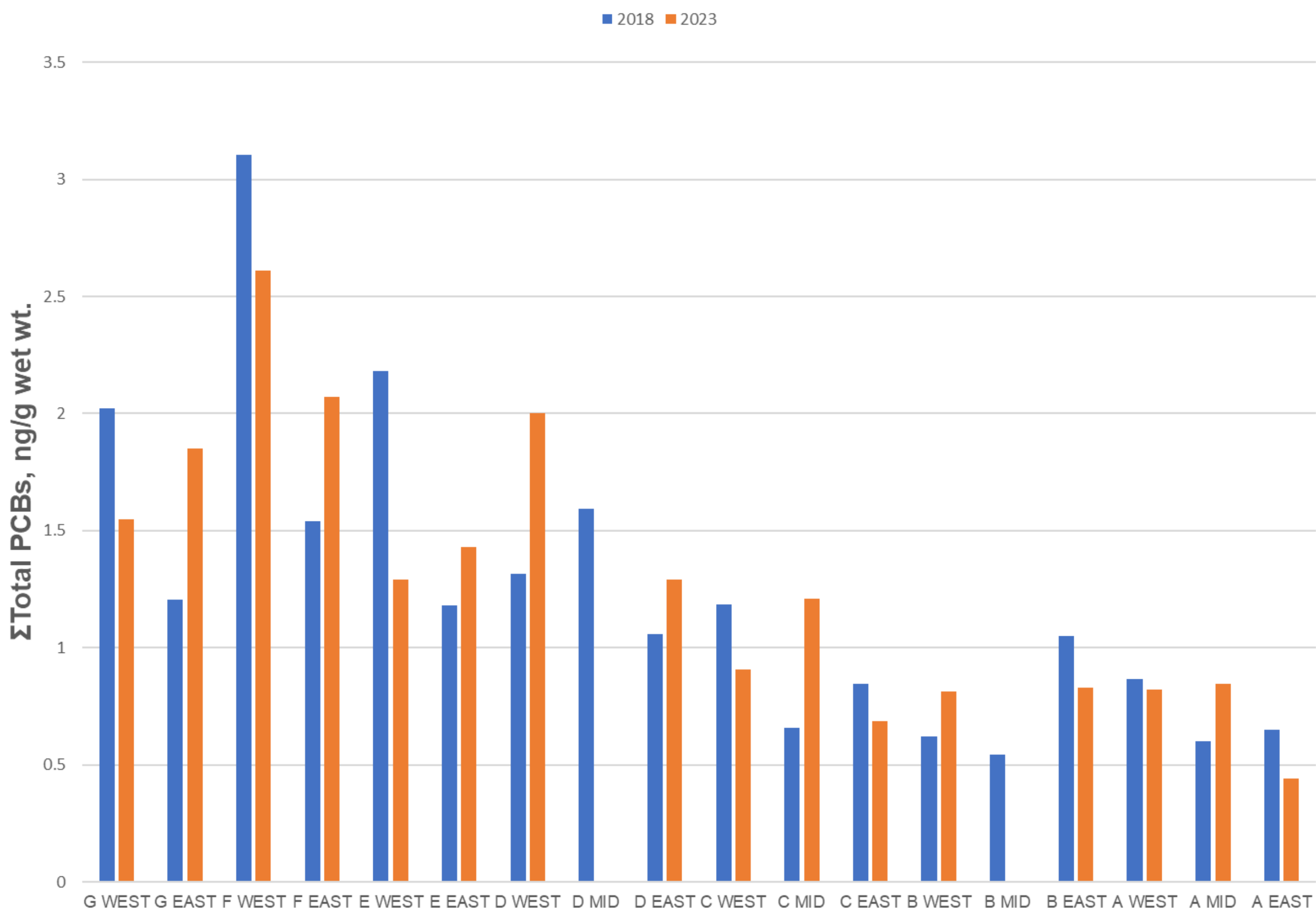

Figure 14. ∑Total PCBs in 2018 and 2023 lobster muscle tissue

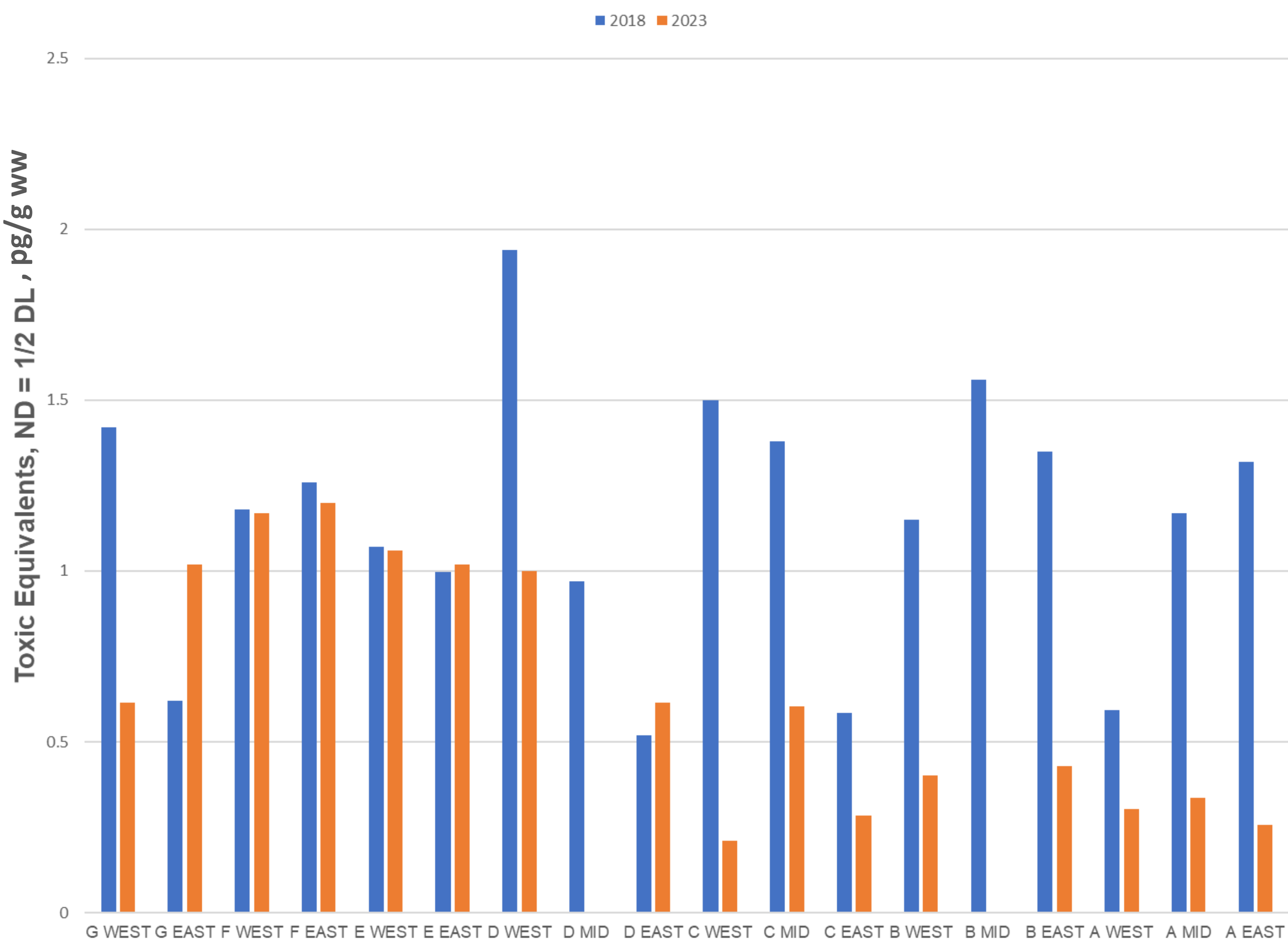

Figure 15. Coplanar PCB TEQs (CTEs) in 2018 and 2023 lobster hepatopancreas tissue

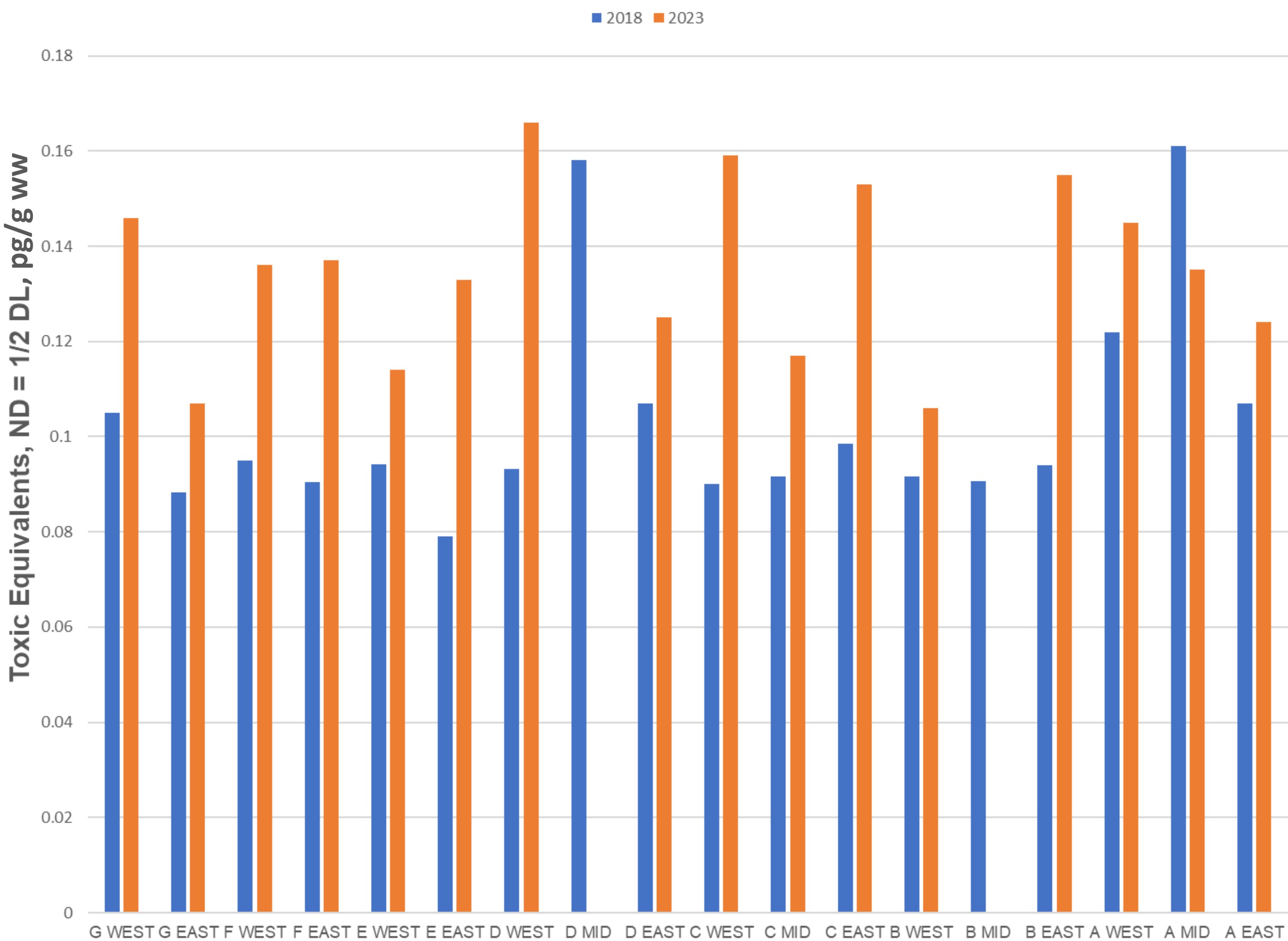

Figure 16. Coplanar PCB TEQs (CTEs) in 2018 and 2023 lobster muscle tissue

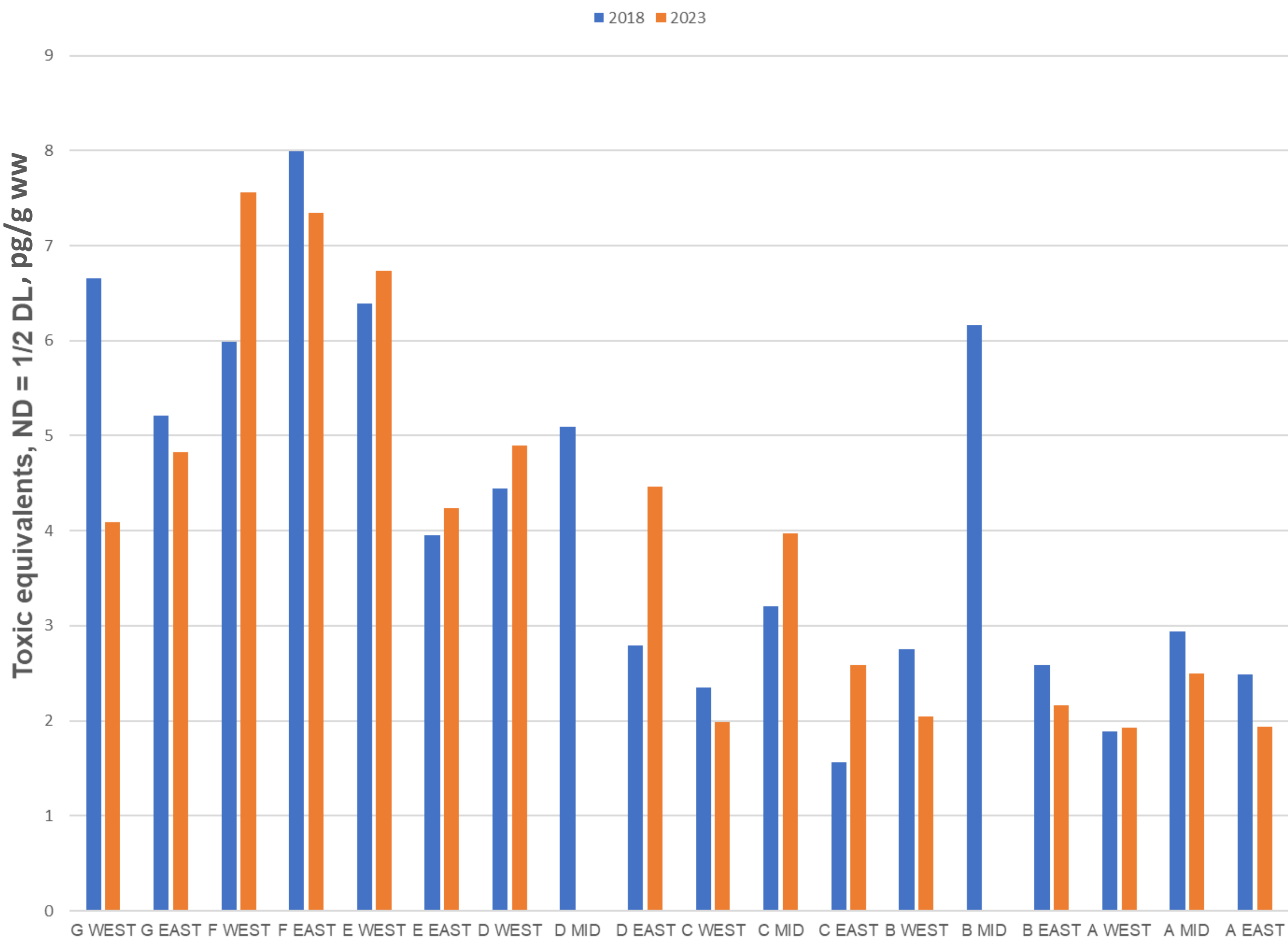

Figure 17. Dioxin TEQs (DTEs) in 2018 and 2023 lobster hepatopancreas tissue

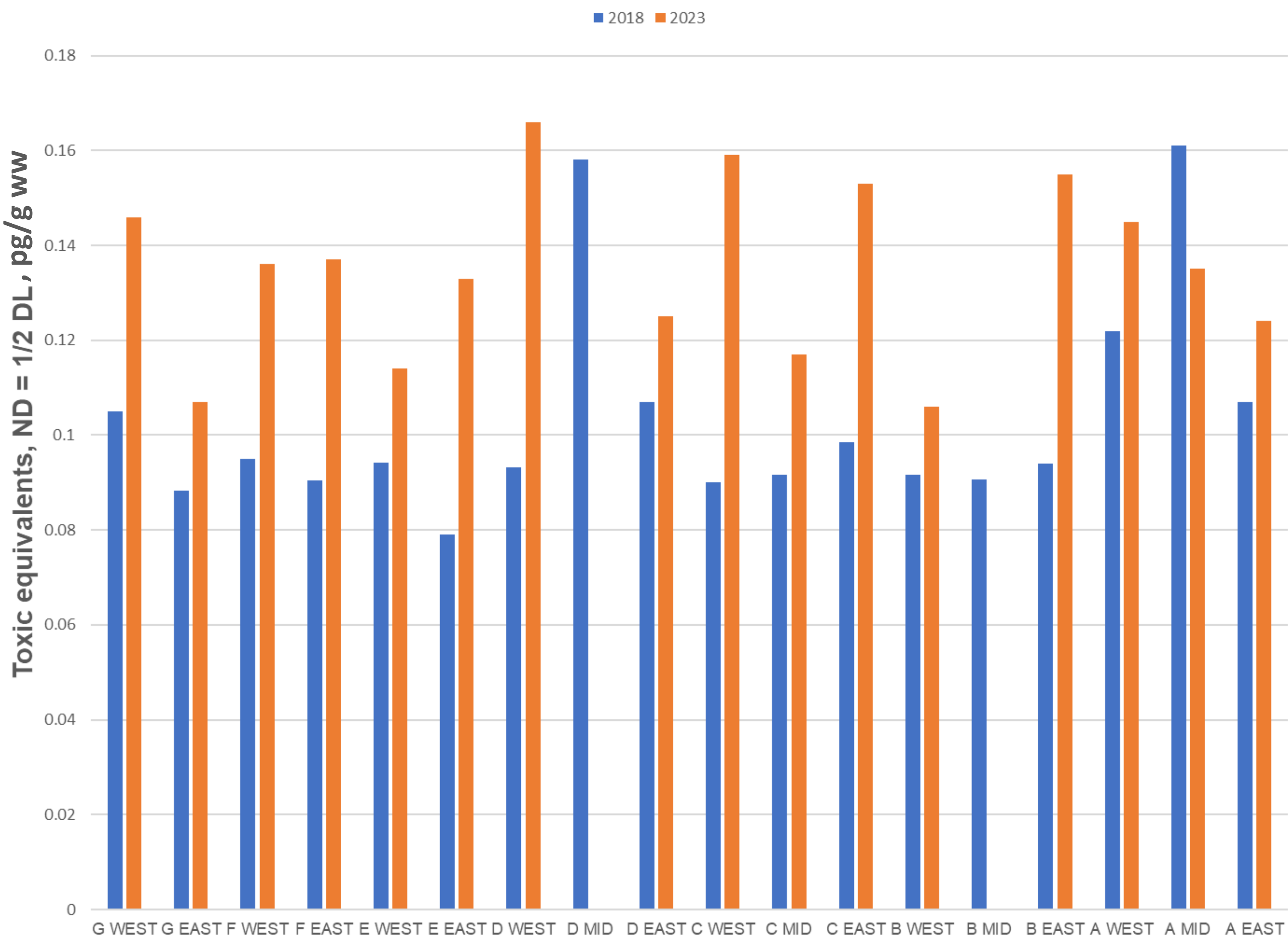

Figure 18. Dioxin TEQs (DTEs) in 2018 and 2023 lobster muscle tissue

American Lobster - Metals

American lobster metals analyses in hepatopancreas and muscle tissues are presented in this section.

Silver

Silver concentrations in hepatopancreas ranged from 0.22 ug/g wet wt. (C East) to 1.55 ug/g wet wt. (G East). Silver concentrations in muscle ranged from 0.067 ug/g wet wt. (A East) to 0.22 ug/g wet wt. (G West). CDC silver non-cancer FTAL is 11 ug/g wet wt. for non-commercially caught finfish. The highest hepatopancreas concentration (1.55 ug/g) was 14% of the FTAL, while the highest muscle concentration (0.22 ug/g) was 2% of the FTAL.

Arsenic

Arsenic (total arsenic) concentrations in hepatopancreas ranged from 5.46 ug/g wet wt. (C East) to 9.61 ug/g wet wt. (D West). Arsenic concentrations in muscle ranged from 3.77 ug/g wet wt. (C Mid) to 9.28 ug/g wet wt. (G East). For non-commercially caught finfish, CDC reports a cancer FTAL of 0.014 µg/g and a non-cancer FTAL of 0.6 µg/g, both for inorganic arsenic (the most toxic form). Most fish tissue data and the SWAT lobster tissue data are analyzed for total arsenic, not inorganic arsenic. CDC uses FDA's 1993 assumption that 10% of total arsenic in finfish is inorganic arsenic. Using this assumption, approximate inorganic arsenic concentrations for SWAT lobster tissues were calculated by dividing wet weight concentrations by a factor of 10. Therefore, lobster tissue inorganic arsenic concentrations are estimated to range from 0.55 µg/g wet wt. to 0.96 µg/g wet wt. in hepatopancreas and from 0.38 ug/g wet wt. to 0.93 ug/g wet wt. in muscle. All tested tissues exceeded CDC cancer FTAL of 0.014 µg/g wet wt. This is typical of many marine bivalve and other marine shellfish tissues, as arsenic concentrations in marine tissues are typically high even from very pristine, non-anthropologically influenced areas.

Cadmium

Cadmium concentrations in hepatopancreas ranged from 3.56 ug/g wet wt. (C East) to 15.8 ug/g wet wt. (G West). Cadmium concentrations in muscle ranged from 0.002 ug/g wet wt. (C East, F East) to 0.012 ug/g wet wt. (C West). From a human health perspective, CDC non-cancer FTAL for cadmium in non-commercially caught finfish is 2.2 µg/g wet wt. The FDA action level for clams, oysters, and mussels is 4 µg/g wet wt. (Kimbrough et al., 2008). All 16 hepatopancreas samples analyzed had cadmium concentrations exceeding the 2.2 ug/g wet wt. CDC non-cancer FTAL, while 14 of 16 samples of hepatopancreas had cadmium concentrations exceeding the FDA action level of 4 ug/g wet wt. All 16 lobster muscle tissue samples had cadmium concentrations well below CDC non-cancer FTAL. The highest cadmium concentration in lobster muscle was 0.5% of CDC FTAL.

Chromium

Chromium concentrations in hepatopancreas ranged from 0.018 ug/g wet wt. (D West) to 0.138 ug/g wet wt. (C West). Cadmium concentrations in muscle ranged from 0.256 ug/g wet wt. (D East) to 3.61 ug/g wet wt. (A East). From a human health perspective, CDC FTALs (7 µg/g cancer action level and 11 µg/g non-cancer action level) for chromium are based on chromium VI, and are not directly comparable to SWAT results, which measure total chromium (less toxic Cr III and more toxic Cr VI, combined).

Copper

Copper concentrations in hepatopancreas ranged from 8.35 ug/g wet wt. (C East) to 85.4 ug/g wet wt. (F West). Copper concentrations in muscle ranged from 2.37 ug/g wet wt. (E East) to 5.16 ug/g wet wt. (C West). Copper is not highly toxic to humans, though exposure can lead to some chronic effects. There is no recommended FDA safety level for human consumption for copper in fish or shellfish (Kimbrough et al., 2008), and CDC does not report a FTAL for copper in non-commercially caught sportfish.

Iron

Iron concentrations in hepatopancreas ranged from 17.9 ug/g wet wt. (C West) to 54.7 ug/g wet wt. (D East). Iron concentrations in muscle ranged from 2.35 ug/g wet wt. (D East) to 27.5 ug/g wet wt. (A East). From a human health perspective, CDC does not report an FTAL for iron.

Aluminum

Aluminum concentrations in hepatopancreas ranged from 0.541 ug/g wet wt. (A Mid) to 3.28 ug/g wet wt. (A East). Aluminum concentrations in muscle included 13 non-detects and three detected aluminum concentrations at the A West, Mid, and East sites. Detected values ranged from 1.7 ug/g wet wt. (A Mid) to 4.81 ug/g wet wt. (A East). From a human health perspective, CDC does not report an FTAL for aluminum.

Nickel

Nickel concentrations in hepatopancreas ranged from 0.145 ug/g wet wt. (E West) to 0.592 ug/g wet wt. (C West). Nickel concentrations in muscle ranged from 0.022 ug/g wet wt. (D East) to 0.186 ug/g wet wt. (A Mid). CDC reports a non-cancer FTAL for nickel in non-commercially caught finfish of 43 µg/g wet wt., which is more conservative than the FDA action level for shellfish of 80 µg/g wet weight. Nickel concentrations detected by SWAT in lobster hepatopancreas and muscle tissues were 1.4% and 0.4% of the more conservative CDC action level. CDC does not report a cancer action level for nickel.

Lead

Lead samples were not analyzed as requested in 2023 lobster tissues.

Mercury
Total mercury concentrations in hepatopancreas ranged from 0.033 ug/g wet wt. (C East) to 0.088 ug/g wet wt. (F West). Mercury concentrations in muscle ranged from 0.07 ug/g wet wt. (A East) to 0.197 ug/g wet wt. (F West). From a human health perspective, the developmental methylmercury FTAL (more protective) used by CDC is 0.2 µg/g wet wt. for non-commercially caught finfish (fish filet). This FTAL assumes an 8 oz. meal size is consumed weekly. Maine SWAT data uses a total mercury value, which is a more complete measure of mercury than the methylmercury concentration but includes this more toxic form. The highest hepatopancreas total mercury concentration, 0.088 ug/g wet wt. (F West), is approximately 44% of the more protective CDC developmental methylmercury FTAL. The highest muscle total mercury concentration, 0.197ug/g wet wt. (F West), is approximately 98.5% of the more protective CDC developmental methylmercury FTAL. The mean muscle tissue total mercury concentration across the 16 sites sampled in 0.12 ug/g wet wt., which is approximately 60% of CDC developmental methylmercury FTAL. It should be noted that we are comparing a methylmercury FTAL to higher total mercury tissue value, a more inclusive measure of mercury, and that the FTAL assumes an 8 oz. meal size consumed on a weekly frequency.

Zinc
Zinc concentrations in hepatopancreas ranged from 15.8 ug/g wet wt. (C East) to 40.5 ug/g wet wt. (G West). Zinc concentrations in muscle ranged from 14.6 ug/g wet wt. (D East) to 22.6 ug/g wet wt. (E West). From a human health perspective, CDC reports a non-cancer FTAL for zinc of 648 µg/g wet wt., which is higher than any wet wt. concentrations observed in SWAT lobster tissues. There is no recommended FDA safety level for zinc in fish (Kimbrough et al., 2008).

2023-24 Marine Minnow and Sport Finfish Species

Atlantic silverside and pollock
Atlantic silverside and pollock tissues were analyzed for the same suite of 40 PFAS compounds found earlier in this report in Table 4. Figure 19 shows concentrations of the compound PFOS detected in whole silverside and in pollock skinless fillet. In 2023, one composite sample was analyzed at each site, while in 2024, two replicate samples were composited at each site, and the mean PFOS concentration of the two composites is displayed.

PFOS was detected at 26 of 29 sites where silverside were sampled, with Rockland, Owls Head, and York River samples at non-detect. Concentrations in Fore River, inner Fore River, Upper Presumpscot River, Presumpscot River, East End, and Mare Brook were higher than other estuaries tested in 2023-24. The Fore River concentration was 2.89 ng/g wet wt., the East End concentration was 2.74 ng/g wet wt., and the Mare Brook mean concentration was 1.83 ng/g,

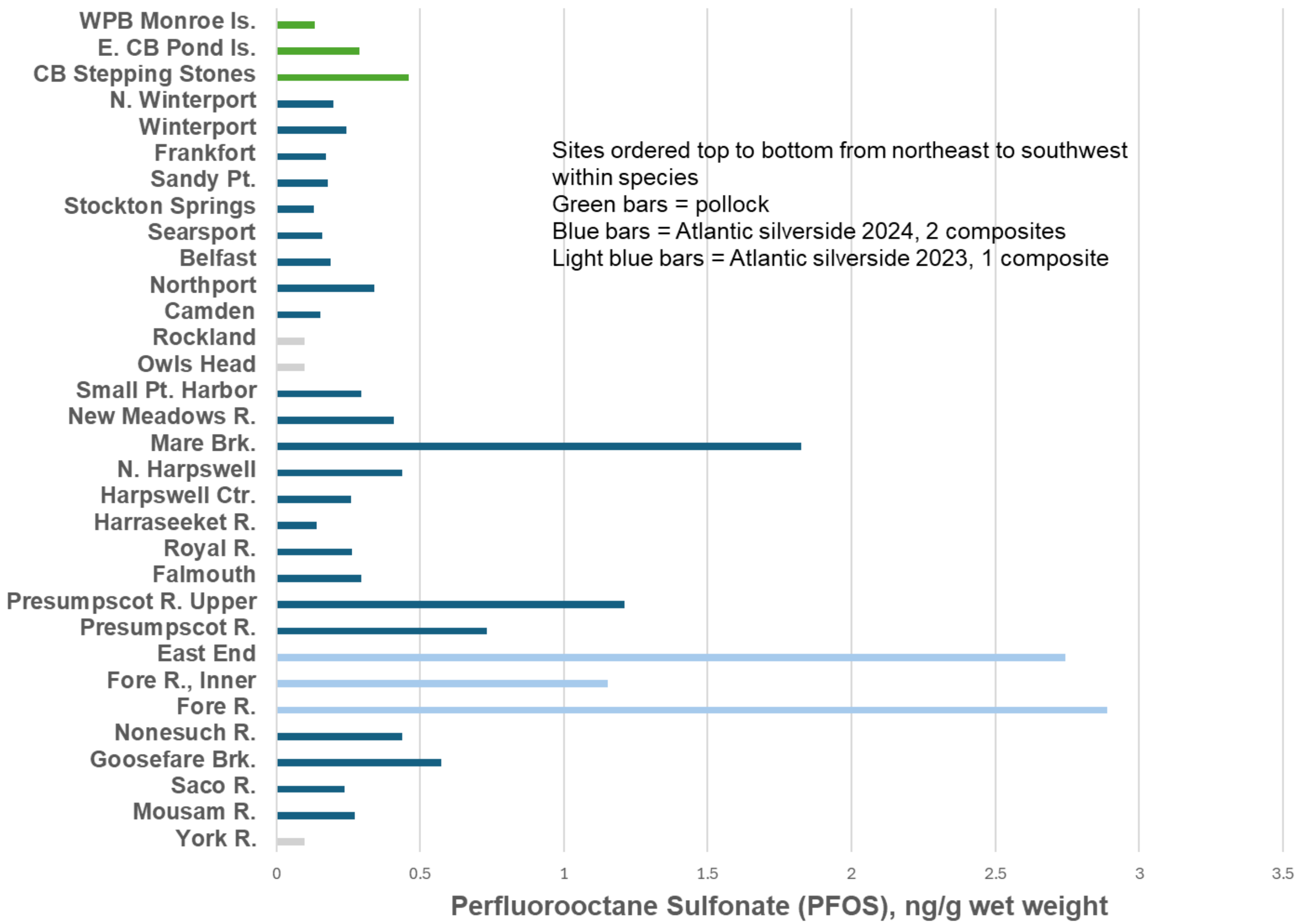

Figure 19. PFOS in 2023 - 2024 Atlantic silverside and pollock

The upper Presumpscot River and inner Fore River tissue mean concentrations were 1.21 and 1.15 ng/g wet wt., respectively. Fore River and East End PFOS concentrations exceed those found in Kennebec River silverside tested in 2022. The Mare Brook PFOS concentration is similar to previously tested lower Kennebec River concentrations (between 1.67 and 1.69 ng/g wet wt. in 2022). The Mare Brook sample was collected the day of the August 2024 AFFF spill at the former BNAS just upstream of the site. This concentration represents a background PFOS concentration in silverside tissue prior to any signal from fish tissue uptake post-spill. The Fore River silverside tissue PFOS concentration is approximately 28 times higher than the laboratory detection limit.

PFOS concentrations in pollock skinless fillet ranged from 0.13 ng/g wet wt. at West Penobscot Bay (Monroe Island) to 0.29 ng/g wet wt. at east Casco Bay (Pond Island) and to 0.46 ng/g wet wt. at the Stepping Stones, northeast of Long Island, in western Casco Bay. All pollock skinless fillet wet wt. PFOS concentrations were below CDC fish tissue action level of 3.5 ng/g wet wt.

Figure 20 shows the concentration of PFOSA detected in the silverside and pollock tissue samples collected in 2023-24. PFOSA was detected in whole silverside at 22 of 29 sites sampled, with North Winterport, Stockton Springs, Searsport, Belfast, Camden, Rockland, and Owls Head at non-detect. Concentrations in Upper Presumpscot River and Presumpscot River were higher than other estuaries tested in 2024. Upper Presumpscot and Presumpscot river tissue concentrations were 3.29 and 3.28 ng/g wet wt., respectively. PFOSA silverside tissue concentrations in Casco Bay and some southern Maine rivers were higher than Penobscot Bay concentrations, many of which were non-detect or near the detection limit.

PFOSA concentrations were detected in pollock skinless fillets at two of three sites. PFOS concentrations in pollock skinless fillet ranged from 0.37 ng/g wet wt. at east Casco Bay (Pond Island) to 0.46 ng/g wet wt. at the Stepping Stones, northeast of Long Island, in western Casco Bay. At Monroe Island, west Penobscot Bay, PFOSA concentration was non-detect. PFOSA pollock skinless fillet tissue concentrations in Casco Bay were higher than the Penobscot Bay tissue tested from west Penobscot Bay, Monroe Island (non-detect).

Figure 21 shows the concentration of PFOA detected in the silverside and pollock tissue samples collected in 2024. PFOA was detected in whole silverside at 25 of 29 sites sampled, with North Winterport, Rockland, East End, and Fore River at non-detect. Concentrations in Royal River, Mare Brook, Presumpscot River, and Frankfort were higher than other estuaries tested. Royal River and Mare Brook tissue concentrations were 0.80 and 0.37 ng/g wet wt., respectively. With the exceptions of the four highest PFOA concentrations noted (three in Casco Bay and one in Penobscot Bay), PFOA concentrations across southern Maine, Casco Bay, and Penobscot Bay were similar, suggesting little overall regional difference in background concentration.

PFOA concentrations were detected in pollock skinless fillet tissue at all three sites tested in 2024. PFOA concentrations in pollock skinless fillet ranged from 0.13 ng/g wet wt. at Monroe Island,

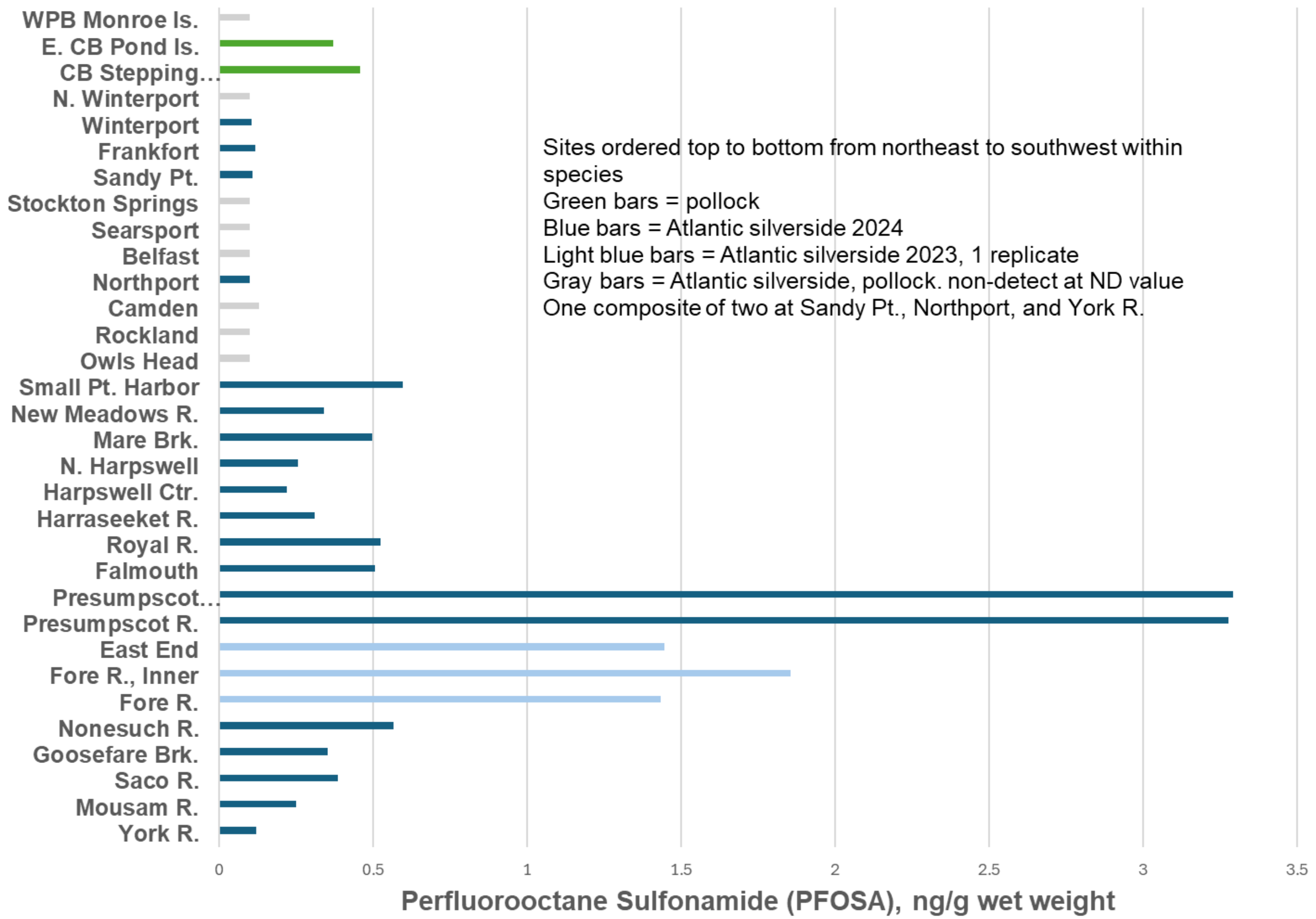

Figure 20. PFOSA in 2024 Atlantic silverside and pollock

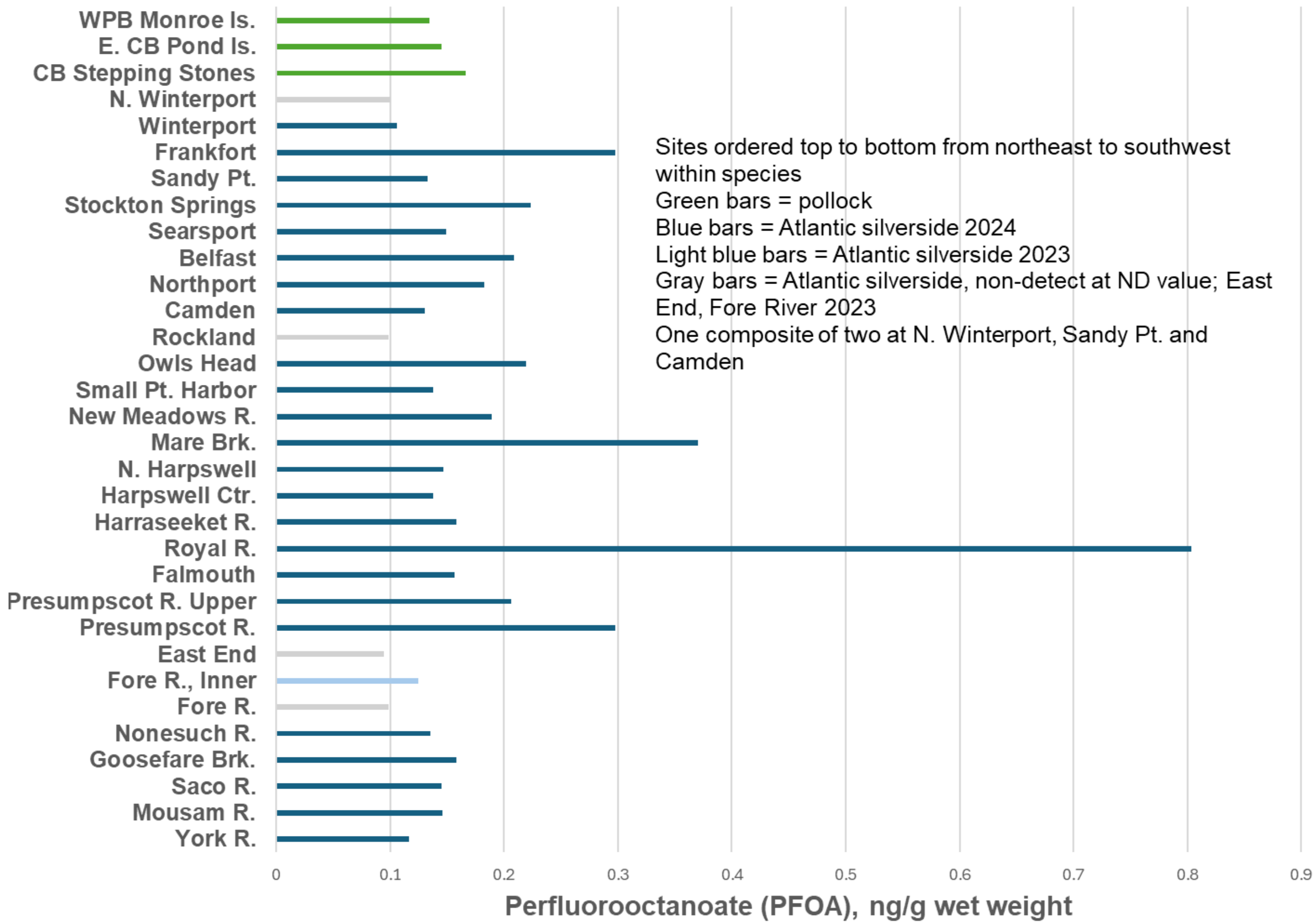

Figure 21. PFOA in 2024 Atlantic silverside and pollock

west Penobscot Bay, to 0.17 ng/g wet wt. at the Stepping Stones, northeast of Long Island, in western Casco Bay.

In addition to PFOS, PFOSA, and PFOA, ten additional PFAS compounds were detected at various frequencies in whole Atlantic silverside and pollock skinless fillet. Compounds detected and their frequency and maximum concentration were:

Perfluorobutanoate (PFBA)	4 sites, silverside max. conc. = 1.12ng/g wet wt.
Perfluorobutane sulfonate (PFBS)	1 site, silverside max. conc. = 0.20 ng/g wet wt.
Perfluoroheptanoate (PFHpA)	1 sites, silverside max. conc. = 0.22 ng/g wet wt.
Perfluorohexane sulfonate (PFHxS)	2 sites, silverside max. conc. = 0.22 ng/g wet wt.
Perfluorohexanoate (PFHxA)	7 sites, silverside max. conc. = 0.47 ng/g wet wt.
Perfluorononanoate (PFNA)	7 sites, silverside; 1 site, pollock max. conc. = 0.21 ng/g wet wt.
Perfluoroundecanoate (PFUnDA)	4 site, silverside; 2 sites, pollock max. conc. = 0.14 ng/g wet wt.
Perfluorododecanoate (PFDoA)	5 sites, silverside max. conc. = 0.10 ng/g wet wt.
N-ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	11 sites, silverside max. conc. = 0.95 ng/g wet wt.
N-ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	16 sites, silverside; 1 site, pollock max. conc. = 2.77 ng/g wet wt.
Perfluorotridecanoate (PFTrDA)	5 sites, silverside; 3 sites, pollock max. conc. = 0.36 ng/g wet wt.
Perfluorotetradecanoate (PFTA)	2 sites, silverside max. conc. = 0.13 ng/g wet wt.

2024 Softshell Clam

PFAS analysis for 40 compounds in softshell clam tissue was completed from two new sites, collected in 2024 in the lower Kennebec River estuary. PFAS concentrations from these two sites, in coves adjacent to Bald Head, Arrowsic, and Parker Head, Phippsburg, are presented along with PFAS concentrations from Atkins Bay, Phippsburg, (also in the lower Kennebec estuary) sampled in 2022. Further sampling in the lower Kennebec was completed in 2024 after Atkins Bay softshell clam tissue was documented to have measurable concentration of PFOS, the first detected in softshell clam tissue tested as part of the SWAT program. Comparison of the 2022 Atkins Bay data to the additional sites completed in 2024 gives a better spatial picture of PFAS in lower Kennebec estuary softshell clam tissue.

The concentrations of PFOS detected in softshell clam tissues are presented in Figure 22. Detected concentrations are represented by blue bars, while corresponding reporting limits are presented as gray bars. At Atkins Bay, three spatial subsamples were tested in 2022. In Atkins Bay clam tissue, PFOS was detected in two of three composites, although the third composite had a much higher reporting limit value (0.2451 ng/g wet wt.). Some interference in the sample analysis led to the higher reporting limit, which is above the detected concentrations found in the other two spatial subsamples. In coves near Parker Head and Bald Head in 2024, PFOS was detected in all four spatial subsamples analyzed at each site. PFOS concentrations appear to be slightly higher at Parker Head and Bald Head when compared to Atkins Bay, perhaps due to Parker and Bald being further upriver nearer sources of PFOS. Atkins Bay is closer to the mouth of the estuary and likely experiences more flushing (see Figure 3). In 2024, detected concentrations in edible tissue ranged from 0.31 to 0.44 ng/g wet wt. The PFOS concentration in these clam tissue samples is an order of magnitude below the 3.5 ng/g wet wt. FTAL utilized by CDC for PFOS in recreationally caught sportfish. Nevertheless, it is interesting that clam tissues from the Kennebec River estuary, all three sites tested, are the first in SWAT sampling to show PFOS in detectable concentrations.

PFOSA was detected in softshell clam tissue from all spatial subsamples analyzed, both in 2022 at Atkins Bay and in 2024 at coves adjacent to Parker Head and Bald Head. PFOSA concentrations at all three softshell clam sites are presented in Figure 23. Previous SWAT PFAS testing in bivalves indicates PFOSA as frequently present in blue mussel and softshell clam tissues, even in the absence of detectable concentrations of PFOS (also an 8 carbon PFAS but with a different sulfonate functional group). PFOSA concentrations in softshell clam tissue did not exhibit large differences across the three sites tested.

PFOA was detected in softshell clam tissue from three of four spatial subsamples at Parker Head and all four spatial subsamples from Bald Head, however all PFOA detects were noted by the laboratory to have some degree of blank contamination. In 2022, Atkins Bay clam tissue had no detects for PFOA, and had very similar reporting limits in two of three spatial subsamples tested. Blank contamination may be the source of the PFOA detects in the 2024 samples. See Figure 24.

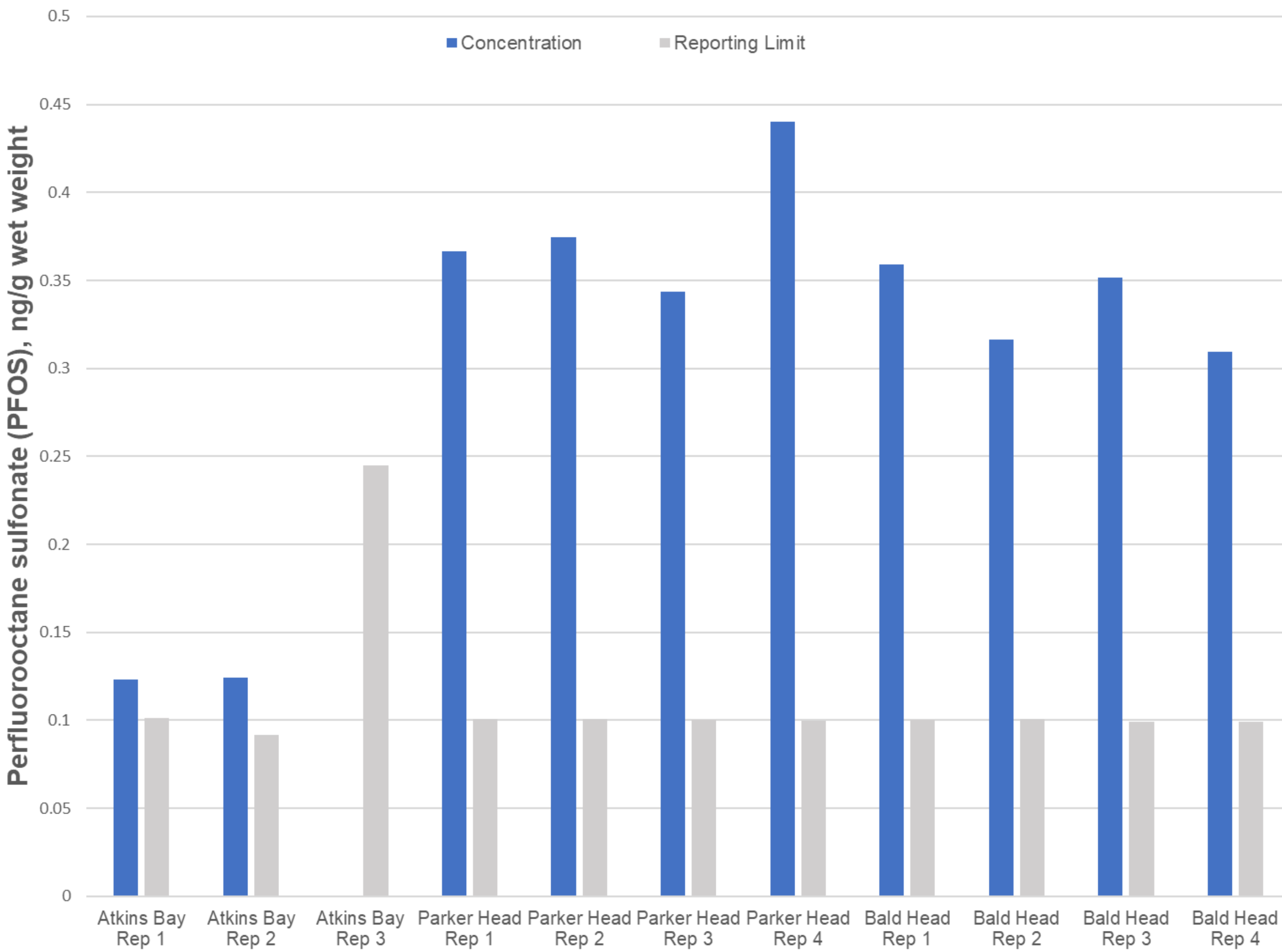

Figure 22. PFOS in softshell clam tissue

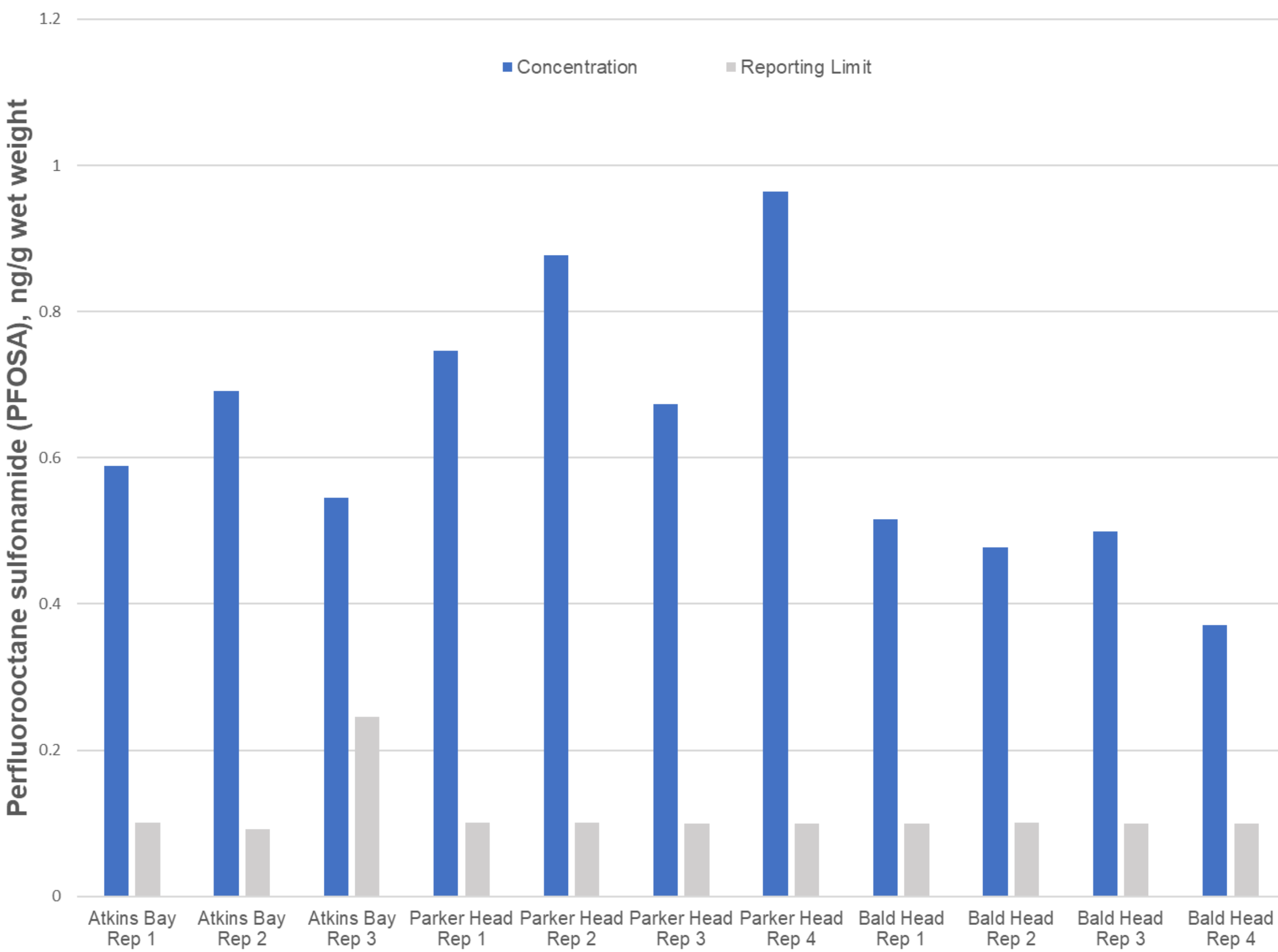

Figure 23. PFOSA in softshell clam tissue

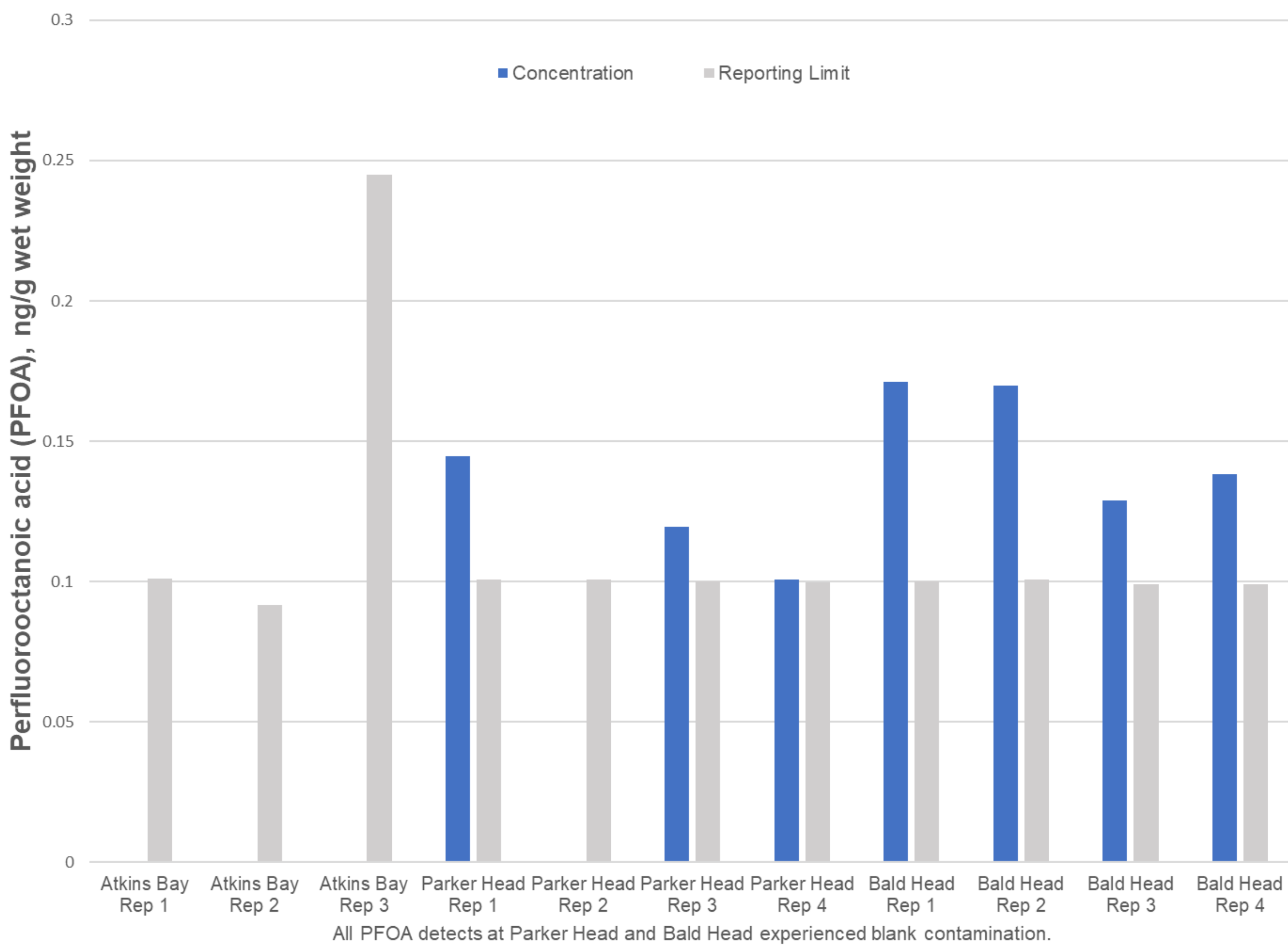

Figure 24. PFOA in softshell clam tissue

In 2024, in addition to PFOS, PFOSA, and PFOA, eight additional PFAS compounds were detected at various frequencies in softshell clam tissue at Parker and Bald heads. Compounds detected and their frequency and maximum concentration are:

Perfluorodecanoate (PFDA)	2 sites, ¾ replicates at Parker and Bald max. conc. = 0.16 ng/g wet wt.
Perfluorodecanoic acid (7:3 FTCA)	2 sites, all replicates max. conc. = 4.86 ng/g wet wt.
Perfluoroundecanoate (PFUnDA)	1 site, ¼ replicates at Bald max. conc. = 0.13 ng/g wet wt.
Perfluorododecanoate (PFDoA)	1 site, ¾ replicates at Parker max. conc. = 0.15 ng/g wet wt.
N-ethyl perfluorooctane sulfonamidoacetic acid (N-EtFOSAA)	2 sites, all replicates max. conc. = 0.39 ng/g wet wt.
N-ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE)	2 sites, ¾ replicates Parker, all replicates at Bald max. conc. = 2.12 ng/g wet wt.
Perfluorotridecanoate (PFTrDA)	1 site, ¼ replicates Parker max. conc. = 0.11 ng/g wet wt.
Perfluorotetradecanoate (PFTeDA)	2 sites, ¼ Parker, 2/4 Bald max. conc. = 0.30 ng/g wet wt.

2. Contaminants in Freshwater Fish

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2.1 Background
2.2 PFAS in 2023 Fish Samples
2.3 PFAS in 2024 Fish Samples
2.4 Overview of PFAS in 2014-2024 Fish Samples
2.5 DDT in 2023-2024 Fish Samples
2.6 PCBs in 2023-2024 Fish Samples

2.1 Background

Sampling in 2023 and 2024 focused primarily on per- and polyfluoroalkyl substances (PFAS) in the fillets of freshwater fish. PFAS are a class of highly persistent and mobile chemicals that have at least one fluorine atom bonded to a carbon atom. There are thousands of different PFAS. The most common PFAS in the environment have linear chains of 4 to 14 carbons that are fully fluorinated, meaning that the carbons are only bonded to fluorine atoms and adjacent carbons (Figure 1). The linear chain of carbon atoms is called the "tail". A functional group (aka, "head"), such as a carboxyl, sulfonate, and sulfonamide group, is attached to one end of the tail. Per- and polyfluoroalkyl substances differ in the proportion of carbons that are bonded to fluorine atoms. In **per**fluoroalkyl substances, all carbons are fully bonded to fluorine atoms and adjacent carbons. Perfluorooctane carboxylate (PFOA), perfluorooctane sulfonate (PFOS), and perfluorooctance sulfonamide (PFOSA) are examples of perfluoroalkyl substances (Figure 2). In contrast, some but not all carbons in the tail of a **poly**fluoroalkyl substance are fully bonded to fluorine atoms. Fluorotelomer acids are examples of polyfluoroalkyl substances because they have one or more carbons in the tail bonded to hydrogen atoms instead of fluorine atoms (Figure 2 and Table 1).

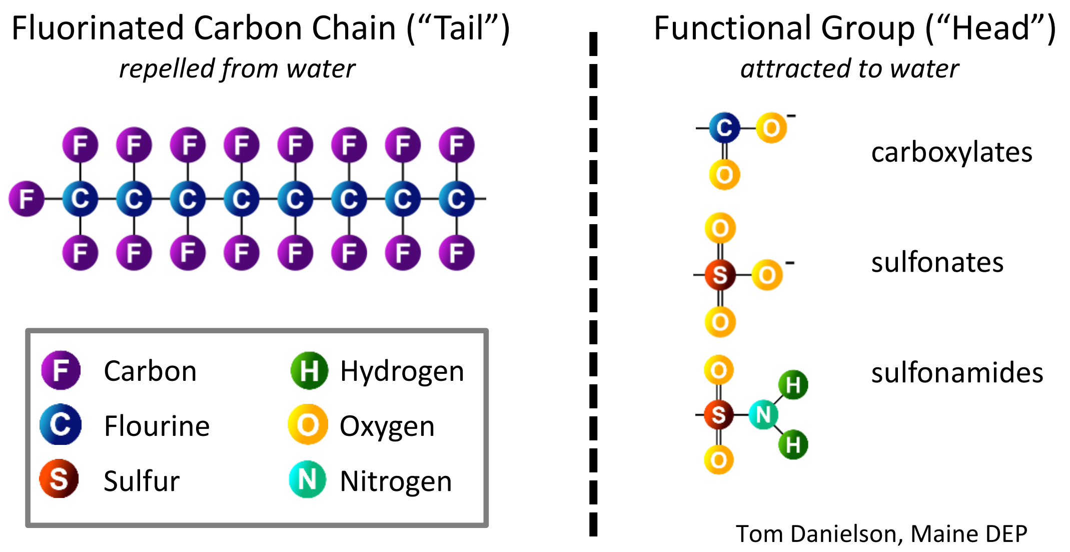


Figure 1. Structure of common linear PFAS included in Table 1, such as perfluoroalkyl carboxylates (PFCAs), perfluoroalkyl sulfonates (PFSAs), and perfluoroalkyl sulfonamides.

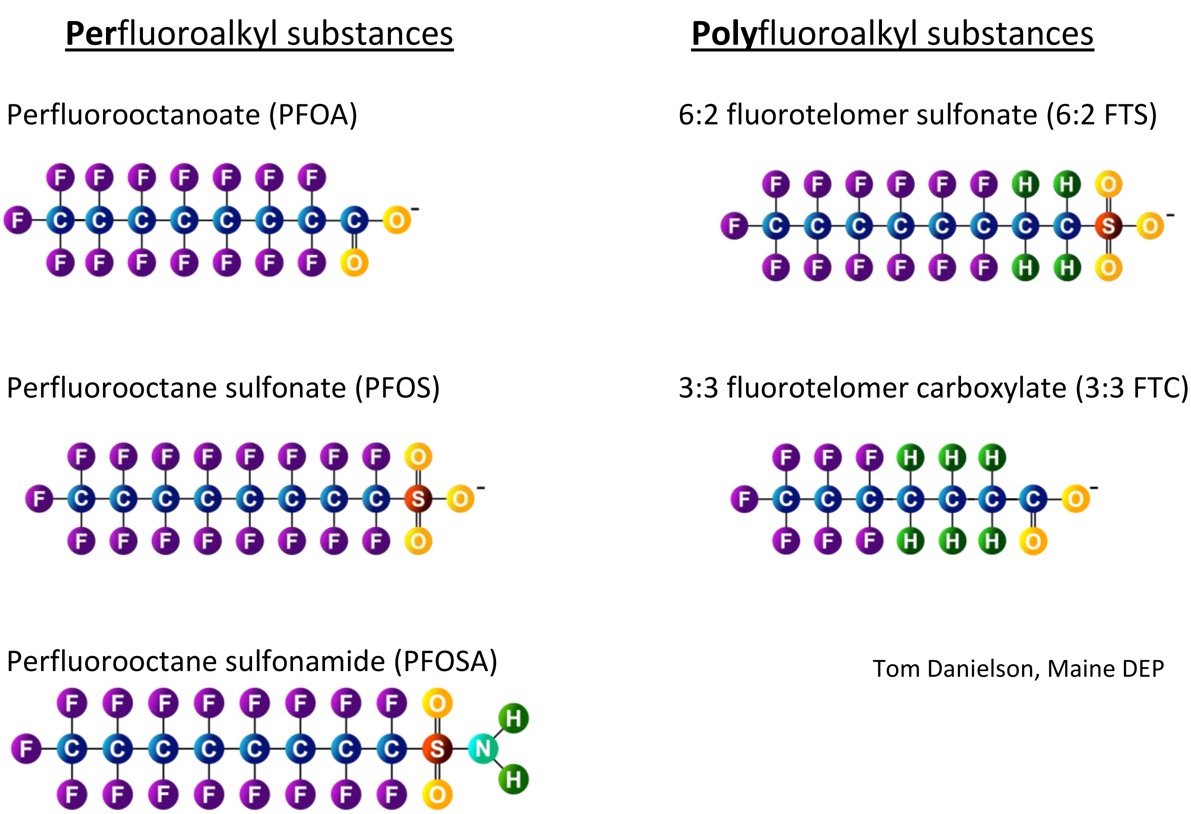


Figure 2. Examples of per- and polyfluoroalkyl substances

The chemical structure of PFAS give them properties that make them useful in many commercial and industrial products and processes. The carbon-fluorine bonds are very strong and resist degradation from heat and normal biogeochemical processes. Some PFAS are used in aqueous film-forming foam (AFFF), industrial lubricants, and heat-resistant products. In addition, PFAS tails often repel water (hydrophobic) and the heads are attracted to water (hydrophilic). As a result, PFAS are used in many fabrics, paper, food wrappers, frying pans, and other products designed to repel water, repel oil, or resist stains. PFAS can persist in the environment for a very long time (thousands of years) because normal biogeochemical processes can't break the carbon-fluorine bonds. Therefore, PFAS have the nickname of "forever chemicals".

Although there are thousands of PFAS, typical lab analysis will include 28-40 varieties of PFAS, often focusing on sulfonates, carboxylates, sulfonamides, and fluorotelomers (Table 1). It is important to point out that naming conventions for sulfonates and carboxylates can be confusing because the carbon in the carboxylate functional group is counted with the carbons in the tail. While perfluoro**octane** sulfonate (PFOS) has 8 fluorinated carbons, perfluoro**octan**oate (PFOA) has only 7 fluorinated carbons (Figure 2). The eighth carbon in PFOA is the carbon in the carboxylate functional group. Some labs report results as acids, such as carboxylic acids instead of carboxylates, meaning they have a hydrogen attached to the functional group instead of having a negative charge. They are essentially the same compounds and are treated interchangeably. For example, pefluorooctane sulfonate, perfluorooctane sulfonic acid, and perfuorooctanesuflonic acid are synonyms for PFOS.

PFAS are emitted into the environment from both point sources (such as industrial or municipal wastewater treatment plants, WWTPs) and nonpoint sources (such as atmospheric deposition; Ahrens and Bundschuh 2014). In a study of sources of PFAS in major rivers of the world, Kimacjeva et al. (2012) found higher levels in industrial areas than in non-industrial areas. PFAS have been found in humans and wildlife all over the world including the artic and deep seas (Yingling 2013), which suggests atmospheric transport (Houde et al., 2011).

PFAS with 8 or more carbons are considered bioaccumulative with sulfonates (e.g., PFOS) having a greater bioaccumulation rate than PFOA and other PFAS, indicating that the functional group is also important (Martin et al., 2013). In some circumstances, people can inadvertently ingest a significant amount of PFOS and other PFAS when eating freshwater fish (Augustsson et al., 2021, Barbo et al., 2023). PFAS have been correlated with increased cancers, thyroid disease, interference with normal growth and development, and endocrine disruption in humans (Yingling 2013, Panieri et al., 2022). There are also reports in the literature of high concentrations in invertebrates, fish, reptiles, and marine mammals worldwide (Houde et al., 2011). PFAS have been linked to many adverse impacts to fish and other aquatic organisms (Lee et al., 2020).

Table 1. PFAS analyzed by the laboratory

Group	# Carbons in the Tail	Abbreviation (Trade Name)	Name	Mean Detection Limit (ng/g, ppb)
Perfluoroalkyl carboxylates (PFCAs)	3	PFBA	Perfluorobutanoate*	0.38
	4	PFPeA	Perfluoropentanoate*	0.19
	5	PFHxA	Perfluorohexanoate*	0.10
	6	PFHpA	Perfluoroheptanoate*	0.10
	7	PFOA	Perfluorooctanoate*	0.10
	8	PFNA	Perfluorononanoate*	0.10
	9	PFDA	Perfluorodecanoate*	0.10
	10	PFUnDA	Perfluoroundecanoate*	0.10
	11	PFDoDA	Perfluorododecanoate*	0.08
	12	PFTrDA	Perfluorotridecanoate*	0.10
	13	PFTeDA	Perfluorotetradecanoate*	0.10
Perfluoroalkyl sulfonates (PFSAs)	4	PFBS	Perfluorobutane sulfonate*	0.10
	5	PFPeS	Perfluoropentane sulfonate*	0.10
	6	PFHxS	Perfluorohexane sulfonate*	0.10
	7	PFHpS	Perfluoroheptane sulfonate*	0.10
	8	PFOS	Perfluorooctane sulfonate*	0.10
	9	PFNS	Perfluorononane sulfonate*	0.10
	10	PFDS	Perfluorodecane sulfonate*	0.10
	12	PFDoDS	Perfluorododecane sulfonate	0.10
Fluorotelomer substances	3 fluorinated & 3 unfluorinated	3:3 FTC	3:3 fluorotelomer carboxylate	0.38
	4 fluorinated & 2 unfluorinated	4:2 FTS	4:2 fluorotelomer sulfonate*	0.38
	5 fluorinated & 3 unfluorinated	5:3 FTC	5:3 fluorotelomer carboxylate	2.38
	6 fluorinated & 2 unfluorinated	6:2 FTS	6:2 fluorotelomer sulfonate*	0.34
	7 fluorinated & 3 unfluorinated	7:3 FTC	7:3 fluorotelomer carboxylate	2.38
	8 fluorinated & 2 unfluorinated	8:2 FTS	8:2 fluorotelomer sulfonate*	0.32

Table 1 (continued)

Group	# Carbons in the Tail	Abbreviation (Trade Name)	Name	Mean Detection Limit (ng/g, ppb)
Perfluoroalkane sulfonamides	8	PFOSA	Perfluorooctane sulfonamide	
	8	N-ETFOSA	N-ethyl perfluorooctane sulfonamide	0.27
(PASFs)	8	N-MEFOSA	N-methyl perfluorooctane sulfonamide	0.10
Perfluorooctane sulfonamido-acetic acids	8	N-EtFOSAA	N-ethyl perfluorooctane sulfonamidoacetic acid*	0.10
	8	N-MeFOSAA	N-methyl perfluorooctane sulfonamidoacetic acid*	0.10
Pefluorooctane sulfonamide ethanols	8	N-EtFOSE	N-ethyl perfluorooctane sulfonamidoethanol	0.95
	8	N-MEFOSE	N-methyl perfluorooctane sulfonamidoethanol	0.95
Perfluoroether carboxylic acids		ADONA	4,8-dioxa-3h-perfluorononanoate*	0.38
		HFPO-DA (Gen-X)	Hexafluoropropylene oxide dimer acid*	0.38
	1+2+1 separated by oxygens	PFDHA	Perfluoro-3,6-dioxaheptanoic acid	0.34
	1+3 separated by an oxygen	PFMBA	Perfluoro-4-methoxybutanoic acid	0.10
	1+2 separated by an oxygen	PFMPA	Perfluoro-3-methoxypropanoic acid	0.19
Ether sulfonates	8+2 separated by an oxygen	11CL-PF3OUdS	11-chloroeicosafluoro-3-oxaundecane-1-sulfonate	0.38
	6+2 separated by an oxygen	9CL-PF3ONS (F53-B)	9-cholorohexadecafluoro-3-oxanonane-1-sulfonate	0.38
	2+2 separated by an oxygen	PFEESA	Perfluoro(2-ethoxyethane) sulfonic acid	0.10

PFAS compounds marked with a “*” are measured in water samples (EPA method 537) as well as in fish tissue samples (EPA method 1633). Two additional PFAS are measured in water samples that are not listed in this table: PFODA and PFHxDA, both of which are usually not detected.

The Maine Center for Disease Control and Prevention (CDC) establishes fish tissue action levels (FTAL) for certain toxic chemicals. The FTALs are used to determine if fish are safe to eat. When the concentration of a chemical in a fish sample exceeds the FTAL, then CDC will review the data and determine if a fish consumption advisory is necessary to protect human health. The concentrations of PFAS are measured in nanograms (ng) of a PFAS per gram (g) of wet muscle tissue. The units are commonly expressed as ng/g, wet weight. One ng/g is equivalent to 1 part per billion (ppb). Currently, PFOS is the only kind of PFAS with a FTAL. The FTAL for PFOS is 3.5 ng/g (ppb, wet weight). In 2022, CDC lowered the FTAL for PFOS from 34.1 ng/g for sensitive populations and 79.0 ng/g for the general population to the current 3.5 ng/g for everyone. For all species of fish other than landlocked salmon and brook trout, there is a statewide mercury consumption advisory. This advisory provides protection for up to 7.5 ng/g of PFOS in species such as largemouth and smallmouth bass, black crappie, togue, and white perch. Thus, CDC will not consider issuing additional consumption advisories for fish other than brook trout or landlocked salmon at a given site unless they have PFOS concentrations above 7.5 ng/g at that site.

In September of 2024 the US EPA released aquatic life criteria for PFOS and PFOA. These criteria represent the highest concentrations of these chemicals that allow fish and other aquatic animals to live, grow, and reproduce. For water samples, these criteria have chronic and acute exposure values. Chronic values are the maximum concentrations fish or other aquatic life can be exposed to over long time periods (e.g., weeks to months) and still live, grow, and reproduce. Acute exposure values are the highest values that fish and other aquatic life can be exposed to over short time periods (e.g., minutes to hours) and still live, grow, and reproduce. For fish tissue, these values represent the maximum concentration of PFOS or PFOA that can accumulate in their muscle tissue before they suffer adverse effects to their ability to grow, survive, and reproduce. The chronic and acute criteria for PFOS and PFOA can be found in Table 2.

Table 2. US EPA aquatic life criteria for PFOS and PFOA concentrations in fish tissue, adapted from EPA PFAS aquatic life criteria fact sheet. Note the different units for fish tissue (ppb) vs water (ppt).

Criteria Component	Fish Muscle Tissue	Acute Water[1]	Chronic Water[2]
PFOS	87 ng/g, ppb	71,000 ng/L, ppt	250 ng/L, ppt
PFOA	133 ng/g, ppb	3,100,000 ng/L, ppt	100,000 ng/L, ppt
Frequency	Not to be exceeded	Not to be exceeded more than once in three years	Not to be exceeded more than once in three years

1 – instantaneous value, 2 – four-hour average

2.2 PFAS in 2023 Fish & Water Samples

Methods

Grant money from the EPA allowed the DEP to sample more species, and more bodies of water in 2023 than would have otherwise been possible. In 2023, sampling focused on the waterbodies listed in Table 3. Most of the sampling in 2023 was focused along the I-95 corridor from Southern Maine up to Bangor with additional sampling conducted in Aroostook County, especially near Presque Isle and Houlton. Previous sampling has shown that these areas have higher rates of PFAS contamination than other parts of the state.

Sixteen of the forty-six sites sampled in 2023 had been sampled previously. Repeat sampling was conducted at sites where contamination was potentially high enough for CDC to consider issuing a fish consumption advisory. Often, CDC will request additional, follow-up samples at contaminated sites to assist in informing their decisions to issue fish consumption advisories.

The objective at each site was to collect 10 fish per species, except where CDC requested more fish to better inform decisions about fish consumption advisories. In some cases, field crews were unable to collect 10 fish. In such instances, field crews would collect as many fish as they were able. Most fish were collected by angling. When angling was not practical or productive, fish were collected with seines. Sample collection and preparation followed standard protocols to minimize the potential for contamination. Upon capture, fish were stored in new, clean plastic bags on ice until transfer to DEP. At DEP, the fish were rinsed with PFAS-free water and then measured and weighed. Ten-gram pieces of skinless fillets were cut from the fish and placed in plastic bags or plastic jars and frozen at -80°C. The fillets were combined into composite samples of 5 fish whenever possible. In some cases, such as when field crews ran into difficulties collecting fish at a field site, composite samples consisted of fewer than 5 fish. Samples were shipped overnight to SGS AXYS in British Columbia, Canada for analysis. The lab homogenized the composite samples and analyzed the tissue for 40 kinds of PFAS using Method 1633 (Table 1). The lab provided PFAS concentrations based on wet weight and dry weight for each composite sample.

In addition to fish, water samples were collected at most sites. Field crews would take a grab sample from the surface of the body of water, away from the shoreline. Samples were taken using new, plastic sample jars and immediately put on ice. Samples were then taken back to DEP where they were kept in a refrigerator until they could be shipped off to Pace Analytical in Boston for analysis. A single sample was taken at each site such that even if a site was visited multiple times (e.g., to collect multiple types of fish) only one water sample would be collected for that pond, lake, river, or stream in 2023. Pace Analytical analyzed the water samples for 28 kinds of PFAS (Table 1) using EPA method 537. The lab provided PFAS concentrations on a wet-weight basis for all samples.

Data were analyzed with R (version 4.4.2.) in RStudio (version 2024.04.1). Summary statistics were computed for the wet weight concentration of PFAS in composite samples, excluding results below detection limits (Table 4). Average PFAS concentrations were also computed for each species at each site. For these calculations, non-detect values were conservatively set to method detection limits. The distribution of the average PFAS concentrations were displayed as box-and-whisker plots for PFAS detected in at least 5 samples (Figure 3). The average concentration of PFOS from all fish collected at a site were computed and plotted on a map (Figure 5).

Table 3. 2023 Freshwater sites and samples

Waterbody	Town	Species	# of fish	# of composites	Potential contamination[1]
Androscoggin Lake	Wayne	Black Crappie	10	2	Landfill, sludge
Androscoggin Lake	Wayne	Smallmouth Bass	10	2	Landfill, sludge
Androscoggin River	Brunswick	Smallmouth Bass	10	2	Industry, WWTP
Annabessacook Lake	Monmouth	Black Crappie	10	2	Landfill
Annabessacook Lake	Monmouth	Largemouth Bass	10	2	Landfill
Aroostook River	Caribou	Brook Trout	10	2	Former military base, WWTP, Landfill
Aroostook River (Little Madawaska River confluence)	Caribou	Brook Trout	10	2	Former military base, WWTP, Landfill
Aroostook River	Fort Fairfield	Brook Trout	10	2	Former military base, WWTP, Landfill
Auburn Lake*	Auburn	Largemouth Bass	10	2	
Auburn Lake*	Auburn	Smallmouth Bass	10	2	
B Stream*	Houlton	Brook Trout	10	2	
Collyer Brook	Gray	Brook Trout	10	2	
East Pond	Smithfield	Black Crappie	10	2	
East Pond	Smithfield	Largemouth Bass	10	2	

Table 3 (continued)

Waterbody	Town	Species	# Fish	# Composites	Potential Contamination[1]
Fairfield PAL Pond 1	Fairfield	Brook Trout - Hatchery	10	2	Sludge, landfill
Fairfield PAL Pond 2	Fairfield	Brook Trout - Hatchery	10	2	Sludge, landfill
Great Works River	North Berwick	Brook Trout	10	2	AFFF, industry
Halfmoon Stream	Thorndike	Brook Trout	10	2	Sludge
Halfmoon Stream	Thorndike	Smallmouth Bass	10	2	Sludge
Kenduskeag Stream	Bangor	Largemouth Bass	5	1	Airport
Kenduskeag Stream	Bangor	Smallmouth Bass	10	2	Airport
Kenduskeag Stream	Kenduskeag	Smallmouth Bass	15	3	
Kennebec River	Augusta	Smallmouth Bass	10	2	Sludge, industry, WWTP
Kennebec River (Downstream of Carrabassett Stream)	Fairfield	Black Crappie	10	2	Sludge, industry, landfill
Kennebec River (Upstream of Carrabassett Stream)	Fairfield	Smallmouth Bass	10	2	Sludge
Kennebec River	Norridgewock	Smallmouth Bass	10	2	WWTP
Kennebeck River	Richmond	Smallmouth Bass	10	2	Sludge, WWTP
Kennebec River	Waterville	Smallmouth Bass	10	2	Sludge, industry
Limestone Stream	Fort Fairfield	Brook Trout	10	2	Former military base, sludge, WWTP
Mattanawcook Pond	Lincoln	Largemouth Bass	10	2	
McGrath Pond	Oakland	Black Crappie	10	2	Landfill
McGrath Pond	Oakland	Largemouth Bass	5	1	Landfill
McGrath Pond	Oakland	Smallmouth Bass	5	1	Landfill

Table 3 (continued)

Waterbody	Town	Species	# Fish	# Composites	Potential Contamination[1]
Meduxnekeag River	Houlton	Brook Trout	10	4	Landfill, WWTP
Meduxnekeag River*	Littleton	Brook Trout	10	2	
Meduxnekeag River*	Littleton	Smallmouth Bass	10	2	
Messalonskee Stream*	Waterville	Smallmouth Bass	5	1	**Sludge**
Messalonskee Stream*	Waterville	Northern Pike	5	1	**Sludge**
North Branch Presque Isle Stream	Mapleton	Brook Trout	10	4	WWTP
North Pond	Smithfield	Largemouth Bass	10	2	
North Pond	Smithfield	White Perch	10	2	
Pearce Brook	Littleton	Brook Trout	10	2	
Prestile Stream	Blaine	Brook Trout	10	2	
Presumpscot River	Westbrook	Smallmouth Bass	10	2	Industry, Landfill
Presumpscot River	Windham	Smallmouth Bass	10	2	
Pushaw Lake	Glenburn	Largemouth Bass	10	2	
Sabattus Pond	Greene	Black Crappie	10	2	
Salmon Falls River*	South Berwick	Largemouth Bass	10	2	WWTP
Salmon Lake (Ellis Pond)	Oakland	Black Crappie	10	2	Landfill
Salmon Lake (Ellis Pond)	Oakland	Largemouth Bass	10	2	Landfill
Salmon Lake (Ellis Pond)	Oakland	Smallmouth Bass	10	2	Landfill
Sandy Stream	Unity	Smallmouth Bass	10	2	Sludge
Silver Lake	Bucksport	Largemouth Bass	10	2	
Togus Pond	Augusta	Black Crappie	10	2	
Togus Pond	Augusta	Largemouth Bass	10	2	
West Branch Sebasticook River	Palmyra	Largemouth Bass	10	2	WWTP

1 - "WWTP" stands for Wastewater Treatment Plant. "Sludge" refers to the spreading of biosolids on agricultural fields as fertilizers.
* indicates that a water sample was NOT collected at that field site

Results: 2023 Fish Samples

Field crews caught 10 fish (2 composites of 5 fish) at most sites (Table 3). Crews caught 15 smallmouth bass in Kenduskeag Stream near the town of Kenduskeag at the request of CDC. At a handful of sites (McGrath Pond in Oakland, Messalonskee River in Waterville, Kenduskeag Stream in Bangor), crews were only able to collect 5 individuals of target species resulting in just a single composite sample consisting of 5 individuals for the species of interest at that site (Table 3). Samples were collected at 2 locations from the Meduxnekeag River in Houlton. Samples were collected from 2 locations on the North Branch Presque Isle Stream, upstream and downstream of a wastewater treatment plant (sample points NPM1 and NPM2).

Similar to previous years, PFOS was detected in all of the 114 composite samples collected in 2023 and was found in the highest concentrations compared to other kinds of PFAS (Figure 3, Table 4). 70 of the 114 samples collected in 2023 were above the FTAL of 3.5 ng/g PFOS. However, of these 70 samples, 18 were smallmouth bass, largemouth bass, or black crappie with PFOS concentrations below 7.5 ng/g indicating that the current state-wide mercury consumption advisory covers these fish, and CDC will not need to consider issuing additional, PFAS specific consumption advisories for those sites. That leaves 52 samples from 23 different sites that CDC may use to help them consider fish consumption advisories.

Near Presque Isle and Caribou, samples from the Aroostook River showed variation in their PFOS concentrations (Figure 4, Figure 5). For example, brook trout collected from the Aroostook River near where the Caribou Mill Pond drains into the river had average PFOS concentrations of 4 ng/g, above the FTAL of 3.5 (Figure 4, Figure 5). Similarly, a little way downstream just past where the Little Madawaska River flows into the Aroostook River, brook trout samples averaged 5 ng/g PFOS, still above the FTAL (Figure 4, Figure 5). However, even further downstream where the Aroostook River flows through Fort Fairfield, brook trout had PFOS concentrations averaging 3 ng/g, just below the FTAL (Figure 4, Figure 5). There was a similar pattern in the nearby North Branch Presque Isle Stream where upstream samples of brook trout taken close to Mapleton had an average PFOS concentration of 5 ng/g while those collected further downstream had a lower average PFOS concentration of 3 ng/g (Figure 4, Figure 5). The samples taken from North Branch Presque Isle Stream were close to the FTAL so additional samples were collected from these sites in 2024 to assist CDC in determining if fish consumption advisories are necessary (see section 2.3).

There were two other streams sampled in the Caribou-Presque Isle Region: Limestone Stream and Prestile Stream (Figure 5). Brook trout collected at these two sites had very different concentrations of PFOS. In Limestone Stream, brook trout averaged 27 ng/g PFOS, significantly higher than the FTAL of 3.5 ng/g. CDC extended an existing PFAS-specific fish consumption advisory in this stream all the way to the Canadian border based on these findings. Alternatively, brook trout in Prestile Stream averaged 3 ng/g PFOS. While this number did approach the FTAL in one of the samples, both composites were below the threshold and CDC is unlikely to take further action there.

Table 4. Summary statistics of PFAS detected in 2023 composite fish tissue samples (n = 114, skinless fillets, ng/g wet weight (ppb))

PFAS[1]	Min.	1st quartile	Median	Mean	3rd quartile	Max.	# of detects	# of non-detects
5:3 FTC	2.52	2.91	3.31	3.31	3.70	4.10	2	112
6:2 FTS	0.23	0.33	0.40	0.51	0.42	2.15	13	101
7:3 FTC	2.50	3.31	5.64	12.46	20.83	30.79	7	107
8:2 FTS	0.33	0.41	0.43	0.42	0.44	0.46	5	109
N-EtFOSAA	0.11	0.16	0.32	0.76	0.54	5.19	24	90
N-EtFOSE	0.91	0.99	1.04	1.48	1.48	3.96	9	105
N-MeFOSA	0.10	0.11	0.11	0.12	0.12	0.15	6	108
PFBA	0.31	0.47	0.55	0.52	0.60	0.66	4	110
PFBS	0.10	0.10	0.10	0.10	0.10	0.10	1	113
PFDA	0.08	0.25	0.47	1.05	0.85	16.11	114	0
PFDoDA	0.07	0.20	0.42	0.77	0.64	32.69	111	3
PFDS	0.07	0.10	0.11	0.15	0.16	0.55	18	96
PFHpA	0.07	0.11	0.16	0.27	0.31	0.81	16	98
PFHpS	0.09	0.12	0.20	0.44	0.63	1.68	12	102
PFHxA	0.12	0.21	0.27	0.24	0.29	0.31	5	109
PFHxS	0.07	0.11	0.16	1.71	0.43	27.90	29	85
PFNA	0.10	0.18	0.29	0.57	0.66	3.49	59	55
PFNS	0.19	0.28	0.37	0.37	0.46	0.56	2	112
PFOA	0.07	0.12	0.22	0.52	0.60	2.02	33	81
PFOS	0.97	2.57	4.86	15.41	10.50	292.60	114	0
PFOSA	0.08	0.22	0.41	1.37	1.42	11.17	43	71
PFPeA	0.25	0.25	0.25	0.25	0.25	0.25	2	112
PFPeS	0.67	0.85	1.04	1.04	1.22	1.41	2	112
PFTeDA	0.08	0.18	0.30	0.42	0.41	6.02	79	35
PFTrDA	0.08	0.29	0.60	0.71	0.94	6.63	95	19
PFUnDA	0.09	0.36	0.92	1.17	1.25	23.20	114	0

1 – The following 14 PFAS were not detected in any of the 114 composite fish samples processed in 2023: 11CL-PF3OUDS, 3:3 FTC, 4:2 FTS, 9CL-PF3ONS, ADONA, HFPO-DA, N-EtFOSA, N-MeFOSAA, N-MeFOSE, PFDH, PFDoDS, PFEESA, PFMB, PFMP

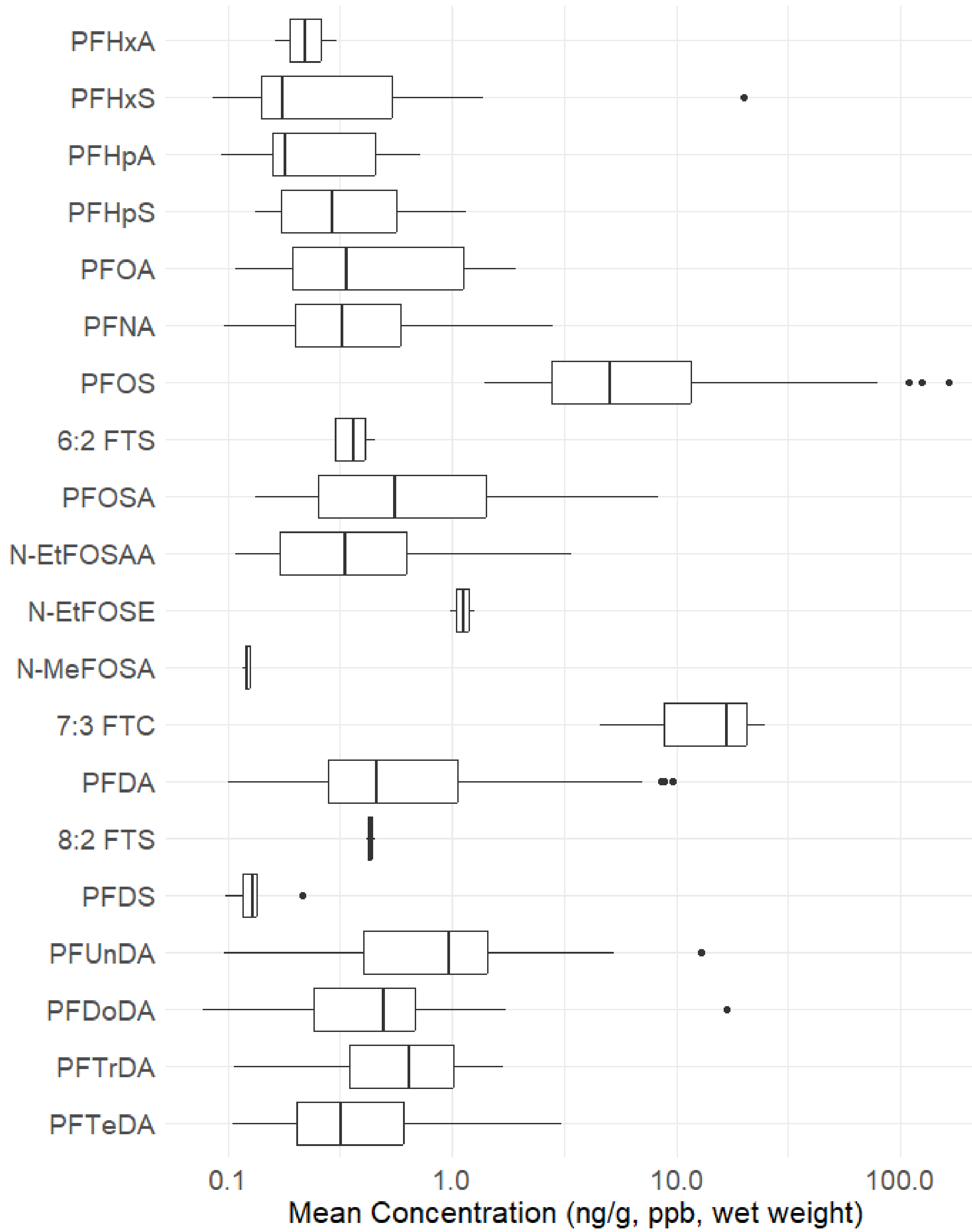


Figure 3. Box-and-whisker plots of mean concentrations of PFAS detected in 5 or more samples in 2023 samples (skinless fillets, wet weight). Non-detect results were excluded. Note that the x-axis increases logarithmically, not linearly. *The boxes show the middle half of the data. Vertical lines inside the boxes show median values. Horizontal lines to the left and right of the boxes show the lowest quarter and highest quarter of concentrations, respectively. Points indicate unusually high or low values compared to other data.*

Further south, in and near Houlton, a number of samples were taken in the Meduxnekeag River and two of its tributaries. All samples of brook trout and smallmouth bass taken from three sites in the Meduxnekeag River were below the FTAL of 3.5 ng/g (Figure 4, Figure 5). Similarly, brook trout collected from B Stream had an average PFOS concentration of 2 ng/g, also below the FTAL (Figure 4, Figure 5). This was not the case for brook trout collected from Pearce Stream. These fish had average PFOS concentrations of 5 ng/g (Figure 4, Figure 5). While these samples were above the FTAL, CDC requested additional sampling from Pearce Stream in 2024 before considering a consumption advisory (see section 2.3). Whatever source of contamination is causing the fish in Pearce Brook to have elevated PFOS levels appears to not affect the fish in the Meduxnekeag River. Likely, the amount of PFAS pollution that Pearce Brook brings into the Meduxnekeag is quickly diluted by the larger river resulting in minimal impacts to the fish there. Additional samples were collected in 2024 from the Meduxnekeag River to help CDC determine whether fish consumption advisories are warranted at this site (see section 2.3).

A

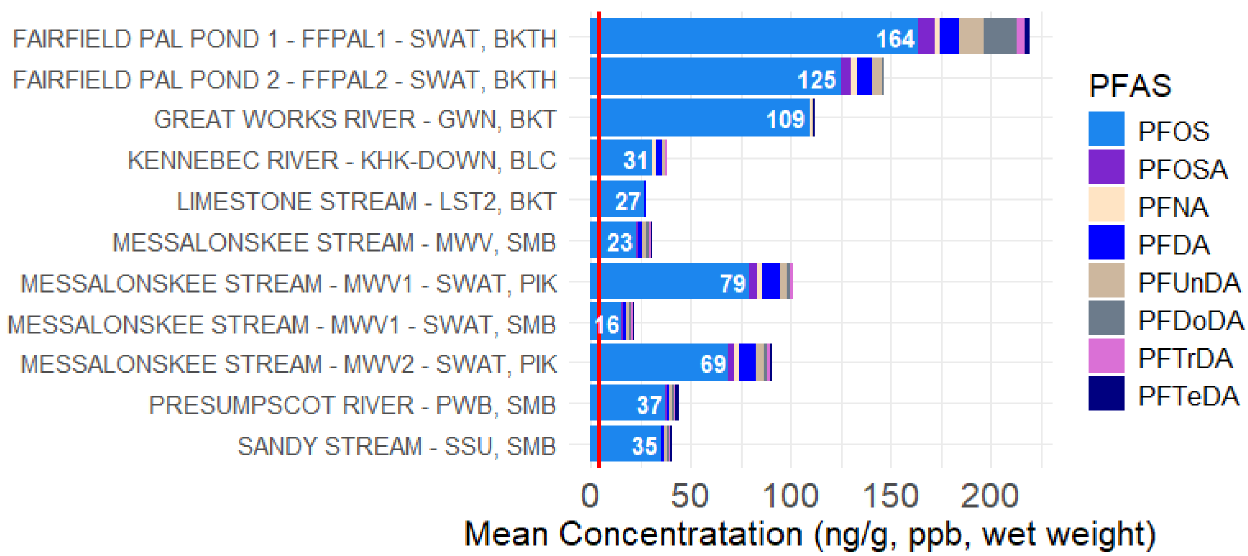


Figure 4. Average concentrations of PFOS and other most common PFAS in 2023 fish tissue samples (skinless fillets, wet weight). *The white numbers are the average PFOS concentrations. Panel A includes samples with high PFOS concentrations and panel B includes samples with low PFOS concentrations. The vertical red line in panel B shows the Fish Tissue Action Level (FTAL) for PFOS, which is 3.5 ng/g. The vertical red line should only be compared to PFOS concentrations. Fish Codes: BLC = black crappie, BKT = brook trout, BKTH = hatchery brook trout, LMB = largemouth bass, PIK = northern pike, SMB= smallmouth bass, WHP = white perch*

B

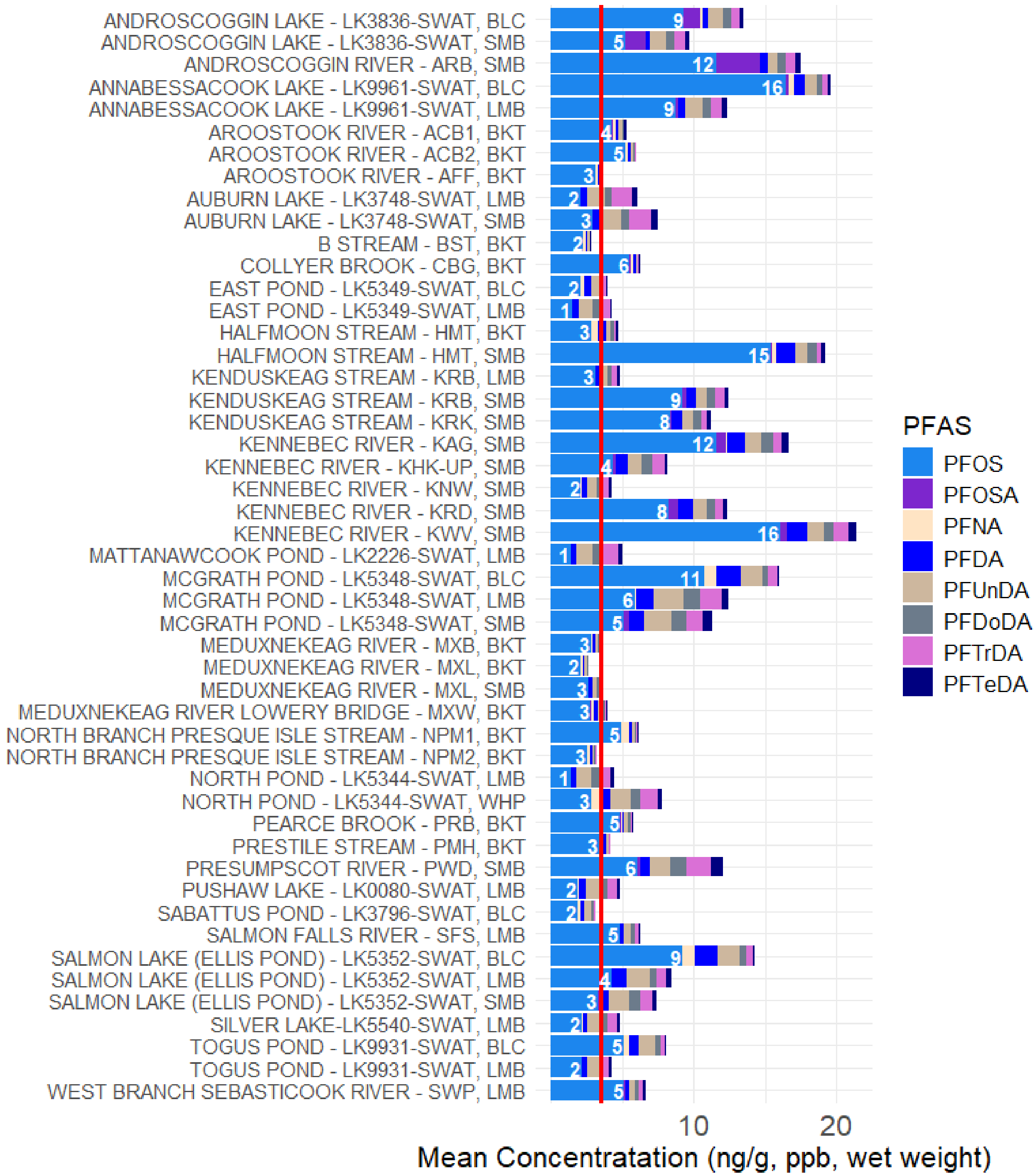


Figure 4. (Continued)

In the Bangor area, samples were collected from the Kenduskeag River in two locations (Figure 5). Smallmouth bass both upstream of Bangor and in Bangor had average PFOS concentrations well above the FTAL, 16 ng/g and 8 ng/g respectively (Figure 4, Figure 5). Interestingly, Largemouth bass collected from the site in Bangor had PFOS levels below the FTAL, averaging 3 ng/g (Figure 4). It is not clear what is driving the dramatic differences in these species within the same stream. It was surprising to catch largemouth bass at that location. 2023 was a rainy year and it is possible that the largemouth bass were washed downstream from a pond. CDC has issued a consumption advisory for smallmouth bass in parts of this stream.

Nearby, Pushaw Lake had low concentrations of PFOS in fish where largemouth bass averaged 2 ng/g PFOS. Similarly, a bit further north in Mattanawcook Lake (Lincoln), largemouth bass averaged just 1 ng/g PFOS. To the South of Bangor, near Bucksport, largemouth bass continued to have low PFOS concentrations, again averaging 2 ng/g. However, west of Bangor in the West Branch Sebasticook River (Palmyra), largemouth bass had higher average PFOS concentrations of 5 ng/g. While this is below the 7.5 ng/g level that the state-wide mercury advisory covers, these elevated levels dictated that follow-up sampling should occur in 2024 (see section 2.3). The West Branch Sebasticook River (Palmyra) has a wastewater treatment plant upstream.

The Kennebec River has a long history with pollutants and was the focus of intensive sampling during 2023 with six different reaches of the river being sampled (Table 3, Figure 5). The furthest upstream site, near Norridgewock had the lowest levels of contamination with smallmouth bass averaging 2 ng/g PFOS, below the FTAL (Figure 4, Figure 5). Downstream near Hinkley, PFOS levels became elevated in smallmouth bass where they averaged 4 ng/g (Figure 4, Figure 5). Still in Hinkley but downstream of the Sappi mill, PFOS were greatly elevated in smallmouth bass with PFOS levels averaging 31 ng/g (Figure 4, Figure 5). These were the most contaminated fish in the Kennebec collected in 2023. Further downstream, in Waterville, smallmouth bass from the Kennebec River averaged 16 ng/g PFOS (Figure 4, Figure 5). While lower than those collected in Hinkley, they were still well above the FTAL. PFOS concentrations in smallmouth bass continued to slowly decline further downstream with smallmouth bass samples from Augusta averaging 12 ng/g and samples from Richmond averaging 8 ng/g (Figure 4, Figure 5). CDC currently has consumption advisories for the Kennebec River in segments between Fairfield and Sidney. Additional sampling was conducted in 2024 to help CDC determine whether additional consumption advisories are needed (see section 2.3).

The Messalonskee River, a tributary of the Kennebec, was also a focus of intensive sampling in 2023 (Table 3, Figure 5). Two composites of smallmouth bass and two composites of northern pike were collected across three different reaches of this river. At each site, all composites were well above the FTAL (Figure 4, Figure 5). Northern pike were especially elevated, averaging 79 ng/g PFOS and 69 ng/g PFOS from the two reaches they were collected in. These findings are consistent with previous sampling of the Messalonskee River which also showed elevated PFOS

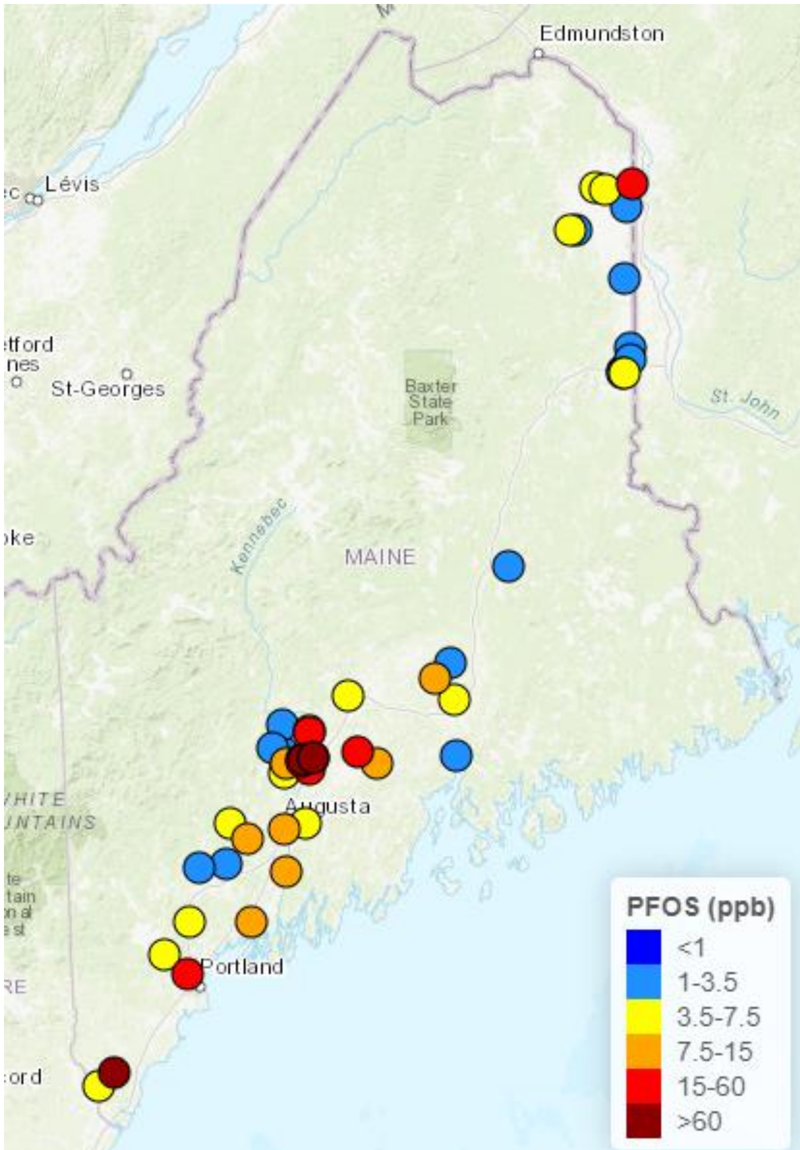


Figure 5. Map of the 46 sample sites visited in 2023. Colors represent the average PFOS concentrations (ng/g, ppb) of skinless fillets of all fish caught at each site.

levels in fish (Figure 11). CDC has issued a fish consumption advisory for the Messalonskee River between the Rice Rips Dam in Oakland and the Automatic Dam in Waterville.

Nearby in Fairfield, stocked brook trout were collected from the Police Athletic League (PAL) ponds. The brook trout from these ponds had average PFOS concentrations of 164 ng/g in one pond and 125 ng/g in the other pond (Figure 4). The brook trout in these ponds are part of a 'put-and-take' fishery meaning that they do not naturally persist and the population of brook trout in this pond is only sustained by stocking. CDC has issued their highest-level consumption advisory for these ponds based on these data (do not eat any fish in any amount). Moreover, the fish samples collected from these ponds all exceed the EPA's water quality criteria for PFOS in fish tissue (87 ng/g) indicating that the levels of pollution in this pond are likely harmful to the life, reproduction, and/or growth of these fish.

In the Belgrade Lakes region, there was variation in the amount of PFOS contamination in fish. North Pond and East Pond had very low concentrations of PFOS (Figure 4, Figure 5). This was not the case for McGrath Pond. Black Crappie from McGrath Pond had average PFOS concentrations of 11 ng/g (Figure 4), well above the FTAL and above the 7.5 ng/g covered by the state-wide mercury advisory. Largemouth bass and smallmouth bass were also above the FTAL, averaging 6 and 5 ng/g PFOS respectively, but below 7.5 ng/g. CDC has issued a fish consumption advisory for this lake. Salmon Lake (Ellis Pond) is hydrologically connected to McGrath Pond also had elevated levels of PFOS in its fish (Figure 5). Black Crappie averaged 9 ng/g PFOS while Largemouth bass and smallmouth bass averaged 4 and 3 ng/g PFOS respectively (Figure 4). While lower than McGrath Pond, the fish consumption advisory that CDC issued for that lake extends to Salmon Lake (Ellis Pond) as well.

The area surrounding Unity saw high amounts of sludge spreading in the past. As a result, surface waters in this region have been a focus for sampling. In 2023 samples of smallmouth bass collected from Sandy Stream and Halfmoon Stream all had PFOS levels well above the FTAL, averaging 35 ng/g and 15 ng/g respectively (Figure 4, Figure 5). Interestingly, brook trout collected from Halfmoon Stream had much lower levels of PFOS, averaging 3 ng/g, below the FTAL. Given the high levels of PFOS in the bass, CDC has issued a consumption advisory in Halfmoon Stream and part of the Sandy Stream. Additional sampling was conducted in the Sandy Stream in 2024 to determine whether the extent of those advisories was sufficient (see section 2.3).

In the Augusta area, three lakes were sampled and all had elevated levels of PFOS in their fish. Among these three lakes, the highest levels of PFOS were found in fish from Annabessacook Lake where black crappie averaged 16 ng/g PFOS and largemouth bass averaged 9 ng/g PFOS (Figure 4). These values were above the FTAL and above the 7.5 ng/g level that is covered by the state-wide mercury advisory for these fish species. This lake was resampled in 2024 to provide CDC with enough data to accurately assess whether a consumption advisory is needed (see section 2.3). Androscoggin Lake had lower levels of PFOS than Annabessacook Lake, but they were still elevated (Figure 5). Black crappie averaged 9 ng/g PFOS in this lake while smallmouth bass averaged 5 ng/g (Figure 4). Like Annabessacook Lake, Androscoggin Lake was resampled in 2024 to provide CDC with the data they needed to accurately assess the need for a consumption advisory (see section 2.3). Alternatively, Togus Pond had lower levels of PFOS in black crappie and largemouth bass, averaging 5 and 2 ng/g respectively (Figure 4). Given that both of these values fall below the 7.5 ng/g protected by the state-wide mercury advisory for these species, this pond was not resampled in 2024.

Near Lewiston, fish from Auburn Lake and Sabattus Pond had low concentrations of PFOS, well below the FTAL (Figure 4, Figure 5). In Brunswick, smallmouth bass collected from the Androscoggin River had elevated levels of PFOS averaging 12 ng/g. These data proved to be useful reference points in 2024 when sampling in response to the Brunswick AFFF spill occurred (see section 2.3). CDC previously issued a fish consumption advisory for that section of the Androscoggin River (6-12 meals/year) because of high concentrations of polychlorinated biphenyls (PCBs). This fish consumption advisory provides protection for the elevated PFOS concentrations in that section of river.

Like the Kennebec River, the Presumpscot River in southern Maine has a long history with contaminants. Smallmouth bass were sampled in two reaches of this river for PFAS (Table 3, Figure 5). The smallmouth bass in the downstream reach near Westbrook, had high levels of PFOS, averaging 37 ng/g (Figure 5). Upstream near Windham, however, smallmouth bass had less PFOS contamination, averaging just 6 ng/g (Figure 5). Based on these data, CDC issued a consumption advisory from Saccarappa Falls in Wesbrook to Presumpscot Falls in Falmouth. Additional sampling was conducted in 2024 to determine whether the spatial coverage of this advisory needed to be extended (see section 2.3).

In the Gray area, brook trout from Collyer Brook (Gray) had elevated levels of PFOS, averaging 6 ng/g (Figure 4, Figure 5) which is above the FTAL. Follow-up sampling was conducted in 2024 to provide CDC with enough data to determine whether a consumption advisory was warranted (see section 2.3).

In far southern Maine, brook trout from Great Works River (North Berwick) had very high levels of PFOS (Figure 5). Fish from this river averaged 109 ng/g and were among the highest ever recorded to that point (Figure 4). Not only does this value exceed the FTAL, it also exceeds the EPA PFOS water quality criterion for fish tissue (87 ng/g), indicating that the levels of PFAS pollution in this stream is likely harmful to the life, growth and/or reproduction of fish in this river. Trout collected from the same location in 2022 had 3.8 ng/g PFOS. We suspect that there was a release of aqueous film-forming foam (AFFF) into the stream based on large increase in PFOS from 2022 to 2023, combined with unusually high concentrations of perfluorohexane sulfonate (PFHxS) at the site in 2023. PFOS and PFHxS are key ingredients in some AFFF products. Further south still, largemouth bass collected from Salmon Falls River (South Berwick) had PFOS concentrations averaging 5 ng/g (Figure 4) which was above the FTAL but below the 7.5 level protected by the state-wide mercury advisory. As a result, CDC is unlikely to request additional samples from this river or issue additional, PFAS-specific advisories.

Aside from PFOS, other commonly detected PFAS were PFDA, PFUnDA, PFDoDA, PFTrDA, and PFTeDA. While commonly found in fish tissue samples, these PFAS were typically found at low concentrations with their average concentrations ranging from 0.3 to 0.85 ng/g. Little is known about the toxicity of these compounds, but they are all long-chain PFAS which tend to be of higher health concern than short-chain PFAS.

Results: 2023 Water Samples

In total, field crews collected 41 water samples in 2023 (Figure 6). Both PFOS and PFOA were relatively common in the water samples collected in 2023 and often present in relatively high quantities (Table 5). In general, areas that had high concentrations of PFOS in water samples were the same places that had high PFOS concentrations in fish tissue samples meaning that water samples with high PFOS were typically found in the I-95 corridor (Figure 6). Two sites in 2023 exceeded the chronic exposure limits for PFOS according to the EPA water quality criterion for PFOS. These sites were the Fairfield Police Athletic Leage (PAL) Ponds in the town of Fairfield (Figure 6). PFOS concentrations in fish tissue from these ponds also exceeded EPA criteria so it is unsurprising that the water does as well. No sites exceeded the acute EPA water quality criterion for PFOS. While PFOA was commonly found in the water samples and at times found in high quantities (particularly at the Fairfield PAL Ponds), no sites exceeded the acute or chronic EPA water quality criteria for PFOA.

Table 5. Summary statistics of PFAS in water samples collected in 2023 (n = 41)

PFAS[1]	Min.	1st quartile	Median	Mean	3rd quartile	Max.	# of detects	# of non-detects
6:2 FTS	1.59	1.665	1.81	2.086667	2.0825	3.52	6	35
N-EtFOSAA	1.15	1.55	9.3	7.14	11.2	12.5	5	36
N-MeFOSAA	0.869	1.08425	1.2995	1.2995	1.51475	1.73	2	39
PFBA	0.485	0.982	1.4	4.081385	2.775	37.9	39	2
PFBS	0.237	0.35	0.465	0.640345	0.619	2.6	29	12
PFDA	0.343	0.5145	1.0255	25.7295	56.15	84.7	8	33
PFDoDA	0.504	1.026	1.24	1.081	1.295	1.34	4	37
PFHpA	0.334	0.664	0.8575	14.12613	2.3675	231	38	3
PFHpS	7.69	7.925	8.16	15.18333	18.93	29.7	3	38
PFHxA	0.298	0.69125	1.017	8.143944	1.9875	114	36	5
PFHxS	0.346	0.4045	0.938	1.64	2.44	5.96	15	26
PFNA	0.324	0.40225	0.5855	10.09725	1.1325	129	28	13
PFOA	0.273	0.77	1.49	31.18841	3.96	576	39	2
PFOS	0.478	0.83025	1.23	96.0127	3.335	1360	30	11
PFOSA	2.24	2.895	3.55	3.346667	3.9	4.25	3	38
PFPeA	0.415	0.7305	1.18	6.069765	1.9175	77.2	34	7
PFPeS	0.259	0.279	0.292	0.3552	0.332	0.614	5	36
PFTeDA	0.318	0.318	0.318	0.318	0.318	0.318	1	40
PFTrDA	0.3	0.3	0.3	0.3	0.3	0.3	1	40
PFUnDA	0.298	11.3245	16	13.5745	18.25	22	4	37

1 – The following 8 PFAS were not detected in any of the 41 water samples collected in 2023: 4:2 FTS, 8:2 FTS, ADONA, HFPO-DA, PFDS, PFHxDA, PFNS, PFODA

Aside from PFOS and PFOA, Other PFAS were more commonly found as well, but typically were found at very low concentrations. These include PFAS such as PFBA, PFHpA, PFHxA, PFPEA. These PFAS are known as 'short-chain' pfas due to the short carbon chains they have (in this instance between three and six carbons long). Short-chain PFAS are known to be commonly found in water samples. Three types of PFAS were relatively rare but typically found at high concentrations when present. These include PFDA, PFHpS, PFNA, and PFUnDA. The drivers behind the high abundances of these PFAS in just a select few locations remain unknown.

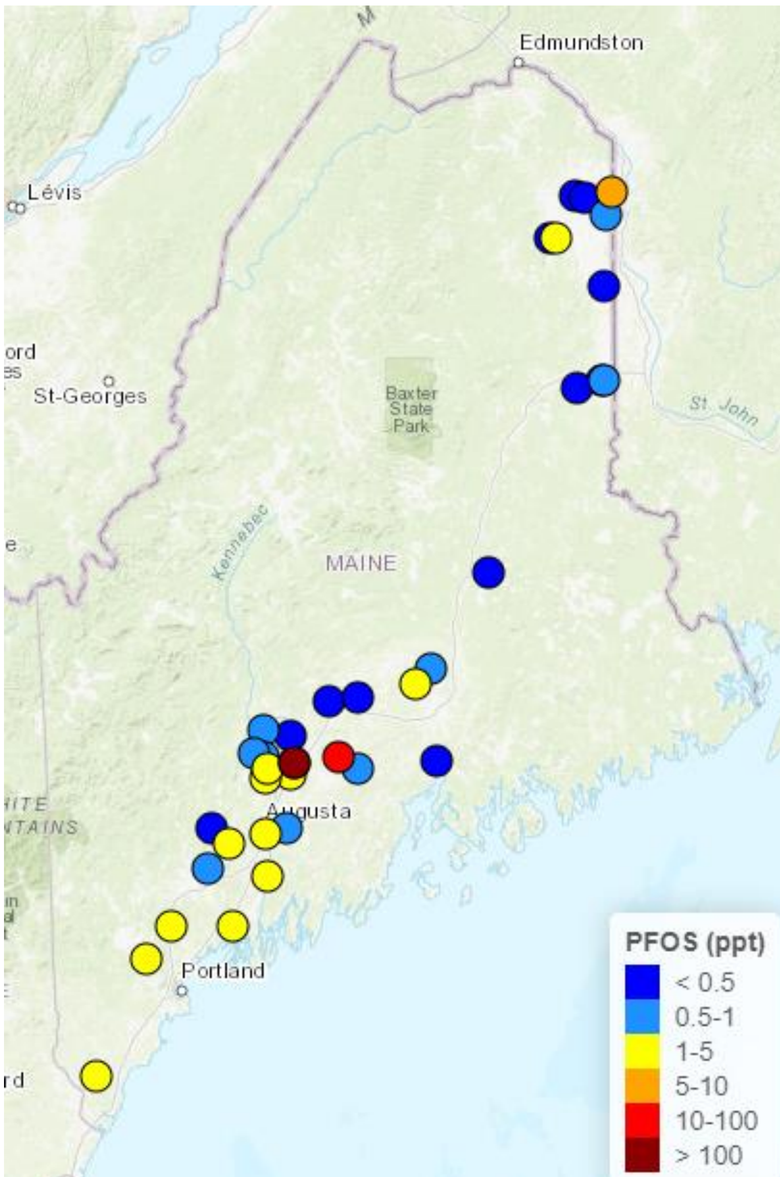


Figure 6. Map of the 41 sites where water samples were collected in 2023. Colors represent the average PFOS concentration (ppt, ng/L) in each of the water samples.

2.3 PFAS in 2024 Fish & Water Samples

Methods

DEP received grant money from the EPA to supplement 2024 SWAT funds for freshwater monitoring. As a result, DEP was able to expand the number of sites and species targeted for PFAS sampling. In 2024, the sites listed in Table 6 were targeted for PFAS analysis. Most of the sampling in 2024 was focused along the I-95 corridor from Southern Maine up to Bangor with additional sampling conducted in Aroostook County, especially near Presque Isle. Previous sampling has shown that these areas have higher rates of PFAS contamination than other parts of the state. Additionally, in 2024 field crews worked with the Passamaquoddy Tribe near Calais to sample Big Lake and Grand Falls Flowage. Previous MIFW sampling suggested that these lakes, important fisheries for the tribe, may be contaminated.

In total, field crews sampled 43 different field sites. Of these, 15 had been sampled in previous years. Repeat sampling was conducted at sites where contamination was potentially high enough for CDC to consider issuing a fish consumption advisory. Often, CDC will request additional, follow-up samples at contaminated sites to assist in informing their decisions to issue fish consumption advisories.

The standard goal was to collect 10 fish per species per site. In some cases, CDC requested more fish to better inform decisions about fish consumption advisories. Occasionally, field crews were unable to catch 10 fish. In these instances, as many fish as could be collected were taken back for processing. Most fish were collected by angling. However, at a few sites such as Merriconeag Stream (Brunswick) and Mare Brook (Brunswick) electrofishing was used. Sample collection and preparation followed standard protocols to minimize the potential for contamination. Upon capture, fish were stored in new, clean plastic bags on ice until transfer to DEP. At DEP, the fish were rinsed with PFAS-free water and then measured and weighed. For most fish, ten-gram pieces of skinless fillets were taken from the fish, placed in plastic bags or plastic jars, and frozen. Some fish, like the eels, were quite small and ten-gram fillets were unable to be obtained. In these instances, as much skinless tissue as possible was collected, no less than three grams per fish. The fillets were combined into composite samples of 5 fish whenever possible. In some cases, such as when field crews ran into difficulties collecting fish at a field site, composite samples consisted of fewer than 5 fish. Samples were shipped overnight to SGS Axys in British Columbia, Canada for analyses. The lab homogenized the composite samples and analyzed the tissue for 40 kinds of PFAS using Method 1633 (Table 1). The lab provided PFAS concentrations based on wet weight and dry weight for each composite sample. Subsequent analysis focused on average PFAS concentrations for each site based on wet weight.

In addition to fish, water samples were collected at most sites. Field crews would take a grab sample from the surface of the body of water, away from the shoreline. Samples were taken using new, plastic sample jars and immediately put on ice. Samples were then taken back to DEP where they were kept in a refrigerator until they could be shipped to Pace Analytical in Boston for analysis. In general, a single sample was taken at each site such that even if a site was visited multiple times (e.g.. to collect multiple types of fish) only one water sample would be collected for that pond, lake, river segment, or stream reach in 2024. Pace Analytical analyzed the water samples using either EPA method 537 (which tests for 28 different PFAS) or EPA method 1633 (which tests for 40 different PFAS). The lab provided PFAS concentrations on a wet-weight basis for all samples.

On August 19th, 2024, there was an accidental discharge of over 1,450 gallons of aqueous film-forming foam (AFFF) at the Brunswick Executive Airport (BEA), formerly the Brunswick Naval Air Station. AFFF contains high concentrations of PFOS. In response to this spill, field crews were dispatched to sample fish and surface water in streams near the former airbase for contamination at multiple timepoints following the spill. The sites sampled included Mare Brook, Merriconeag Stream, and the Androscoggin River. Sites upstream of the airbase in Mare Brook and the Androscoggin River were sampled as reference sites. In total, field crews sampled each of the sites downstream of the spill for fish on two occasions each with each sampling event separated by a span of two weeks. Reference sites were only sampled once. All fish collected were processed using the same methods as those collected at other sites. Water samples were collected more frequently with samples taken every week from the Androscoggin River and every other week from Mare Brook and Merriconeag Stream during the same timeframe. More information about DEP's sampling of ambient water, soil, drinking water wells, and biota associated with the AFFF spill can be found on this website: https://maine.maps.arcgis.com/apps/webappviewer/index.html?id=5bdc42d73a484e1982370371e97aae83.

Data were analyzed with R (version 4.4.2.) in RStudio (version 2024.12.0). Summary statistics were computed for the concentration of PFAS in composite samples, excluding results below detection limits (Table 7). Average PFAS concentrations were computed for each species at each site. For purposes of computing average PFAS concentrations, non-detect values were conservatively set to method detection limits. The distribution of the average PFAS concentrations in skinless fillets were displayed as box-and-whisker plots for PFAS detected in at least 5 samples (Figure 7). Stacked bar plots of the average concentrations of PFOS and other common PFAS were created (Figure 8). The average concentration of PFOS from all fish (skinless fillets) collected at a site were computed and plotted on a map (Figure 9).

Table 6. 2024 freshwater sites and samples.

Waterbody	Town	Species	# of fish	# of composites	Potential contamination[1]
Androscoggin Lake	Wayne	Black Crappie	10	2	Landfill, sludge
Androscoggin Lake	Wayne	Largemouth Bass	10	2	Landfill, sludge
Androscoggin River (Downstream of BFNAB)	Brunswick	Smallmouth Bass	20	4	AFFF spill
Androscoggin River (Downstream of BFNAB)	Brunswick	White Catfish	1	1	AFFF spill
Androscoggin River (Upstream of BFNAB)	Topsham	Smallmouth Bass	10	2	Reference for AFFF spill
Annabessacook Lake	Monmouth	Black Crappie	15	3	Landfill
Annabessacook Lake	Monmouth	Largemouth Bass	10	2	Landfill
Aroostook River	Fort Fairfield	Brook Trout	10	2	Former military base, WWTP, Landfill
Big Lake	Big Lake TWP	Smallmouth Bass	10	2	
Big Lake	Big Lake TWP	White Perch	5	1	
Clary (Pleasant) Lake	Jefferson	Largemouth Bass	10	2	
Clary (Pleasant) Lake	Jefferson	White Perch	10	2	
Cobbosseecontee Lake	West Gardiner	Black Crappie	10	2	Landfill
Cobbosseecontee Lake	West Gardiner	Largemouth Bass	10	2	Landfill
Collyer Brook	Gray	Brook Trout	15	3	
Damariscotta Lake	Jefferson	Largemouth Bass	10	2	
Damariscotta Lake	Jefferson	Smallmouth Bass	10	2	
Gagnon Brook	Frenchville	Brook Trout	10	2	
Grand Falls Flowage	Princeton	Smallmouth Bass	10	2	
Great Pond	Belgrade	Black Crappie	10	2	
Great Works River	North Berwick	Brook Trout	10	2	AFFF, Industry
Hermon Pond	Hermon	Largemouth Bass	10	2	
Highland Lake	Bridgton	Largemouth Bass	5	1	
Highland Lake	Bridgton	Smallmouth Bass	5	1	

Table 6 (continued)

Waterbody	Town	Species	# of Fish	# of composites	Potential contamination[1]
Kenduskeag Stream	Corinth	Smallmouth Bass	10	2	Sludge
Kennebec River	Norridgewock	Smallmouth Bass	10	2	WWTP
Kennebec River	Sidney	Smallmouth Bass	10	2	Sludge, industry, WWTP
Little Madawaska River	Caribou	Brook Trout	10	2	Former military base
Long Lake	Bridgton	Smallmouth Bass	10	2	
Long Pond	Belgrade	Smallmouth Bass	10	2	
Lovejoy Pond	Albion	Largemouth Bass	10	2	Sludge
Lovejoy Pond	Albion	White Perch	10	2	Sludge
Maranacook Lake	Readfield	Black Crappie	10	2	
Maranacook Lake	Readfield	Largemouth Bass	10	2	
Mare Brook (Upstream of AFFF spill)	Brunswick	Brook Trout	10	2	Reference for AFFF spill
Mare Brook (Downstream of AFFF spill)	Brunswick	Brook Trout	6	2	AFFF spill
Mare Brook (Downstream of AFFF Spill)	Brunswick	American Eel	12	4	AFFF spill
Meduxnekeag River (Lowery Bridge)	Houlton	Brook Trout	10	2	Landfill, WWTP
Merriconeag Stream	Brunswick	Brook Trout	3	2	AFFF spill
Merriconeag Stream	Brunswick	Black Crappie	12	4	AFFF spill
North Branch Presque Isle Stream	Mapleton	Brook Trout	10	2	WWTP
North Branch Presque Isle Stream	Presque Isle	Brook Trout	10	2	WWTP
Pearce Brook	Littleton	Brook Trout	10	2	WWTP

Table 6 (continued)

Waterbody	Town	Species	# of fish	# of composites	Potential contamination
Presque Isle Stream	Presque Isle	Brook Trout	10	2	
Presumpscot River	Gorham	Smallmouth Bass	10	2	Industry, landfill
Quiggle Brook	Union	Brook Trout	10	2	
Saco River	Biddeford	Smallmouth Bass	10	2	
Sandy Stream (Confluence of Halfmoon Stream)	Unity	Smallmouth Bass	10	2	Sludge
Sebago Lake	Sebago	Lake Trout	10	2	Landfill
Sebago Lake	Sebago	Landlocked Salmon	10	2	Landfill
Sebago Lake	Sebago	Smallmouth Bass	10	2	Landfill
Sebasticook Lake	Newport	Smallmouth Bass	10	2	
Sebasticook River	Clinton	Smallmouth Bass	10	2	Sludge
Seven Tree Pond	Union	Largemouth Bass	5	1	
Stantial Brook	Brooks	Brook Trout	10	2	
West Branch Sebasticook River	Palmyra	Largemouth Bass	5	1	WWTP
Wilson Pond	Monmouth	Largemouth Bass	10	2	

1 – "BEA" stands for Brunswick Executive Airport, formerly the Brunswick Naval Air Station, "AFFF" stands for Aqueous film forming foam, "WWTP" stands for wastewater treatment plant, "Sludge" refers to the spreading of biosolids on agricultural fields as fertilizer

Results: 2024 Fish Samples

Field crews collected two composites of five fish per species (10 individual fish per species) at most sites (Table 6). At two sites, Annabessacook Lake and Collyer Brook, field crews collected 15 black crappie and 15 brook trout respectively at the request of CDC (Table 6). These were split into three composites of five individuals each. At Big Lake, Highland Lake, Seven Tree Pond, and West Branch Sebasticook River, sampling constraints led to the collection single composites of five fish (Table 6). At some sites associated with the Brunswick AFFF spill, atypical numbers of fish were collected (e.g., 12 individual black crappies split into 4 composites in Merriconeag Stream) (Table 6). Such sampling was conducted due to the low abundance of fish at some of these sites, the need for repeated sampling through time, and opportunistic collection of fish.

As in previous years, PFOS was detected in every composite sample and was found at a higher concentration than all other types of PFAS (Table 7, Figure 7). The significantly higher average concentration of PFOS compared to other types of PFAS was primarily driven by the samples taken in response to the BEA AFFF spill. However, even if these samples are removed from the calculations, PFOS remains the most abundant PFAS found in fish tissues sampled in 2024. Sixty-five samples spanning twenty-three different sites had PFOS concentrations greater than the 3.5 ng/g FTAL. Out of these sixty-five samples, twenty-four samples were of smallmouth bass, largemouth bass, white perch, black crappie, or togue below 7.5 ng/g PFOS. These fish are already covered by the state-wide mercury consumption advisory, and CDC does not consider PFAS-specific consumption advisories for them. That leaves a total of forty-one samples at fourteen sites that may be used by CDC to inform whether consumption advisories are warranted.

In Aroostook County, most of the sites sampled in 2024 had low concentrations of PFOS (Figure 8, Figure 9) with samples from Meduxnekeag River (Lowery Bridge), Pearce Brook (Houlton), Gagnon Brook (Frenchville), Aroostook River (Fort Fairfield), Presque Isle Stream (Presque Isle) and North Branch Presque Isle Stream (Mapleton) all below the FTAL (Figure 8). However, brook trout samples taken in the Little Madawaska River (Caribou) did have PFOS concentrations greater than the FTAL, averaging 13.36 ng/g across two composite samples (Figure 8). This site is downstream of the former Loring Air Force Base. Other samples taken downstream of the former airbase in previous years in different streams have also had high concentrations of PFOS, exceeding the FTAL (Figure 11). There is already one consumption advisory in this area, and it is likely that there will be future sampling to help CDC determine whether more are needed.

In eastern Maine all the samples taken from Big Lake (Princeton) and Grand Falls Flowage (Princeton) were below the FTAL (Figure 8, Figure 9). These lakes are important fisheries for the Passamaquoddy Tribe in the area, especially for white perch. Previous sampling done by Maine Inland Fish and Wildlife (MDIFW) suggested that the concentrations of PFOS in these fish might be near

Table 7. Summary statistics of PFAS detected in 2024 composite fish tissue samples (n = 116, skinless fillets, wet weight). Values are in ng/g (ppb).

PFAS[1]	Min.	1st quartile	Median	Mean	3rd quartile	Max.	# of detects	# of non-detects
5:3 FTC	4.89	9.29	14.86	23.11	31.73	57.56	12	104
6:2 FTS	0.70	2.37	2.80	3.02	3.53	7.21	13	103
7:3 FTC	3.23	8.24	9.87	10.98	13.12	26.09	15	101
8:2 FTS	0.58	2.13	3.15	3.90	4.36	11.74	13	103
N-EtFOSAA	0.11	0.16	0.33	0.36	0.47	0.83	26	90
N-EtFOSE	1.00	1.42	2.15	3.38	4.04	15.84	58	58
N-MeFOSA	0.22	0.23	0.24	0.25	0.26	0.28	4	112
N-MeFOSAA	0.10	0.16	0.22	0.22	0.29	0.33	8	108
PFBA	0.40	0.40	0.40	0.40	0.40	0.40	1	115
PFBS	0.17	0.20	0.26	0.39	0.39	1.32	10	106
PFDA	0.10	0.31	0.44	1.01	0.73	15.35	107	9
PFDoDA	0.08	0.24	0.41	0.72	0.72	5.69	108	8
PFDoDS	0.11	0.13	0.19	0.39	0.39	1.38	8	108
PFDS	0.10	0.19	1.33	3.29	2.59	24.35	20	96
PFHpA	0.11	0.14	0.16	0.21	0.29	0.42	11	105
PFHpS	0.14	3.81	5.84	18.94	7.59	105.40	13	103
PFHxA	0.11	0.16	0.28	3.09	5.81	13.38	12	104
PFHxS	0.14	1.01	21.89	42.14	77.49	137.80	19	97
PFNA	0.10	0.15	0.25	0.37	0.43	2.00	58	58
PFNS	0.39	0.59	1.81	7.25	2.09	39.24	12	104
PFOA	0.10	0.14	0.18	0.59	0.83	3.41	32	84
PFOS	0.38	2.20	4.58	128.45	10.91	4687.00	116	0
PFOSA	0.10	0.15	0.32	2.21	2.33	15.03	40	76
PFPeA	0.31	0.40	0.46	0.46	0.52	0.59	4	112
PFPeS	0.56	1.81	2.36	2.51	2.98	5.68	12	104
PFTeDA	0.10	0.23	0.33	0.63	0.55	6.62	85	31
PFTrDA	0.11	0.28	0.50	0.70	0.86	3.07	113	3
PFUnDA	0.11	0.49	0.80	0.91	1.14	3.40	114	2

1 – The following 12 PFAS were not detected in any of the 116 composite fish samples processed in 2024: 11CL-PF3OUDS, 3:3 FTC, 4:2 FTS, 9CL-PF3ONS, ADONA, HFPO-DA, N-EtFOSA, N-MeFOSE, PFDH, PFEESA, PFMB, PFMP.

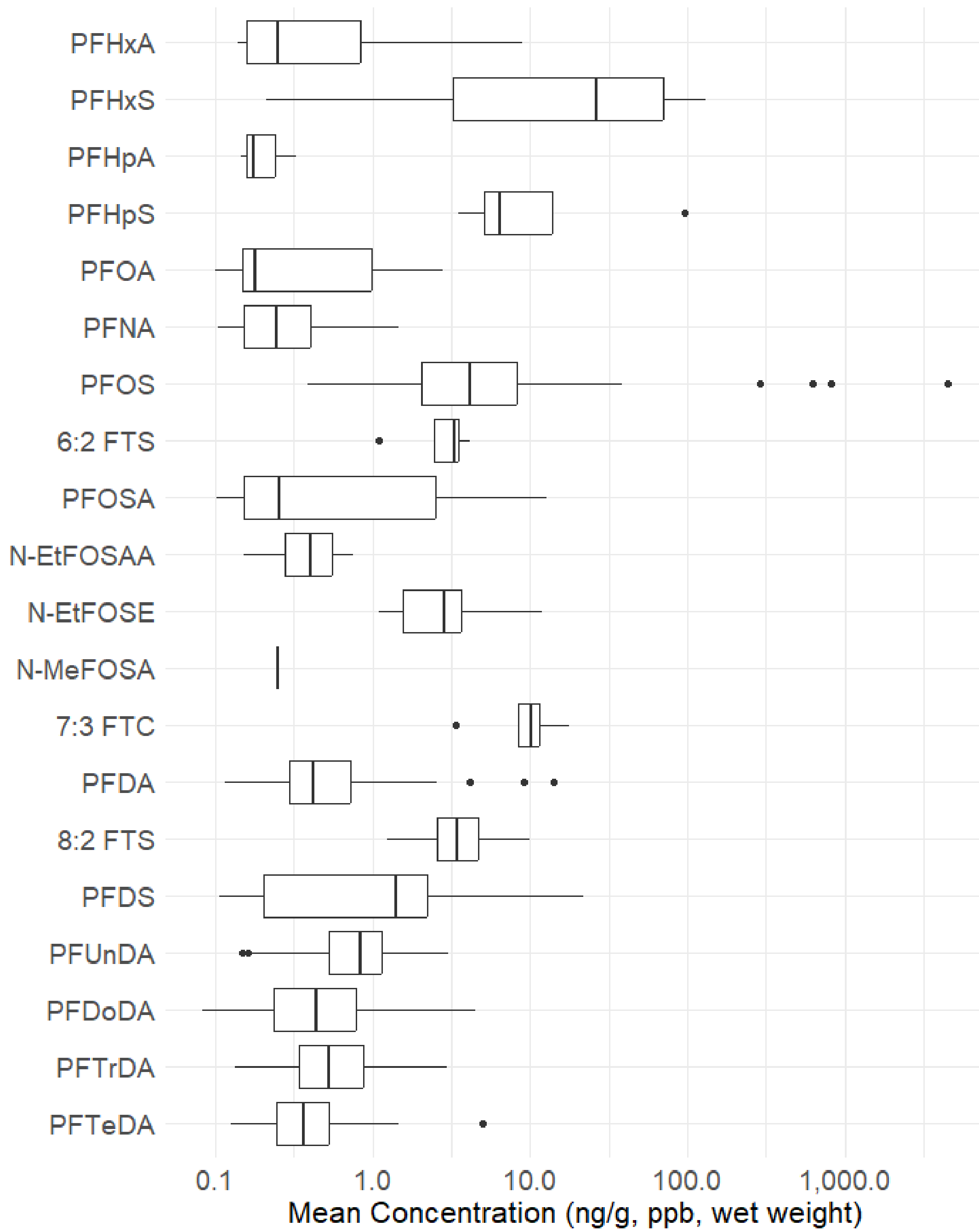


Figure 7. Box-and-whisker plots of concentrations of PFAS in 2024 skinless fillet samples (wet weight). Non-detect results were excluded. The plot includes PFAS that were detected at 5 or more sites. Note that the x-axis increases logarithmically, not linearly. *The boxes show the middle half of the data. Vertical lines inside the boxes show median values. Horizontal lines to the left and right of the boxes show the lowest quarter and highest quarter of concentrations, respectively. Points indicate unusually high or low values compared to other data.*

the FTAL. Our follow-up sampling showed that while, in some instances, the concentration of PFOS does indeed approach the FTAL, bass and perch in this lake do not appear to exceed it.

In central Maine, there was some variation in the amount of PFAS found in fish tissues (Figure 9). In Sebasticook Lake (Newport), smallmouth bass had low PFOS levels, averaging around 2 ng/g (Figure 8). However, in some surrounding waterbodies including Kenduskeag Stream (Corinth), Hermon Pond (Hermon), and West Branch Sebasticook River (Palmyra), largemouth and smallmouth bass had slightly higher levels of PFOS (Figure 9). In each of these three bodies of water samples exceeded the 3.5 ng/g FTAL but were below the 7.5 ng/g level covered for the existing mercury advisory (Figure 8).

Near Unity there were three sites that had high concentrations of PFOS: Sandy Stream (Unity), Lovejoy Pond (Albion), and Sebasticook River (Clinton) (Figure 9). PFOS concentrations from all samples in these bodies of water well exceeded the FTAL (Figure 8). This part of the state saw high levels of sludge spreading for agriculture in the past, which is likely contributing to the high levels of PFOS in fish at these sites. There are already several fish consumption advisories in this area. It is likely that the DEP will continue sampling waterbodies in this area as it is a known hotspot for PFAS contamination to inform potential additional advisories.

Field crews collected smallmouth bass and black crappie from Long Pond (Belgrade) and Great Pond (Belgrade), respectively, in the Belgrade Lakes region west of Waterville. None of the fish collected from these lakes had PFOS concentrations that exceeded the FTAL (Figure 8, Figure 9). Similarly, in mid-coast Maine, none of the brook trout, smallmouth bass, largemouth bass, or white perch had concentrations of PFOS above the FTAL. This includes samples taken from Clary (Pleasant) Lake (Jefferson), Damariscotta Lake (Jefferson), Seven Tree Pond (Union), Quiggle Brook (Union), and Stantial Brook (Brooks) (Figure 8, Figure 9).

West of Augusta, black crappie and largemouth bass from Annabessacook Lake (Monmouth) had PFOS concentrations over the 3.5 ng/g FTAL. The black crappies were especially high with an average of 17 ng/g (Figure 8). Samples of black crappie from this lake were high in 2023 as well (Figure 4, Figure 5). Other lakes in the region including Androscoggin Lake (Wayne), Maranacook Lake (Readfield), and Cobbosseecontee Lake (West Gardiner) all had PFOS levels in black crappie and bass (either largemouth or smallmouth depending on the lake) that exceeded the 3.5 ng/g FTAL (Figure 8, Figure 9). However, the levels of PFOS in fish in these lakes was less than 7.5 ng/g that is covered by the state-wide mercury advisory for those species.

The Kennebec River has a long history with contaminants and continues to be a sampling focus for the DEP. In 2024, two reaches of the river were sampled near Norridgewock and further downstream near Sidney. Near Norridgewock, samples of smallmouth bass had low levels of PFAS (Figure 9), averaging 2 ng/g (Figure 8). However, further downstream near Sidney, smallmouth bass had much higher levels of PFOS (Figure 9), averaging 12 ng/g (Figure 8). This is consistent with previous sampling that has shown elevated levels of PFOS in fish in the Kennebec River in Waterville and Augusta among other downstream reaches (Figure 11).

Sampling in the Sebago region of Maine revealed a range of PFAS contamination levels, even within a single body of water (Figure 9). For example, in Sebago Lake (Sebago) itself, landlocked salmon had average PFOS concentrations of 3 ng/g, lake trout (togue) had average PFOS concentrations of 4 ng/g, and smallmouth bass had PFOS concentrations of 7 ng/g (Figure 8). While togue and smallmouth bass exceeded the 3.5 ng/g FTAL, they were below the 7.5 ng/g needed to consider additional consumption advisories. While the landlocked salmon were below 3.5 ng/g, the fact that they were approaching it suggests that follow-up sampling may be necessary.

Nearby, Highland Lake (Bridgton) and Long Lake (Bridgton) showed variance in PFOS contamination as well (Figure 8, Figure 9). Largemouth and smallmouth bass in Highland Lake were quite low (Figure 8, Figure 9). However, in the adjacent Long Lake, smallmouth bass had slightly elevated levels of PFOS, but levels were still below the 7.5 ng/g that might trigger fish consumption advisories for bass (Figure 8, Figure 9).

Still in the Sebago region, brook trout in Collyer Brook (Gray) had high levels of PFOS (Figure 9), averaging 8 ng/g, well above the 3.5 ng/g FTAL (Figure 8). These concentrations were higher than those measured in brook trout in Collyer Brook in 2023, which were also above the FTAL (Figure 4).

In Southern Maine, there were three rivers that were sampled: the Presumpscot (Gorham), the Saco (Biddeford), and the Great Works River (North Berwick) (Figure 9). Similar to the Kennebec, the Presumpscot has a long history of contaminants including PFAS. There is already a PFAS-specific consumption advisory for fish below Saccarappa Falls. Sampling in 2024 focused upstream of the falls to determine whether that advisory needed to be extended. Samples of smallmouth bass from this upstream portion of the Presumpscot had an average PFOS concentration of 5 ng/g (Figure 8). Smallmouth bass from the Saco River (Biddeford) had an average PFOS concentration of 4 ng/g (Figure 8).

Alternatively, the Great Works River (North Berwick) still had high levels of PFOS in brook trout, averaging 15 ng/g (Figure 8, Figure 9). These levels are significantly lower than they were in 2023 (Figure 4, Figure 5) but still higher than the FTAL. The large decrease from 2023 suggests that the spike in PFOS concentrations in this river may be transient. Brook trout that were collected at this site in 2022 had 4 ng/g. It remains unclear what may have caused the large spike in the concentration of PFOS observed in this river, but AFFF is suspected due unusually high concentrations of PFHxS and 7:3 FTS, which are used in some AFFF products.

There were five sites sampled near Brunswick in response to the AFFF spill at the BEA (Table 6, Figure 9). Two of these, Mare Brook (upstream of BEA) and Androscoggin River (upstream of BEA), were used as reference sites to determine whether the spill had a measurable impact on PFAS contamination in fish near the former air station. The brook trout in Mare Brook above the former air station had detectable levels of PFOS but were below the FTAL (Figure 8). In the Androscoggin River, smallmouth bass had PFOS concentrations greater than the FTAL but below 7.5 ng/g (Figure 8). Downstream of the former air station, smallmouth bass in the Androscoggin

River had elevated levels of PFOS, averaging 8.93 ng/g across four composites taken during two sampling bouts spanning three weeks (Figure 8). Sampling began 21 days after the spill. However, these levels are lower than samples taken from this part of the Androscoggin River in 2022 and 2023 (mean = 12.82 ng/g) suggesting that the AFFF spill at BEA had no noticeable impact on fish PFOS concentrations in the Androscoggin River.

A

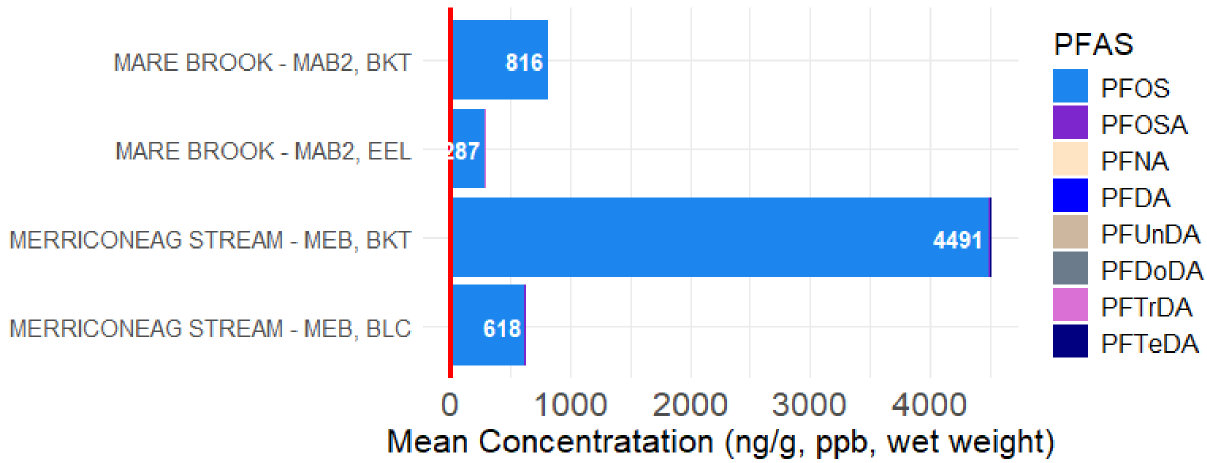


Figure 8. Average concentrations of PFOS and other most common PFAS in 2024 fish tissue samples (wet weight): A) sites with very high concentrations of PFOS, B) the rest of the sites. All samples were skinless fillets. *The white numbers are the average PFOS concentrations. The vertical red line in panel B shows the Fish Tissue Action Level (FTAL) for PFOS, which is 3.5 ng/g. The vertical red line should only be compared to PFOS concentrations. Fish Codes: BLC = black crappie, BKT = brook trout, EEL = American eel, LMB = largemouth bass, LKT = togue, LLS = landlocked Atlantic salmon, SMB = smallmouth bass, WHP = white perch*

B

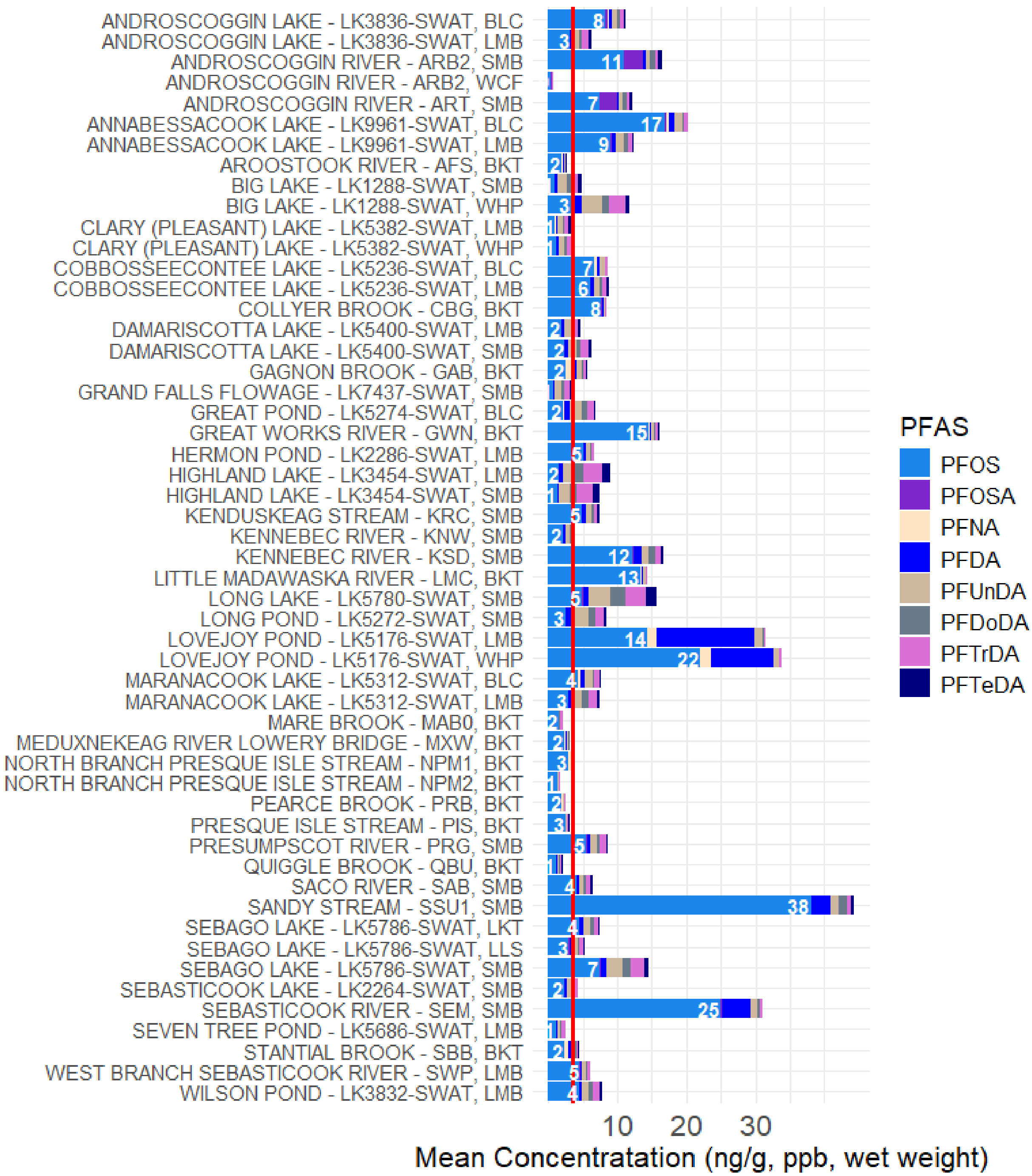


Figure 8. (Continued)

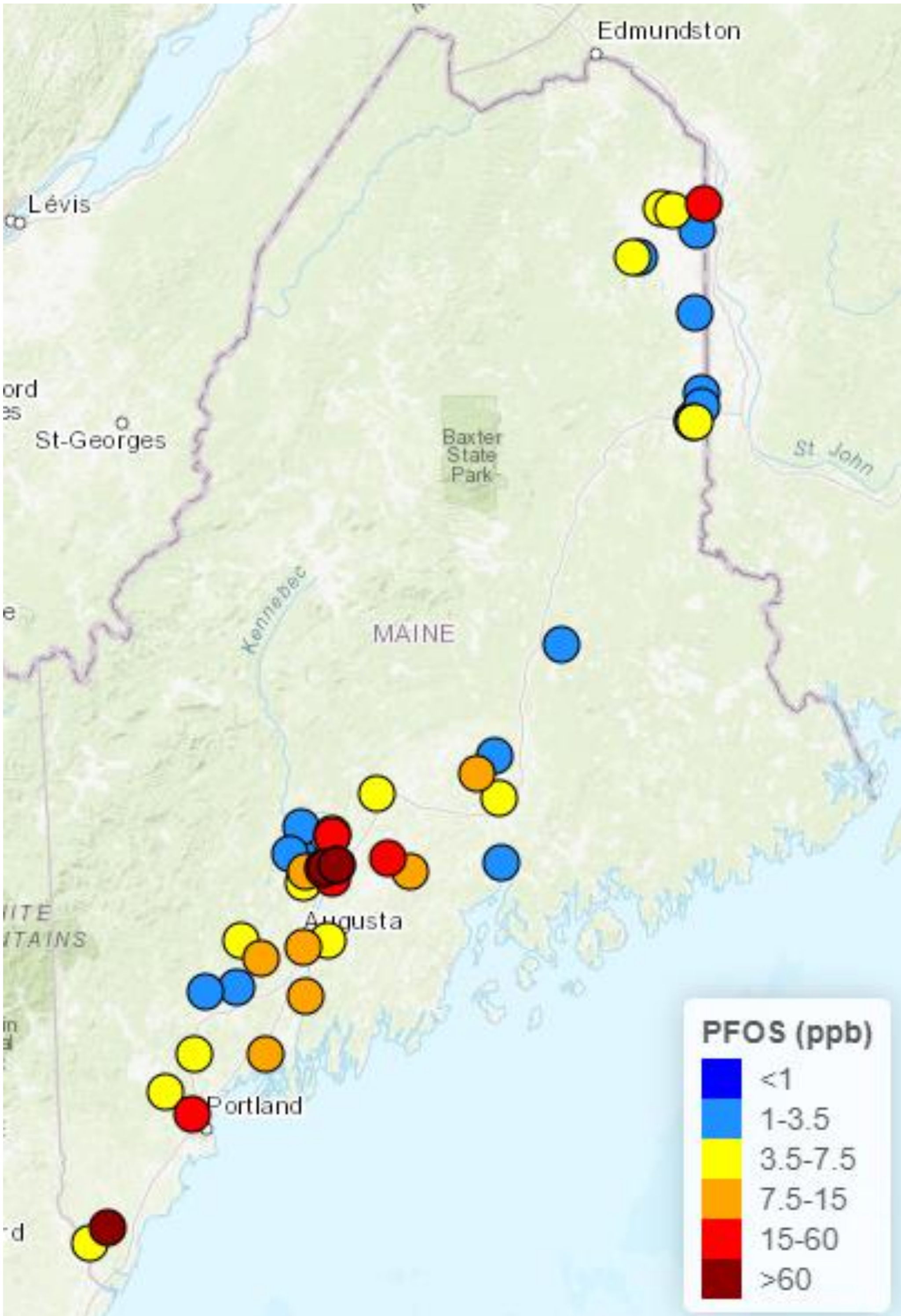


Figure 9. Map of the 43 sample sites visited in 2024. Colors represent the average PFOS concentrations (ng/g, ppb) of skinless fillets of all fish caught at each site.

Downstream of the former air station in Merriconeag Stream, field crews collected three brook trout (split into two composites, one of one fish and one of two fish) and twelve juvenile black crappie (split into four composites of three fish each) during two sampling events. The concentration of PFOS in these samples was the highest that has been recorded in any DEP fish tissue samples in Maine to this date with an average of 1,909.25 ng/g across all samples at that site (Figure 8) and a maximum of 4,687 ng/g in one of the brook trout samples. Further downstream, the Merriconeag flows into Mare Brook where additional samples of brook trout (six individuals split into two composites of three) and American eels (twelve individuals split into four composites of three) were collected (Figure 9). These fish also had high concentrations of PFOS, averaging 463.28 ng/g (Figure 8). All of the samples collected downstream of the former air station in both Mare Brook and Merriconeag Stream were well above the EPA acute and chronic PFOS water quality criteria indicating that the pollution from this spill is likely harmful to the life, growth, and/or reproduction of these fish. In August 2024, CDC issued a "do not eat" consumption advisory for Mare Brook and Merriconeag stream based on data collected by the Navy in 2023. The additional contamination from the spill reinforces the need for such an advisory.

Other commonly detected PFAS included PFDA, PFDoDA, PFTrDA, and PFDUnDA (Table 7, Figure 7). These PFAS are all carboxylic acids with more than seven fluorinated carbons. These 'long-chain' PFCAs, while commonly found, were often at low concentrations in the sampled fish tissue with the mean concentration of all these compounds being less than 1.02 ng/g. There were five other PFAS (5:3 FTC, 7:3 FTC, PFHpA, PFHxS, and PFNS) that were rarely detected (fewer than 20 detects each out of 116 samples) but were found at high concentrations (Table 7, Figure 7). Most of the samples that had these PFAS in high concentrations were collected in response to the BEA AFFF spill. While these PFAS were high in samples associated with the spill, they were still found at lower concentrations than PFOS in the same samples. One of these PFAS, 7:3 FTC has a higher minimum detection limit relative to the other PFAS. This may have biased both the number of samples in which this PFAS was detected and the overall average concentration of it.

Results: 2024 PFAS Water Samples

In total, field teams collected 68 water samples across the 43 sites visited in 2024. The only sites that were sampled repeatedly were those visited in relation to the AFFF spill at BEA. PFOS was present in nearly every water sample collected (Table 8) and at times was present in very high concentrations (Figure 10). The highest concentrations of PFOS were found in samples taken from Merriconeag Stream following the AFFF spill at BEA. Both of the water samples from this site exceeded the chronic and acute EPA water quality criteria for PFOS. Follow-up sampling next in 2025 will assess how these values change over time. While still quite high, the PFOS levels in Mare Brook did not exceed the acute EPA water quality criteria for PFOS but they did exceed the chronic criteria.

Merriconeag Stream also had the highest levels of PFOA in waters samples collected in 2024. These concentrations were likely the result of the AFFF spill at BEA. Mare Brook also had high concentrations of PFOA in the water. While high concentrations were detected in these samples, they did not exceed the acute or chronic EPA water quality criteria of PFOA.

PFOS and PFOA were not the only two commonly found PFAS in water samples in 2024. Other PFAS such as PFBA, PFBS, PFHpA, and PFPeS were also commonly detected. However, these PFAS tended to be found at lower concentrations with the exception of samples related to the AFFF spill at BEA. Two PFAS, 6:2 FTS and PFHpS, were rarely found but tended to be at high concentrations when present. Again, this was largely driven by high concentrations of these PFAS in samples taken in response to the AFFF spill at BEA.

Table 8. Summary statistics of PFAS in water samples collected in 2024 (n = 68)

PFAS[1]	Min.	1st quartile	Median	Mean	3rd quartile	Max.	# of detects	# of non-detects
6:2 FTS	2.29	17.4275	622.5	2552.5	2552.5	7360	8	60
8:2 FTS	1.17	1.17	1.17	1.17	1.17	1.17	1	67
ADONA	1.13	1.13	1.13	1.13	1.13	1.13	1	67
N-EtFOSAA	0.916	1.2	2.15	2.85	2.85	6.56	13	55
PFBA	0.524	1.115	1.565	2.9825	2.9825	484	60	8
PFBS	0.238	0.4355	0.591	1.105	1.105	2460	47	21
PFDA	0.351	0.499	0.9165	2.365	2.365	4.85	8	60
PFDoDA	0.437	0.437	0.437	0.437	0.437	0.437	1	67
PFHpA	0.449	0.65825	0.7615	1.87	1.87	440	68	0
PFHpS	113	116	193	370.75	370.75	676	4	64
PFHxA	0.405	0.71	0.866	1.6225	1.6225	1990	68	0
PFHxS	0.375	0.4265	0.975	1.3525	1.3525	8210	22	46
PFNA	0.3	0.5195	0.613	0.9425	0.9425	30.8	39	29
PFOA	0.49	1.0625	1.325	2.635	2.635	1560	68	0
PFOS	0.446	1.2375	1.72	3.0225	3.0225	39300	64	4
PFOSA	0.618	0.618	0.618	0.618	0.618	0.618	1	67
PFPeA	0.394	0.7295	0.955	3.405	3.405	816	50	18
PFPeS	333	380.25	537	1066	1066	2230	4	64
PFTeDA	0.236	0.236	0.236	0.236	0.236	0.236	1	67
PFTrDA	0.426	0.426	0.426	0.426	0.426	0.426	1	67
PFUnDA	0.33	0.33025	0.3305	0.33075	0.33075	0.331	2	66

1 – The following 21 PFAS were not detected in any of the 68 water samples collected in 2024: PFODA, PFHxDA, 9CL-PF3ONS, PFMBA, N-MeFOSAA, PFDOS, 11CL-PF3OUDS, 7:3 FTC, HFPO-DA, 3:3 FTC, N-MeFOSE, PFDH, PFNS, N-MeFOSA, 5:3 FTC, 4:2 FTS, PFEES, N-EtFOSA, PFDS, PFMP, N-EtFOSE.

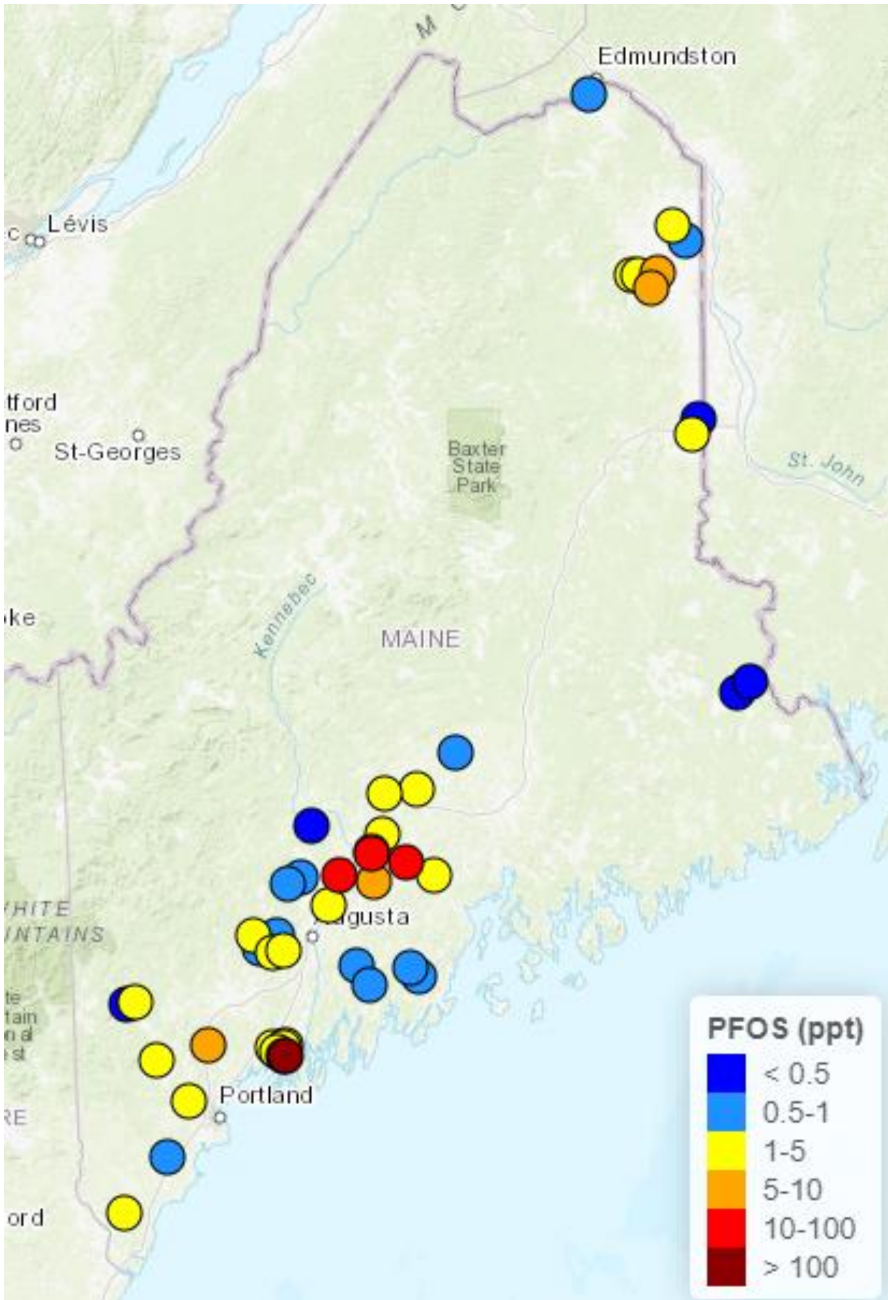


Figure 10. Map of PFAS water samples collected in 2024. Colors represent the average PFOS concentration (ng/L, ppt) in water samples from each site.

2.4 Overview of PFAS in Fish Samples (2014-2024) and Water Samples (2021-2024)

Statewide, most sites with average PFOS concentrations greater than 3.5 ng/g in fish tissue are located in densely populated areas of the state, agricultural areas, or near point sources of contamination, such as airports, landfills, and industries. In contrast, most sites in rural, forested parts of the state had low concentrations of PFOS in fish tissue. Since 2014, PFOS has been found at detectable levels in 598 of the 612 composite samples field crews have collected. This means that there were only 14 samples of fish that did not have detectable levels of PFOS.

Since 2014, 37 samples of fish across 7 different sites have exceeded the EPA aquatic life criteria for PFOS in fish tissue. Over half of these samples were stocked brook trout taken from the Fairfield PAL ponds. Another third of the samples exceeding the EPA criteria were collected in response to the AFFF spill at BEA. The remaining samples exceeding the criteria were collected in Great Works River (North Berwick), Fish Brook (Fairfield), and an unnamed tributary of Fish Brook (Fairfield). These remaining sites are likely associated with nonpoint source pollution such as biosolid sludge in agricultural settings, but further investigation will be required to determine the cause of these high PFOS concentrations with a high degree of certainty.

The sum of the data suggests that PFOS is present in fish throughout the state, even in remote areas. However, the concentrations can often be low and, according to CDC guidelines, may not be harmful to human health. Thus far, CDC has used the data collected by the DEP to issue 21 PFAS-specific fish consumption advisories. These advisories range from limiting the total number of fish meals from a specific body of water to outright 'do not eat'.

PFOS concentrations in surface water samples vary across the state (Figure 12). However, like the fish tissue samples, the highest concentrations are typically found in areas of high population density, agricultural areas, or near point sources of pollution. Indeed, the sites where there are high levels of PFOS in fish tissue also have high levels of PFOS in surface water samples (Figure 12). This is not surprising as higher levels of PFOS in the water will lead to higher levels of PFOS in fish. Fish will absorb PFOS directly from the water across their gills and through consumption of other contaminated organisms (e.g., other fish, aquatic macroinvertebrates, etc.). However, the relative importance of these two pathways to the overall PFOS contamination in fish remains unclear.

There are only a small number of sites where any of the recommended EPA aquatic life criteria for PFOS in water were exceeded. These include Merriconeag Stream, Mare Brook, and both Fairfield PAL ponds. These sites have the highest PFAS pollution of any that have been sampled in the state to date. However, in general, most PFAS are not found at high concentrations in the water, especially compared to the concentrations found in fish. This discrepancy can be explained by a process known as bioaccumulation. Bioaccumulation occurs because organisms absorb and retain contaminants at higher rates than they excrete them.

PFAS commonly found in water samples tend to be short-chain PFAS, having seven or fewer carbons in the hydrophobic tail. This contrasts with fish tissue samples where longer-chain PFAS are more common. This is a well understood phenomenon and is commonly observed in PFAS studies. Large PFAS molecules (i.e., long chain PFAS) are more energetically costly for organisms to export out of their body and are therefore more likely to remain in tissues leading to higher rates of bioaccumulation of these compounds.

In 2022 the Maine Department of Inland Fish and Wildlife collected 85 samples spanning 33 lakes to sample for PFAS. These data were shared with DEP in 2024 and are included in Figure 11. Many of these samples came from remote lakes and rivers in areas that were under-sampled by DEP. As with DEP samples, PFOS was always the PFAS found at the highest concentrations. Overall, only nine of these samples spanning 5 waterbodies exceeded the FTAL for PFOS. Several of these sites including Big Lake, Great Pond, and Hermon Pond had already been sampled by DEP or were sampled by DEP since the 2022 IFW samples. CDC may consider issuing consumption advisories for some of these lakes based on this data. The remaining two lakes sampled by IFW, Webber Pond and Threemile Pond, will likely need additional data.

At some sites, there appears to be single pathways of contamination. For example, the likely pathway of contamination to waterbodies near the former Loring Air Force Base (Little Madawaska River, Limestone Stream, and Durepo Pond) appears to be historic use of AFFF. Past application of residual biosolids from wastewater treatment plants on farm fields appears to be the likely pathway of contamination for some waterbodies in agricultural parts of the state, such as Fifteenmile Stream (Albion), Fish Brook (Fairfield), Halfmoon Stream (Thorndike), Messalonskee Stream (Waterville), and Unity Pond (Unity). In other cases, there are multiple potential pathways of contamination, and it is difficult to determine the primary PFAS source(s). For example, the Mousam River and Estes Lake (Sanford) have a nearby urban area, landfill, airport, and wastewater treatment plant.

In areas far from obvious contamination sources where PFAS are still detected, less conventional pathways may be at work. For example, atmospheric deposition of aerosolized PFAS may explain detections in remote areas such as the Moose River or Aziscohos Lake in the Boundary Mountains in Western Maine. Septic systems for houses and camps could be a source of PFAS. Future sampling focused on these remote parts of the state may help further reveal patterns in PFOS contamination and assist in determining the sources of this widespread pollutant.

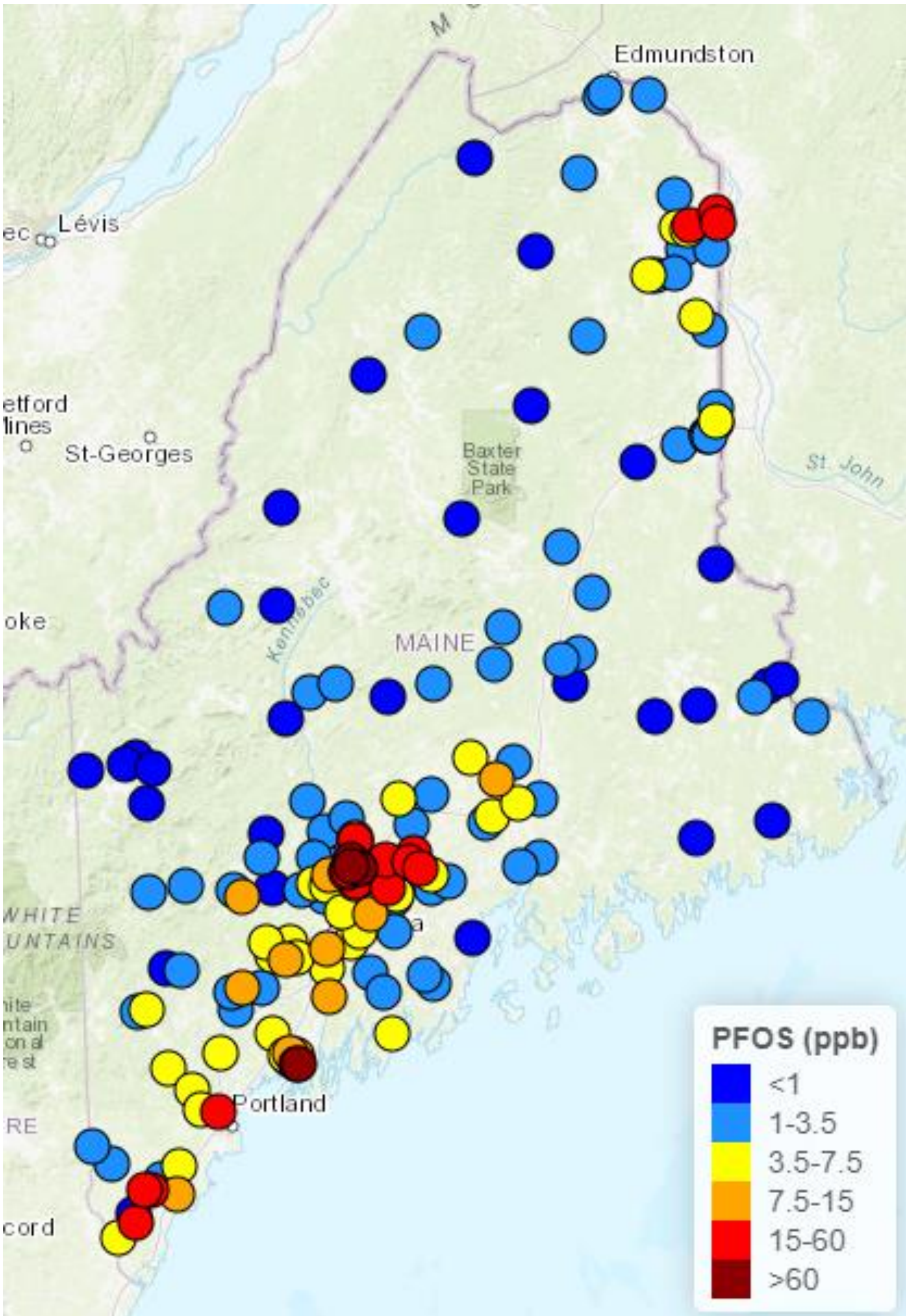


Figure 11. Map of all sample sites from 2014 to 2024. Point colors represent the average PFOS concentrations (ng/g, ppb) of skinless fillets of all fish caught at each site.

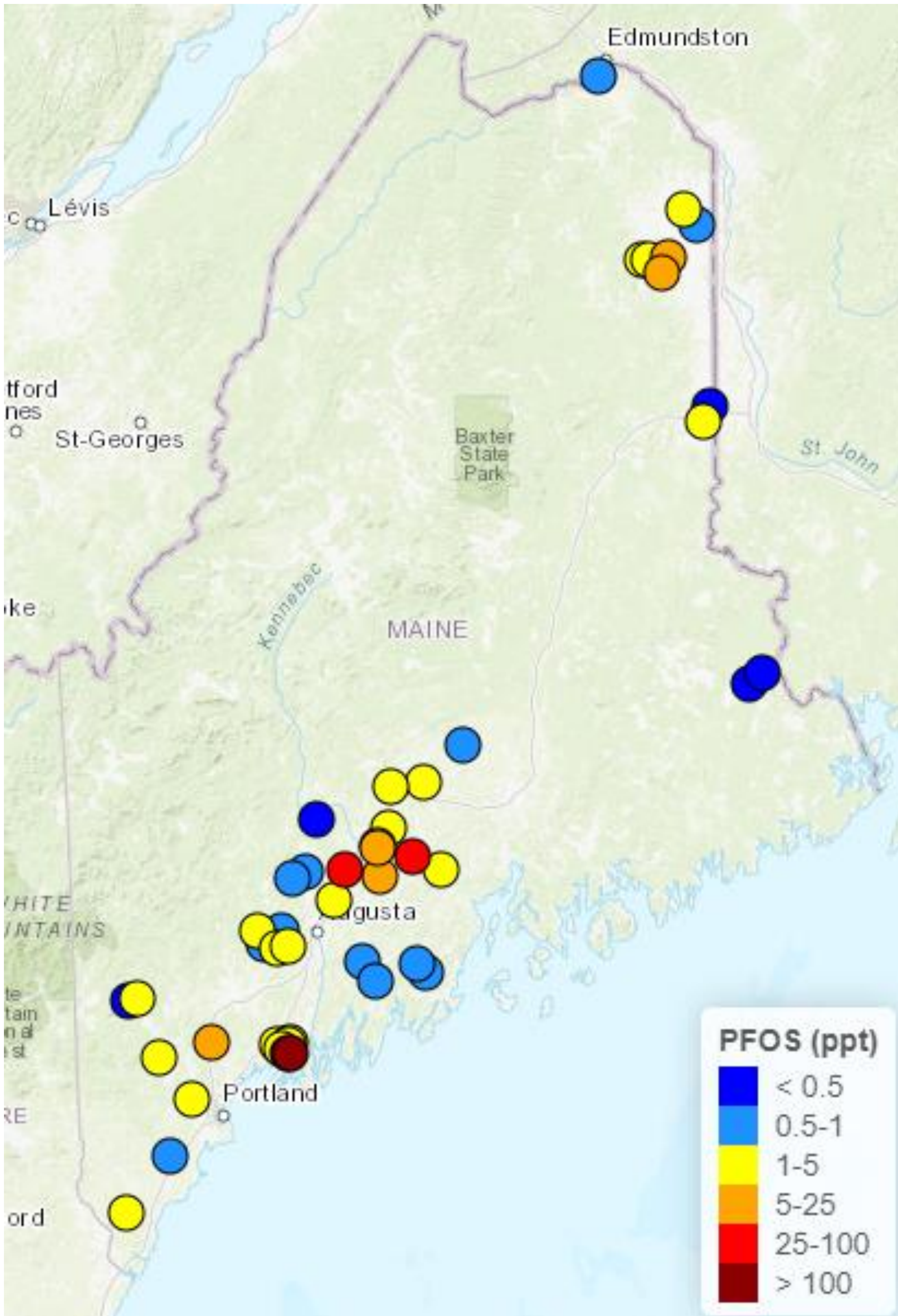


Figure 12. Map of all sites where water samples have been collected from 2021-2024. Colors indicate the average PFOS concentration (ng/L, ppt) in water samples collected at each site.

2.5 DDT in 2023 Fish Samples

Several rivers in Maine have fish consumption advisories because of high concentrations of the pesticide DDT. A small amount of federal grant money from EPA provided funds to analyze DDT in skinless fillets along with PFAS from trout collected from Meduxnekeag River, North Branch Presque Isle Stream, and Prestile Stream (Table 9). SGS AXYS analyzed the samples with Method MLA-007-E1. CDC bases fish consumption advisories on the sum of 6 forms of DDT and products of DDT degradation (∑DDT):

- 2,4' DDT and 4,4' DDT
- 2,4' DDD and 4,4' DDD
- 2,4' DDE and 4,4' DDE.

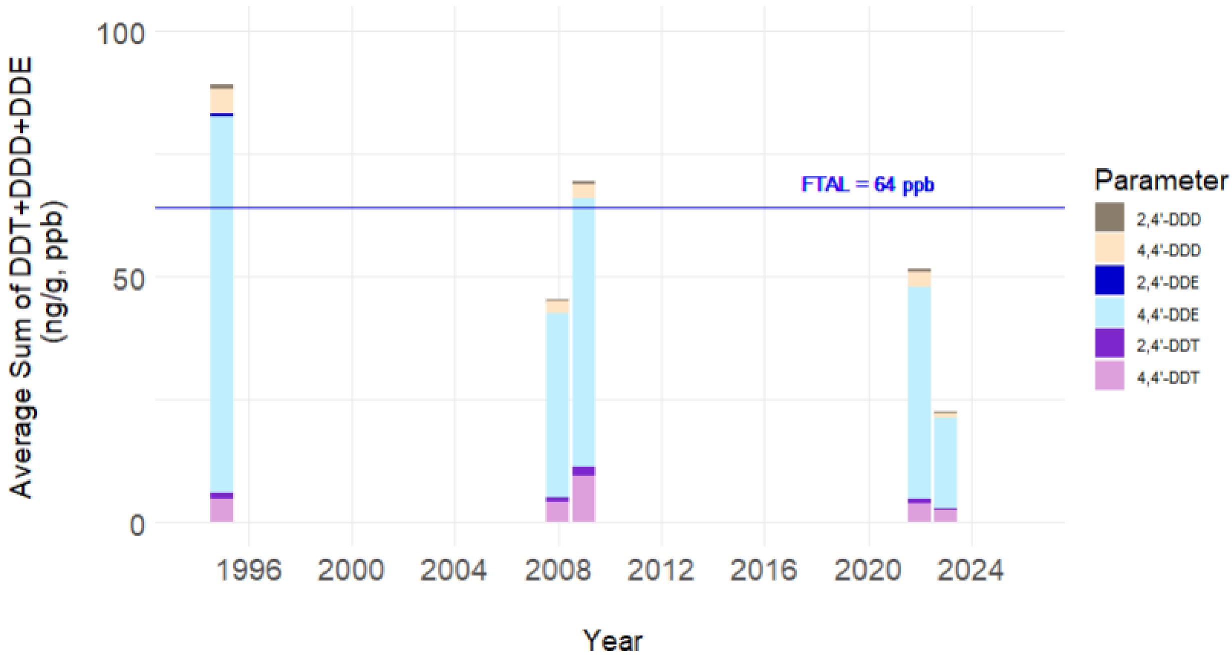
Table 9. DDT samples collected in 2023 and 2024

Waterbody	Town	Year	Species	Number of composite samples (5 fish each)
Meduxnekeag River	Houlton	2023	Brook Trout	2
North Branch Presque Isle Stream (upstream of treatment plant)	Mapleton	2023	Brook Trout	2
North Branch Presque Isle Stream (upstream of treatment plant)	Mapleton	2024	Brook Trout	2
North Branch Presque Isle Stream (downstream of treatment plant)	Mapleton	2023	Brook Trout	2
North Branch Presque Isle Stream (downstream of treatment plant)	Mapleton	2024	Brook Trout	2
Prestile Stream	Mars Hill	2023	Brook Trout	2

The FTAL for ∑DDT is 64 ng/g. SGS Axys analyzed the ∑DDT and individual components and reported results in ng/g (ppb, wet weight). Concentrations of ∑DDT were compared to the FTAL and past samples. The Meduxnekeag River was previously sampled for ∑DDT in 1995, 2008, 2009, and 2022. The Prestile Stream was previously sampled for ∑DDT in 1996, 2000, 2007, and 2022. Samples were previously collected in the North Branch Presque Isle Stream in 1996, 2000, and 2007.

In 2023, the average concentration of ∑DDT in the Meduxnekeag River was 49.5 ng/g compared to 89.2 ng/g in 1995 (Figure 13). The concentration of ∑DDT was lowest in 2008 (45.5 ng/g), but

A



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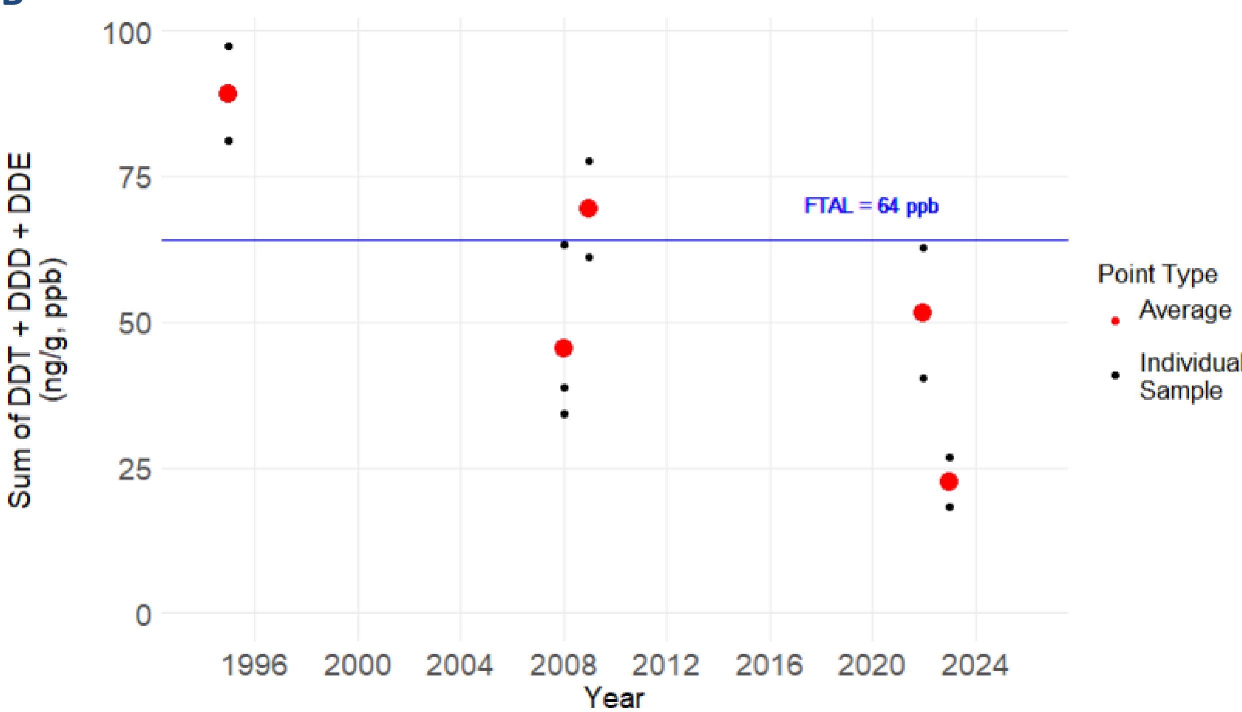


Figure 13. DDT in fish collected from the Meduxnekeag River (skinless fillets, wet weight).
A) stacked bar plot of showing the average concentrations of the 6 forms of DDT,
B) Sum of DDT+DDD+DDE showing individual samples and yearly averages.

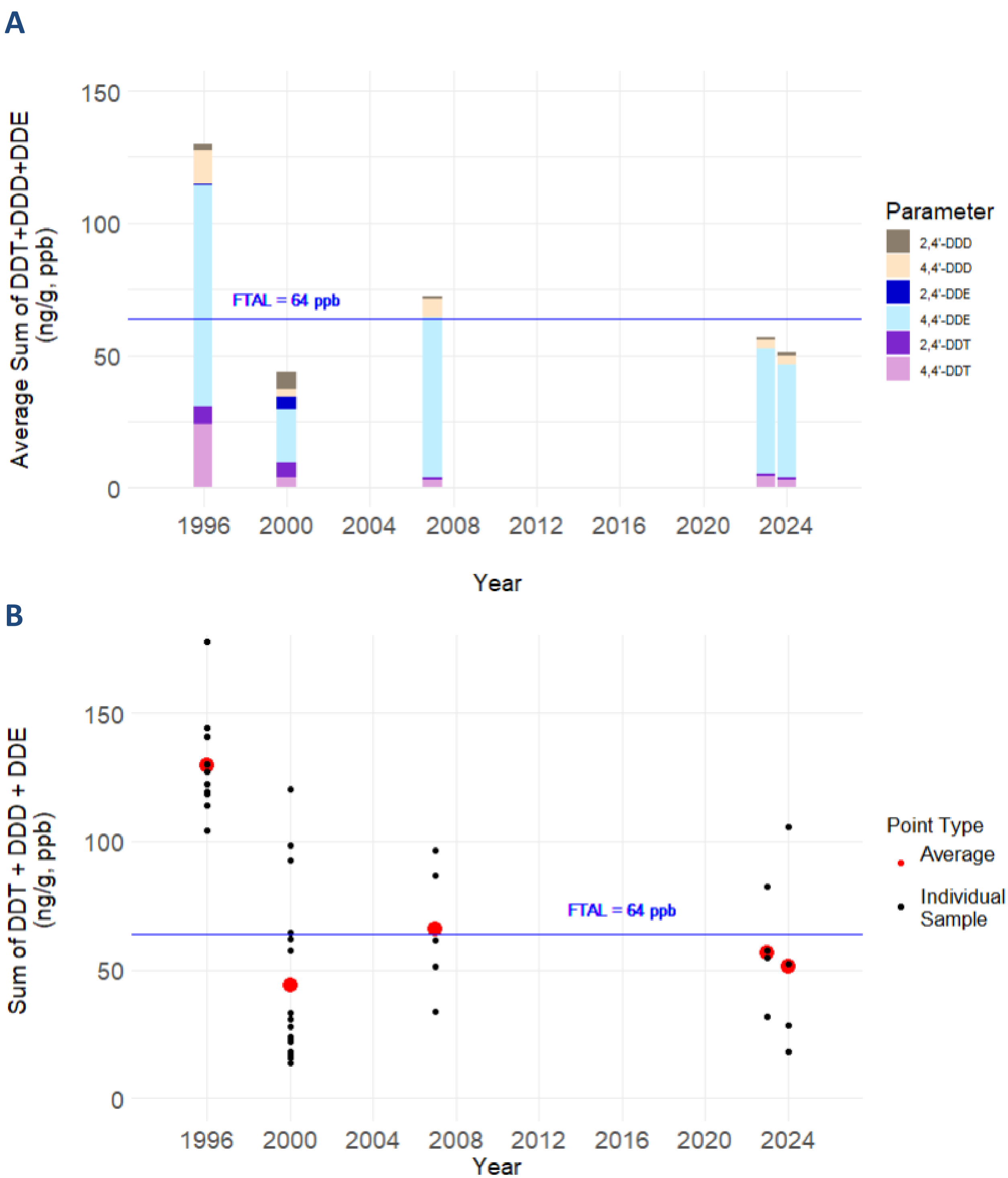
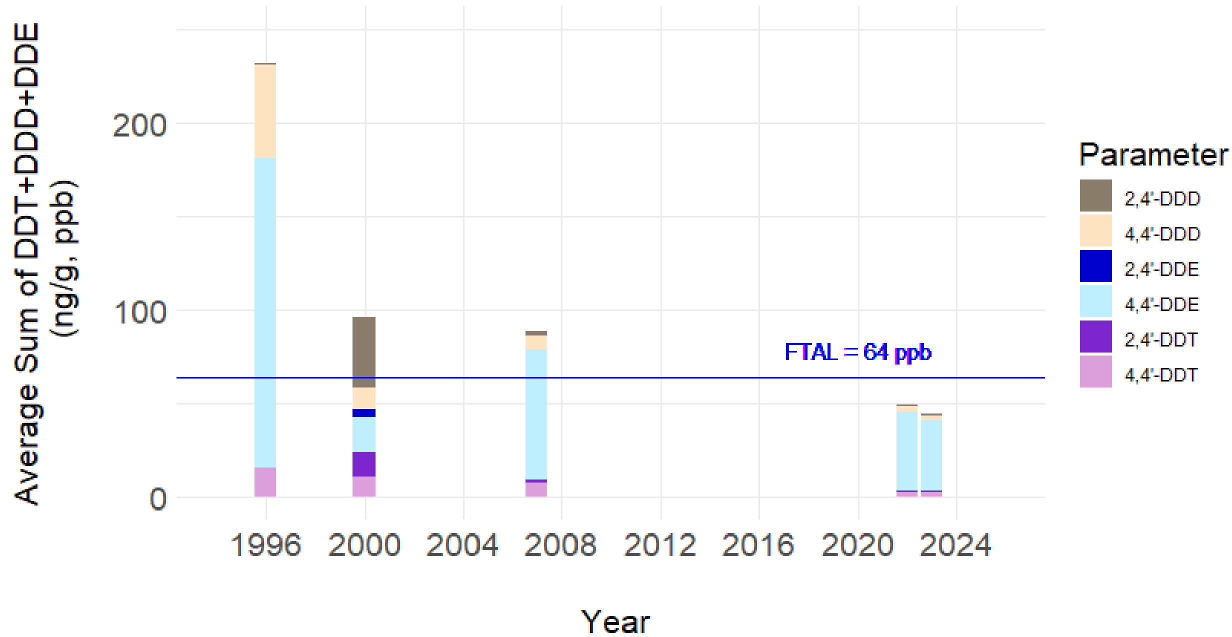


Figure 14. DDT in fish collected from the North Branch Presque Isle Stream (skinless fillets, wet weight). A) stacked bar plot of showing the average concentrations of the 6 forms of DDT, B) Sum of DDT+DDD+DDE showing individual samples and yearly averages.

A



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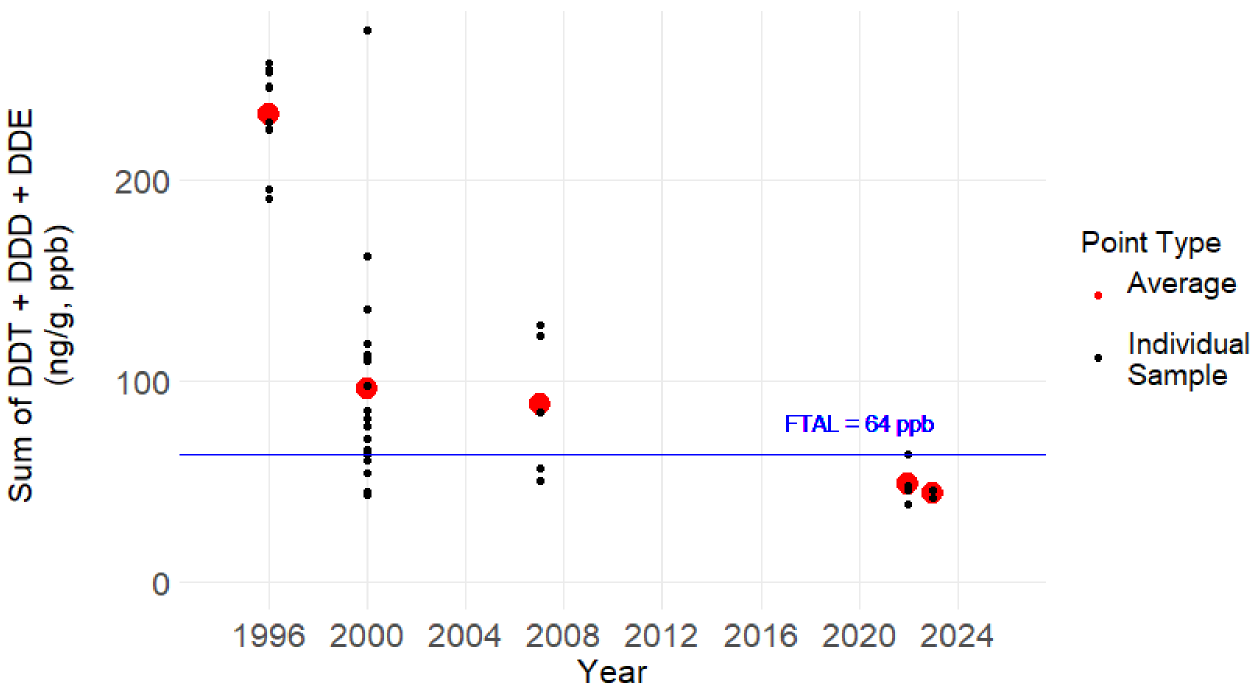

Figure 15. DDT in fish collected from the Prestile Stream (skinless fillets, wet weight). A) stacked bar plot of showing the average concentrations of the 6 forms of DDT, B) Sum of DDT+DDD+DDE showing individual samples and yearly averages.

sampling the following year had higher concentrations (69.3 ng/g). Similar to the Meduxnekeag River, Prestile Stream had the highest concentration of ∑DDT in 1996 (232.3 ng/g) and lowest concentration in 2023 (43.7 ng/g) (Figure 14). It should be pointed out that samples collected before 2022 were analyzed as individual fish. North Branch Presque Isle Stream had the highest ∑DDT in 1996 (129 ng/g) and lowest concentration in 2023 (51.1 ng/g) (Figure 15). Most of the ∑DDT consists of DDT biproducts, particularly 4,4'-DDE.

2.6 PCBs in 2023 and 2024 Fish Samples

Polychlorinated biphenyls (PCBs) are highly carcinogenic chemicals that were formerly used in various industrial and consumer products. Although PCBs were banned in the United States in 1979, several rivers in Maine have fish consumption advisories for total PCBs. The fish tissue action level (FTAL) for Total PCBs is 11 ng/g wet weight (ppb). In 2023 and 2024, fish were collected from the Androscoggin River, Kennebec River, Little Madawaska River, and Presumpscot River (Table 10). SGS AXYS analyzed the fish samples using EPA Method 1668A, SGS AXYS Method MLA-010. Concentrations of total PCBs in smallmouth bass collected in the Kennebec River (Augusta) decreased from 604 ng/g in 1994 to 39 ng/g in 2023 (Figure 16). Looking at Kennebec River samples over the past 4 years, all samples collected from locations upstream of Augusta had average concentrations of total PCBs less than the fish tissue action level (FTAL) of 11 ng/g. In contrast, all smallmouth bass samples collected from the Kennebec River in Augusta and further downstream had total PCB concentrations that exceeded the 11 ng/g FTAL. Total PCBs also exceeded the 11 ng/g FTAL in the Androscoggin River, Little Madawaska, and Presumpscot River (Table 10). Concentrations of total PCBs in the Androscoggin River have decreased over time, but is still well above the 11 ng/g FTAL in Brunswick (Figure 17). Concentrations of total PCBs in smallmouth bass collected from the Presumpscot River in Gorham have decreased from a high of 109 ng/g in 2010 to 12 ng/g in 2024 (Figure 18).

W

Table 10. Concentration of Total PCBs in fish samples collected in 2023 and 2024

River	Town	Year	Fish Species (# of fish)	Average Total PCBs (ng/g)
Androscoggin River	Brunswick	2023	Smallmouth Bass (10)	29
Kennebec River	Norridgewock	2024	Smallmouth Bass (10)	2
Kennebec River	Sidney	2024	Smallmouth Bass (10)	8
Kennebec River	Augusta	2023	Smallmouth Bass (10)	39
Kennebec River	Richmond	2023	Smallmouth Bass (10)	25
Little Madawaska River	Caribou	2024	Brook Trout (10)	58
Presumpscot River	Gorham	2024	Smallmouth Bass (10)	12

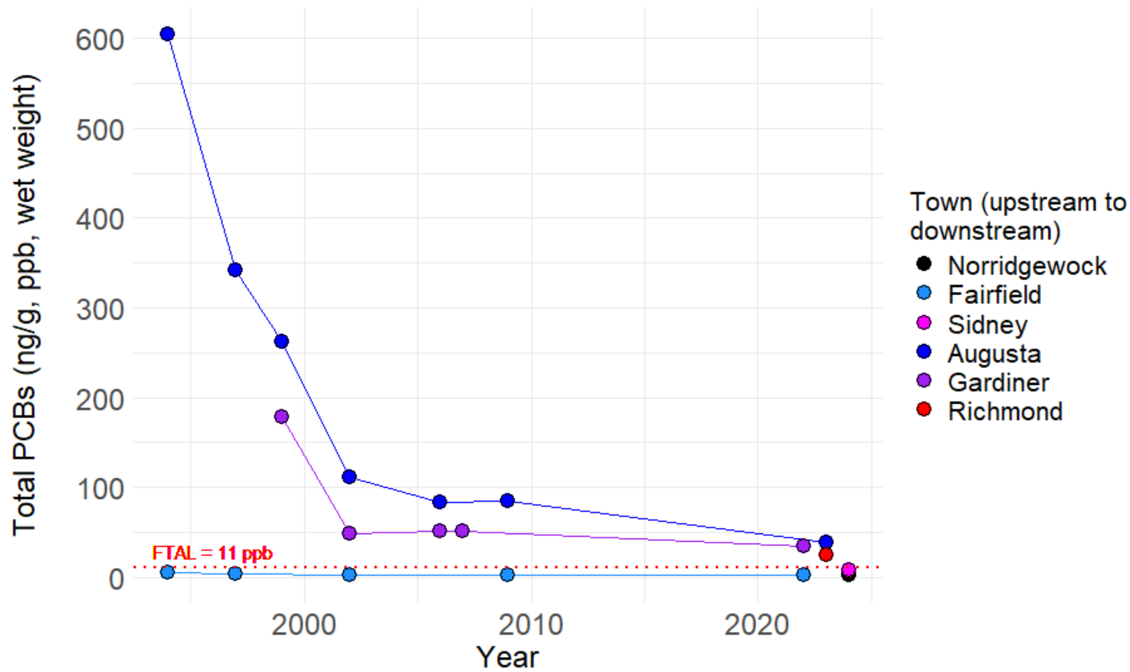

Figure 16. Mean total PCB concentrations in smallmouth bass collected from the Kennebec River (1994-2024)

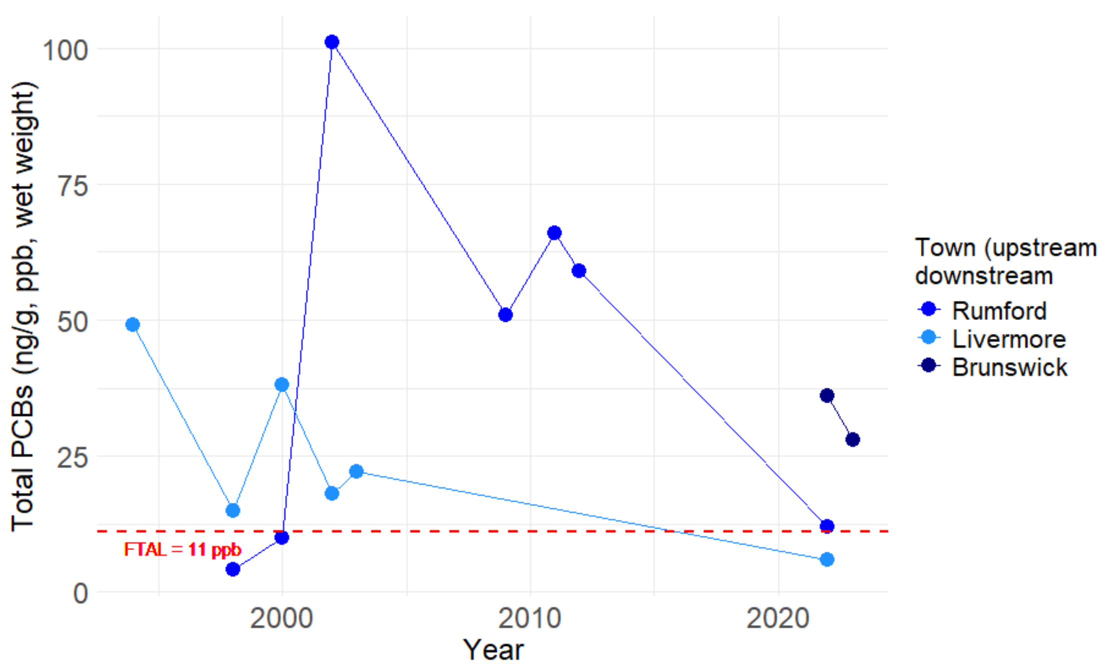

Figure 17. Mean total PCB concentrations in smallmouth bass collected from the Androscoggin River (1994-2023)

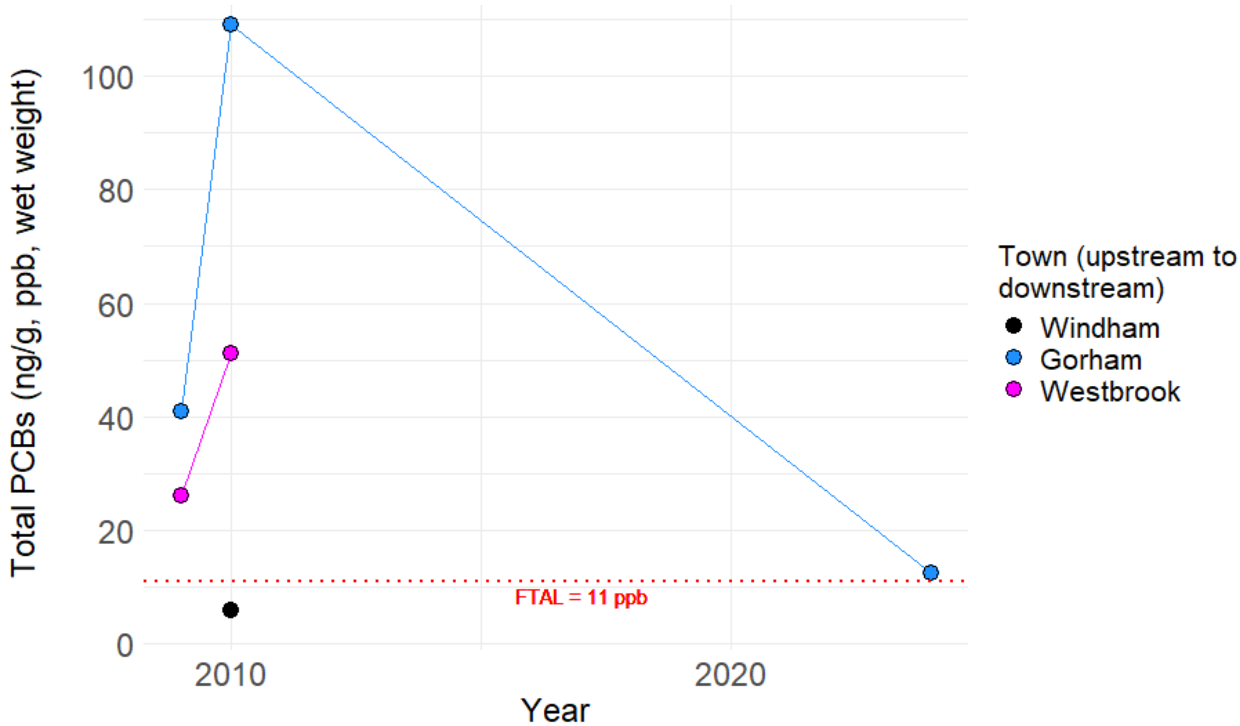

Figure 18. Mean total PCB concentrations in smallmouth bass collected from the Presumpscot River (2009-2024)

2.8 References

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3. Cyanotoxins in Lakes

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3.1 Introduction
3.2 Results

3.1 Introduction

Harmful Algae Blooms (HABs), dominated by species of cyanobacteria (i.e., blue-green algae) genetically capable of producing toxins, continue to be a problem in for lakes in the United States and Maine. HABs can produce hepatotoxic, neurotoxic and acutely dermatotoxic cyanotoxins such as microcystins, cylindrospermopsins, anatoxins, and saxitoxins among others. Maine has several lakes and ponds that have experienced algal blooms for decades. There were two toxic events involving the death of cattle in the 1960s in a hypereutrophic system (per Matt Scott, personal communication) prior to enactment of the Clean Water Act, and a few dog deaths for which HABs were suspected but unconfirmed, that may have been attributable to other causes (e.g., THC in edibles, water intoxication, leptospirosis). Nevertheless, there is a growing concern in Maine about the potential for HABs as lake temperatures reach new highs due to extended growing seasons and warmer air temperatures, coupled with an increase in frequency of intense-storms, which deliver nutrient-rich stormwater to lakes.

Health Advisory Levels. In 1998, the World Health Organization (WHO) established the following advisory levels for cyanotoxins, which were used in Maine until 2015 [Drinking water: 1 µg/L; Low-risk recreation: 10 µg/L (‘*low-risk’ refers to irritation or allergic reactions, not toxicity*)].
In early May of 2015, EPA released 10-day *drinking water* health advisory levels for two populations [Bottle-fed infants and pre-school children: > 0.3 µg/L; School-age children and adults: > 1.6 µg/L]. In May of 2019, EPA released *swimming* advisory levels which were finalized in July of 2021 [8 µg/L is not to be exceeded on any day]. Because children spend more time in the water and ingest more water per body weight while recreating, conservative criteria were derived based on children’s recreational exposures.

In mid-March of 2021, the WHO released their second edition of ***Toxic Cyanobacteria in Water*** (859 pages), which is available for download at https://www.who.int/publications/m/item/toxic-cyanobacteria-in-water---second-edition. This edition presents microcystin-LR ingestion guidelines in terms of exposure duration, which are shown in Table 1 and are higher than their previous guidelines as well as current EPA Health Advisory guidelines.

Table 1. WHO 2021 microcystin-LR Provisional Guideline Values

Exposure Duration	Exposure Category	Exposure Level
Chronic (long-term) term	Lifetime Guideline Value	0.96 µg/L (~1 µg/L)
	Tolerable Daily Intake	0.04 µg/kg/day
Short-term	Drinking Water Guideline Value	12 µg/L
	Recreation Guideline Value	24 µg/L

Historical Studies and Actions in Maine. Over the last decade, samples for microcystin analysis have been collected from Maine lakes using a probability-based approach and a targeted approach. Lakes greater than 150 acres in populated areas of the state were targeted for the probability monitoring (2014 – 2019). Approximately 22 lakes were randomly selected each year, and in 2020, lakes having the highest concentrations of microcystin were revisited. In addition, lakes with a history of algal blooms were targeted for time-series monitoring during the same period, and lakes with reported blooms were sampled opportunistically from 2014-2024. Results from 2014 - 2019 indicated that relatively few probability-draw lakes had elevated microcystin, and as expected, targeted lakes had elevated concentrations. Lakes that had elevated microcystin were primarily located in Kennebec County or areas immediately adjacent. Most lakes that produced actual algal scums had microcystin concentrations in those scums that greatly exceeded EPA health advisory levels. (Refer to the 2021-2022 SWAT report submitted April 2023 for details.)

In 2019 DEP invested in an Abraxis Strip Reader to obtain timely cyanotoxin results. According to EPA Region 1, these results are comparable to results obtained using ELISA test plates. Rapid tests using the GoldStandard/Abraxis test strips for Microcystin and Anatoxin have been used on numerous lake water samples submitted by community members. Note that EPA advisory levels have yet to be established for anatoxin, but the association of that toxin with dog deaths motivated the Department to conduct screening for it. Scum samples from Webber Pond tested above the drinking water advisory levels for both toxins, and a few other lake samples have indicated that microcystin is present, but rarely above the advisory levels. The strips may be costly, but having near real-time results is important.

Over the last four years, staff have focused on obtaining samples from lakes known to support algal blooms and lakes for which bloom conditions have been reported. In addition to collecting samples for 'in-house' analyses, staff have collected and submitted samples to the EPA Region 1 lab for analysis under their BloomWatch project. The 'in-house' analyses of frozen samples has been on hold for two reasons: the move of the Health and Environmental Testing lab to their newly renovated building, where we conduct the analyses, and, one staff member's parental leave. EPA BloomWatch results from 2020 - 2023 are shared in Section 3.2, below; 2024 results have yet to be received.

3.2 Results

The summers of 2023 and 2024 brought weather atypical of the last few decades. After 3.5 years of drought conditions and hot summers, 2023 brought lower air temperatures, more cloud cover, strong winds, and toward the end, much needed heavy rain. Rains continued into the spring of 2024, bringing the state out of its 3+ year drought period. The summer of 2024 started out cool and wet until about August, which saw less rain and warmer weather. As a result, fewer lakes experienced prolonged, severe blooms.

A total of 100 samples were submitted to EPA Region I under their BloomWatch Program from 2020 - 2023. Seventy-nine were obtained from 33 lakes that were either blooming per Maine's standards (Secchi Transparency of less than 2 meters) or have a history of algal blooms. Twenty-one samples were obtained from algal scums from the shore of 15 lakes. The results from these samples were received over the past year. In 2024, approximately 30 sets of samples were submitted, but these results have not yet been released. Table 1 summarizes results received thus far.

Table 1 includes results for microcystin (MC) from all sample years, as well as results for anatoxin, saxitoxin, BMAA and cylindrospermopsin for a subset of those years. The microcystin analytical method developed by EPA likely provides more accurate data than the screening that has been conducted within the department. For example, EPA methods require that samples be submitted in glass containers in which samples are frozen. This reduces the possibility of toxins being adsorped to the inner surfaces of plastic containers, which the Department has been using for its method. Thus, DEP's method may have produced slightly lower results than the EPA method. The drawback of using glass containers that are frozen is that some percentage of those containers crack, and the sample is lost.

Microcystin results from 79 open water samples, ranged from non-detect to 16.5 ug/L. The median of these results is below EPA's drinking water health advisory concentration for infants and non-school-age children; the average also exceeds this level yet is still below EPA's drinking water health advisory concentration for school-age children and adults. The maximum exceeds both drinking water and recreation health advisory concentrations issued by EPA. As expected, samples obtained from algal scums along the shoreline had much higher concentrations of microcystin. Surprisingly, 15 of the 21 lakes samples had concentrations less than the most restrictive drinking water health advisory, however, the maximum of 426 ug/L is well above all advisory levels and underscores the need to inform the public to avoid scums. Exceedances are highlighted in yellow in Table 1. The lake that produced the highest concentrations of microcystin in both open water and scum samples was Sabattus Pond. Figure 1 illustrates the distribution of microcystin concentrations in open water sample and scum samples; EPA health advisory criteria levels are indicated with colored arrows.

Although the number of samples analyzed for cylindrospermopsin was very low, the results are well below the strictest drinking water standard issued by EPA (0.7 ug/L for infants and non-school-age children). It is a little surprising that the scum samples were less than samples taken from open water, although the low sample size is likely introducing sampling or selection bias. Anatoxin and saxitoxin results from both open water and scum samples are below WHO guidelines. No guidelines exist for BMAA.

Table 1. Cyanotoxin results received from EPA's BloomWatch submissions from 2020 – 2023.

		MC (ug/L)	Anatoxin (ug/L)	Saxitoxin (ug/L)	BMAA (ug/L)	Cylindrosperm-opsin (ug/L)
Open Water:	**min**	0	0	0	0	0
(33 lks)	**median**	0.284	0.02	0.01	4.8	0.004
	average	0.84996	0.05	0.04	5.06	0.008
	max	16.5	0.22	0.407	15.5	0.02
	n	*79*	*38*	*29*	*28*	*8*
Scums:	**min**	0	0	0	0	0
(15 lks)	**median**	0.2495	0.07	0.01	1.06	0.001
	average	22.8561	0.17	0.02	2.77	0.001
	max	426	1.7	0.06	9.35	0.002
	n	*21*	*17*	*11*	*11*	*4*

WHO provisional short-term drinking-water health-based reference value for Anatoxin: 30 ug/L
WHO provisional recreational water health-based reference value for Anatoxin: 60 ug/L
WHO acute guideline value for Saxitoxins: 3 ug/L

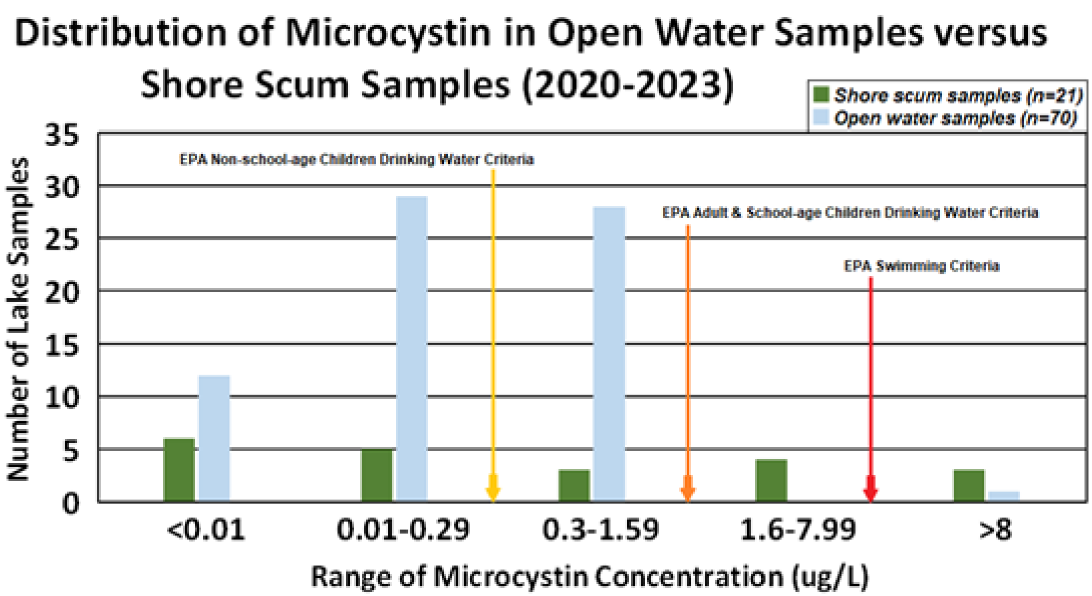

Figure 1. Distribution of microcystin concentrations in open water samples and shore scum samples (2020-2023).

Results obtained from the samples sent to EPA underscore that microcystin production is an issue in a subset of Maine lakes that experience frequent, severe blooms. In 2023 and 2024, DEP collaborated with Bigelow Labs by collecting samples from the same locations as those sent to

BloomWatch. Bigelow is using eDNA to determine which algal populations have the genetic capacity to produce microcystin. Preliminary results indicate that some blooming lakes have populations that lack these genes. DEP has also obtained results from Maine lakes sampled under EPA's National Lake Assessment project in 2022; none of the 15 lakes included in that study had microcystin present at the time of the visit. The Lake Assessment Section plans to continue sending samples to EPA under their BloomWatch program.

An emerging priority throughout the country is evaluation of toxin production from benthic species of algae. The Lake Assessment Section hopes to explore the use of Gold Standard's test kits to begin evaluating the extent to which benthic HABs exist in Maine's lakes.

Discussions Regarding Advisories

Drinking Water. CDC toxicologists believe a major impediment to issuing waterbody-specific advisories for microcystins is the current lack of a timely monitoring system of microcystin levels in surface waters. As noted above, levels of microcystin in water can vary substantially over time and are not necessarily consistent from year to year. CDC's review of the available data to date from DEP suggest that most open-water samples collected to date do not approach EPA's drinking water Health Advisory or swimming advisory recommendations for microcystins. Relatively few open-water concentrations approached or slightly exceeded the drinking water health advisory, and CDC already discourages people from drinking any untreated surface waters.

Swimming. The current Triennial Review of Maine's Water Quality Standards considered adopting EPA's recommended swimming criteria for microcystin. After conversations with EPA staff, it was decided to postpone consideration until the next Triennial Review. This is because EPA guidance requires that not only magnitude, but also duration and frequency be addressed in an advisory. DEP does not currently have the resources to evaluate lakes for all three attributes at this time. Additionally, exceedance of swimming advisory recommendations occurs mostly in samples of surface scum; the general HABs advice to avoid scums already speaks to this exposure concern.

Current Approach. It is recognized by both CDC and DEP that in a lake-rich state like Maine, managing waterbody-specific advisories would be extremely challenging, especially when coupled with the temporal nature of HABs. Thus, the general HABs guidance, including information about waterbodies that are known bloomers, is a more workable approach. Towns or lake entities have the option to issue their own advisories or post lakes that are blooming and/or are known to have elevated microcystin concentrations from their own monitoring efforts.

DEP sponsored a 2024 MOHF grant to explore public messaging regarding algal blooms. The project includes development of signage templates that can be downloaded for use by municipalities, lake associations and swim area property owners to warn lake recreation enthusiasts of algal bloom risks.

4. Biological Monitoring

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4.1 Introduction

As part of the SWAT program, DEP's Biological Monitoring Unit evaluates benthic macroinvertebrate communities of Maine streams, rivers and associated freshwater wetlands to determine if they are potentially impaired by toxic contamination. For reasons of comparability, a small number of unimpaired reference sites are also evaluated. Benthic macroinvertebrates are animals without backbones that can be seen with the naked eye and live on the stream bottom, such as mayflies, stoneflies, caddisflies, crayfish, snails, and leeches. The Biological Monitoring Unit conducts sampling of five major river basins of Maine on a five-year, rotating cycle. Sampling stations in the annual target basin are selected to establish reference conditions, to follow up on previously sampled sites needing additional data, and to target new waterbodies having potential impacts from stressors. A number of stations outside the target basin are also sampled each year, including sites having priority management concerns, those needing timely follow-up data, and long-term reference sites that are sampled annually. In 2023, staff evaluated the condition of 43 sample locations, primarily in the Androscoggin River basin. In 2024, staff evaluated the condition of 35 sample locations, primarily in the St. John River basin.

Sources of toxic contaminants that negatively impact aquatic life in Maine's surface waters include urban, residential and agricultural runoff, municipal and industrial discharges, acid deposition, and historic in-place contamination from landfills, commercial/industrial facilities, military installations and mining sites. Nonpoint sources (NPS) of toxic pollutants from urbanized areas are among the most common causes of biological impairment in streams, often contributing harmful concentrations of chloride (road salt), pesticides, fertilizers and petroleum products. Increasing levels of impervious cover in a stream watershed, including roads, parking lots, rooftops and lawns, can exacerbate toxic contamination by intensifying runoff and altering stream morphology due to heavy flows. The DEP Biological Monitoring Unit conducted a study focusing on impervious cover in urban and residential areas and its relationship to the health of aquatic communities in Maine streams (Danielson, T. J., L. Tsomides, D. Suitor, J. L. DiFranco, and B. Connors. 2016. Effects of Urbanization on Aquatic Life of Maine Streams. Maine DEP – Augusta, ME.). The study report is available on the DEP Biomonitoring web site at the following link: https://www.maine.gov/dep/water/monitoring/biomonitoring/materials/dep-effects-of-urbanization-on-streams.pdf .

The Maine Legislature has assigned a statutory class with associated "designated uses" (management goals) and criteria to all waters of the state (Maine Water Classification Program statute, 38 M.R.S. §464). For flowing fresh surface waters, assigned statutory classes include AA, A, B and C. The Biological Monitoring Unit uses a multivariate statistical model to analyze benthic macroinvertebrate samples and predict if waterbodies attain the biological criteria associated with their statutory class (06-096 CMR Chapter 579). If a waterbody does not meet minimum state aquatic life criteria, Class C, then the model class is predicted as Non-Attainment (NA). Classes AA and A are treated the same in the model. The Biological Monitoring Unit uses a separate wetland model to analyze samples collected from shallow, marshy habitats in freshwater wetlands, low-gradient streams, lakes and ponds. Final decisions on aquatic life attainment of a waterbody are made accounting for factors that may allow adjustments to the model outcome using professional judgement. This is called "the final determination."

Tables 1 and 2 summarize the results of biological monitoring activities, sorted by waterbody name, for the 2023 and 2024 SWAT sampling years respectively. Column headings of Table 1 and 2 are described below:

- *Station* – Since waterbodies are sometimes sampled in more than one location, each sampling location is assigned a unique "Station" number.
- *Log* – Each sample event is assigned a unique sample identification number called a "Log" number. The Log number is used to track macroinvertebrate samples and associated data throughout sample processing, data management, data analysis and reporting.
- *Potential sources of pollution*
- *Statutory Class* – The Maine State Legislature has assigned a statutory class, either AA, A, B, or C, to every Maine stream and river. Class AA and A waterbodies shall support a "natural" biological community. Class B waterbodies shall not display "detrimental changes in the resident biological community". Class C waterbodies shall "maintain the structure and function of the resident biological community". "Great ponds" and natural lakes and ponds less than 10 acres in size are assigned a single class, GPA. The habitat of Class GPA waters must be characterized as "natural".
- *Final determination* – The final decision on aquatic life attainment of a waterbody; this decision accounts for factors that may allow adjustments to the model outcome. An 'NA' (Non-attainment) indicates that the sample did not meet the minimum Class C criteria. An 'I' (Indeterminate) indicates that a final decision could not be made based on the aquatic community collected.

- *Attains Class* – "Yes" is given if the final determination is equal to or exceeds the Statutory Class. A Class B stream, for example, would receive a "Yes" if its final determination was either A or B. "No" is given if a stream does not attain its Statutory Class. A Class B stream, for example, would receive a "No" if its final determination was either C or NA.
- *Probable Cause* – The probable cause column lists potential stressors to benthic macroinvertebrate communities, based on best professional judgment. In some cases, a probable cause may not be related to toxic pollution but instead to other factors.

2023 field and water chemistry data for each sampling event (where available) are presented in Table 2 and 3, respectively. 2024 field and water chemistry data are presented in Tables 6. and 7. Continuous water temperature data for 2023 are shown in Figure 1, and for 2024 in Figure 2. Data are also summarized in reports for each sampling event, known as Aquatic Life Classification Attainment Reports, which are available in electronic format with the web version of this report. The attainment history of sampling stations prior to 2023 and 2024, where available, is summarized in Tables 4 and 8.

For more information about the Biological Monitoring Program, please visit our web site: www.maine.gov/dep/water/monitoring/biomonitoring/. The Data and Maps page of this website provides access to station information and available data via ArcGIS Online.

4.2 2023 Results

The Biological Monitoring Unit concentrated its sampling in 2023 in the Androscoggin River basin. Forty-three stations were sampled under the SWAT Program (Table 1). Thirty of these stations met the aquatic life criteria for their statutory class, but 13 did not attain criteria for their assigned class. The following are descriptions of waterbodies not attaining aquatic life criteria for their assigned class in 2023.

Adams Brook – South Berwick   Station 267

Adams Brook is a second order stream that flows through Berwick into Lovers Brook in South Berwick through a watershed with significant agriculture and some residential development. The headwaters of the stream drain a dairy farm, which has historically led to impairment of water quality in the stream. Station 267 is located in South Berwick above the confluence with Lovers Brook, and has a water quality goal of Class B. In 2023, the macroinvertebrate community at station 267 did not meet aquatic life criteria for any water quality class (non-attainment). The community included very few sensitive organisms, with no stoneflies present, very low relative abundance of mayflies (1%) and combined EPT generic richness (mayflies, stoneflies and caddisflies) of only 6. The Hilsenhoff biotic index score was 5.93, indicating likely organic pollution. The community was dominated by pollution-tolerant aquatic worms (48% relative abundance) along with snails and isopods. Water sample nutrient concentrations were relatively high (for example, total phosphorus was 52 ug/L) and the chloride concentration was also elevated (54 mg/L). While there may be some habitat limitations due to the clay content of the stream substrate, a high proportion of silt observed (20%) provides evidence of agricultural runoff. Dominance by highly pollution-tolerant organisms and lack of sensitive taxa also indicate likely toxic effects from agricultural chemicals in addition to impacts from nutrients and road salt. Additional 2023 macroinvertebrate sampling conducted in a nearby section of Adams Brook using the wetland dipnet method confirmed the result of non-attainment of any aquatic life criteria.

Bird Brook – Norway Station 340

Bird Brook is a second order stream which flows from Paine Pond in Paris through a rural watershed into downtown Norway, where it joins the Pennesseewassee Stream. Station 340 is located in downtown Norway below Main Street, in a reach with a water quality goal of Class B. In 2023 the macroinvertebrate community at station 340 on Bird Brook met class C, but not the assigned class of B. The determination of Class C was based on Best Professional Judgement since the total mean abundance was less than 50 and therefore did not meet criteria for the DEP statistical model. The community had a very low total mean abundance (36.3) and relatively low diversity (generic richness of 24). No stoneflies were present and the most abundant taxa was a mayfly in the genus *Paraleptophlebia* (17.4%). Mayfly relative abundance was 22%, however mean abundance was only 8 individuals. Dissolved oxygen was very low in July when rock bags were deployed (4.21 mg/l) but was higher during retrieval in August (7.18 mg/l). This site has a history of low dissolved oxygen, including in 2008 when it met Class B aquatic criteria. The watershed is mostly natural, with 86.4% natural landcover, 6.2% development, and 8.6% wetland, however development is concentrated in the direct watershed of Station 340 and likely is impacting the macroinvertebrate community. Total phosphorus was also high at 50 ug/l. In addition, in 2023 there were very high flows that could have influenced sample results. Resampling is advised.

Cole Brook – Gray Station 317

Cole Brook is a first order brook that originates from a small pond in New Gloucester, and flows through farmland, forest, and residential development in Gray, and flows into Mill Brook near I-95. Station 317 is located below Weymouth Rd, and has a water quality goal of Class B. In 2023, the macroinvertebrate community met Class C aquatic life criteria, but did not meet Class B criteria. The community contained some sensitive taxa, including the caddisfly Psilotreta, the mayfly Maccaffertium, and a single stonefly, but these were found in very low numbers. Mean mayfly abundance was only 3.67 individuals. Overall, the community had a moderately high mean tolerance level (Hilsenhoff Biotic Index: 5.28). In addition, the total mean abundance was low (53.66 organisms), as well as total generic richness (22 genera). The community characteristics are likely due to runoff from agriculture and development, which was exacerbated by unusually high rainfall and flows in 2023. Water samples collected in July showed elevated nutrient and chloride concentrations. In previous years, Cole Brook attained Class A aquatic life standards (2010, 2015), so resampling is suggested in a year with more normal rainfall.

Rangeley River - Rangeley   Station 136

Rangeley River is a third order stream that flows from Rangeley Lake to Mooselookmeguntic Lake in Rangeley. The watershed of Rangeley Lake contains substantial development, including seasonal camps around Rangeley Lake, but also largely forested headwaters. Station 136 is located below Rangeley Lake dam, above the Cook Aquaculture outfall, and has a water quality goal of A. In 2023, the macroinvertebrate community at station 136 met Class C aquatic life criteria, but did not meet its water quality goal of A. The final class determination was raised from non-attainment of any aquatic life criteria to Class C using best professional judgement due to apparent lake outlet effect. The total mean abundance was extremely high at 5088 organisms, mostly consisting of Hydropsyche netspinning caddisflies (85.38%) which filter organic debris from water. The community also included sensitive stoneflies, mayflies and caddisflies, and water quality was relatively high, with high dissolved oxygen (8.71 and 9.21 mg/l at deployment and retrieval), low specific conductance and relatively low nutrient concentrations. The hyper-abundance of netspinners is likely due to the lake outlet effect, with these filter-feeders being subsidized by organic inputs from Rangeley Lake. This effect was likely exacerbated by unusually heavy rainfall and very high flows in 2023.

Sabattus River - Lisbon   Station 976

The Sabattus River is a 3rd order stream that flows from Sabattus Pond in Sabattus into the Androscoggin River in Lisbon, through a watershed with significant natural areas, agriculture, and industrial and residential development. Station 976 is located above Mill Street in Lisbon in a river section that until recently was impounded by a dam that has been removed. This section of the river has a water quality goal of Class B. In 2023, the macroinvertebrate community at Station 976 met Class C aquatic life criteria, but not the assigned class of B. The community had a good number of sensitive organisms (mayfly relative abundance was 25% and EPT richness was 12), but no stoneflies were present and generic richness was fairly low (26). The Hilsenhoff Biotic Index was also moderately high (4.91). The total mean abundance was very high (2061 organisms), dominated by filter-feeding caddisflies (Cheumatopsyche 39.06%, Hydropsyche 9.75%). The high total mean abundance and dominance of filter feeders is suggestive of nutrient enrichment, which accords with a total phosphorus result at 46 ug/l. This is likely due to agriculture, development, and inputs from Sabattus Pond which has high nutrients and regular algal blooms.

Sheepscot River – N. Whitefield   Station 74

The Sheepscot River is a fourth order river that flows from its headwaters in Montville, through Palermo, Somerville, and Whitefield, where station 74 is located. The watershed includes forest, farmland, two impounded sections of river, and a fish hatchery. At Station 74, the water quality goal is Class AA. In 2023, the macroinvertebrate community at Station 74 met Class B aquatic life criteria, but did not meet Class A criteria (aquatic life criteria for Class A are the same as for Class AA). The final determination of Class B was made using best professional judgement, and the initial statistical model result of Class C was raised due to sensitive taxa present. The community contained a high proportion of sensitive mayflies but lacked stoneflies which are normally present in natural cobble-bottom stream habitat in Maine. Overall mayfly relative abundance was 42% and the most dominant taxa was the mayfly *Maccaffertium,* which comprised 22.7% of the total abundance. The lack of stoneflies may be due to unusual hydrologic conditions in the 2023 season, with high waters and flooding potentially preventing stoneflies from settling on the samplers.

<u>Spring Brook - Augusta</u> Station 478

Spring Brook is a first order stream that originates in Augusta, and flows into Bond Brook. Station 478 is located near the source of Spring Brook, below the outfall of Governor Hill Hatchery, and has a water quality goal of Class B. In 2023, the macroinvertebrate community at station 478 did not meet Class B aquatic life criteria, but met Class C standards. The physical water conditions were suitable for sensitive aquatic life, with cold temperatures due to the fact that the brook is spring-fed, and high dissolved oxygen. There were sensitive organisms present, but most occurred in low numbers and only 2 individual stoneflies occurred in the sample. The aquatic community showed evident signs of nutrient enrichment, with a total mean abundance of 1954 organisms. The most abundant taxa were midges in the genus *Micropsectra* (32.1%), blackfly larvae (20.3%) mayflies in the genus *Baetis* (16.3%) and the midge *Tvetenia* (14.6%). These organisms are generally adaptable to a variety of physical/chemical conditions and are also able to re-colonize quickly following scouring and substrate disturbances, which are factors at this site. Additional evidence of nutrient enrichment includes the presence of the aquatic plant *Elodea canadensis*. Specific conductance was somewhat elevated both at rock bag deployment (198.2 uS/cm) and retrieval (195.2 uS/cm). Total phosphorus (43 ug/l) and orthophosphate (23 ug/l) were also relatively high in water samples collected in July.

<u>Taylor Brook - Auburn</u> Station 696

Taylor Brook is a second order stream that originates from Taylor Pond in Auburn, and flows through an urban area into the Little Androscoggin River in Auburn. Station 696 is located above Washington Street in Auburn, close to the confluence with the Little Androscoggin River, in a reach with a water quality goal of Class B. In 2023, the macroinvertebrate community at Station 696 met Class C aquatic life criteria, but not the assigned class of B. The community had few sensitive organisms, with no stoneflies, few mayflies and an overall Hilsenhoff Biotic Index of 5 (moderately high). Specific conductance at the site was 167 uS/cm at deployment and 120 uS/cm, suggesting a moderate influence of urban runoff including road salt and other toxics. Total phosphorus was also high at 39 ug/l, suggesting some enrichment as well.

Unnamed Stream (Brunswick 3) - Brunswick   Station 642

Unnamed Stream (Brunswick 3) is a first order stream that originates in Brunswick and flows a short distance into the Androscoggin River. The small watershed is mostly developed, with several large parking lots and a former salt storage location. Station 642 is located above Water Street, and has a water quality goal of Class B. In 2023, the macroinvertebrate community at station 642 did not attain criteria for any aquatic life class (NA). There were no stoneflies and one mayfly present, and the community consisted mostly of amphipods (Gammarus, 47.96% of sample). The specific conductance was 640 uS/cm at deployment and 925 uS/cm at retrieval, and chloride water sample concentration was 300 mg/l at deployment, indicating a strong influence of urban runoff including road salt and other toxics. This is consistent with the abundance of amphipods in the macroinvertebrate community, which are highly tolerant of elevated salinity. Other taxa that were prominent in the sample are also very tolerant, including midges, isopods and snails. Altered hydrology and sedimentation due to high stormwater flows likely also impact the aquatic community.

Unnamed Stream (Topsham 2) Aka Topsham Fairgrounds   Station 633

Unnamed Stream (Topsham 2) is a second order stream with a water quality goal of Class B that originates in Topsham in the Topsham Fairgrounds area and flows through a residential area into the Androscoggin River. In 2023, the macroinvertebrate community at station 633 on Unnamed Stream (Topsham 2) met Class C aquatic life criteria, but not the assigned class of B. There were few sensitive organisms present, with a mean abundance of 12 for mayflies and 1.67 for stoneflies, and fairly low EPT generic richness (9). The most abundant taxa in the sample were isopods (*Caecidotea*, 28%) and amphipods (*Gammarus*, (11.2%), both of which are very tolerant of pollution. Richness of different midge taxa was relatively high, and combined midge taxa comprised approximately 30% of the sample. The specific conductance was 492 uS/cm at deployment and 454.5 uS/cm at retrieval, and chloride was 120 mg/l at deployment, indicating an influence of urban runoff including road salt and other toxics. Altered hydrology and sedimentation due to high stormwater flows likely also impact the aquatic community.

Unnamed Stream (Topsham 4) Aka Topsham Fair Mall Stream   Station 634

Unnamed Stream (Topsham 4) is a second order stream with a water quality goal of Class B that originates in Topsham in the Topsham Fair Mall area and flows through a commercial area into the Androscoggin River. In 2023, the macroinvertebrate community at station 634 on Unnamed Stream (Topsham 4) did not attain any aquatic life class (NA). There were few sensitive organisms present, with no mayflies and only one stonefly present, and the community consisted mostly of midges (Chironomidae, 65% of sample), many of which are generally tolerant of pollution. The specific conductance was 1166 uS/cm at deployment and 990 uS/cm at retrieval, and chloride was 280 mg/l at deployment, indicating a strong influence of urban runoff including road salt and other toxics. Altered hydrology and sedimentation due to high stormwater flows likely also impact the aquatic community.

Unnamed Tributary to Little Brassua Lake - Sandwich Academy Grant Township   Station 1243

'Unnamed Tributary to Little Brassua Lake' is a first order stream that originates in Sandwich Academy Grant Township, and flows into Little Brassua Lake. It has a water quality goal of Class A. Station 1243 is located below the Canadian Pacific Railroad crossing, where there was a derailment and diesel fuel spill in 2023. In 2023, the macroinvertebrate community did meet any aquatic life criteria (NA/non-attainment). Both total abundance and generic richness were low (68.33 and 11), with only pollution-tolerant organisms present. The most abundant organisms were aquatic worms in the genus *Nais* (63.4%). The site was missing important groups of organisms that would be expected to be present given the high quality habitat conditions, including mayflies, stoneflies and caddisflies. This is evidence of acute toxic effects of diesel fuel in the stream on the aquatic macroinvertebrate community. Petroleum was observed welling up in the sediments during both rock bag deployment and retrieval, and there was also a very strong petroleum odor evident at the site on both dates.

Whitney Brook - Canton   Station 342

Whitney Brook is a second order stream that flows from Anasagunticook Lake through downtown Canton, into the Androscoggin River, and has a water quality goal of Class B. Station 342 is located below the outlet of Anasagunticook Lake near the center of Canton below the crossing of Rt 108 in a watershed with a substantial amount of agriculture. In 2023, the macroinvertebrate community at Station 342 met Class C aquatic life criteria, but not Class B criteria. The community had very high total mean abundance (1496 organisms) and was dominated by net-spinning caddisflies (Cheumatopsyche, 44%) and midges (45%). The community also had few sensitive taxa, with no stoneflies present and fairly low numbers of sensitive mayflies (Leucrocuta, 10.67 mean abundance). Combined mayfly mean abundance was 45.3 however. Physical-chemical water quality appeared to be good, with low nutrients and specific conductance, and high dissolved oxygen (8.05 and 9.6 mg/l at deployment and retrieval). The elevated abundance and dominance of net-spinning caddisflies and midges is likely due to a combination of nutrient enrichment and lake outlet effect.

Table 1. 2023 SWAT Benthic Macroinvertebrate Biomonitoring Results

Waterbody	Town	Station	Log	Potential sources of pollution[1]	Statutory Class / Final Determination	Attains Class?	Probable Cause
Adams Brook	South Berwick	267	3043	Agricultural & urban NPS	B/NA	N	NPS toxics, nutrients, habitat
Barkers Brook	Newry	873	3039	Reference	AA/A	Y	
Bean Brook	Rumford	349	3075	NPS / altered hydrology	B/A	Y	
Bear River	Newry	866	3052	Reference	AA/A	Y	
Bird Brook	Norway	340	3073	Urban NPS	B/C	N	NPS toxics
Bobbin Mill Brook	Auburn	357	3032	Lake outlet, urban NPS	B/A	Y	
Bull Branch Sunday River	Riley TWP	659	3040	Reference	AA/A	Y	
Cathance River	Topsham	1240	3029	Agricultural and urban NPS	B/B	Y	
Cold Stream	Enfield	484	3071	Below hatchery	A/A	Y	
Cole Brook	Gray	317	3061	Agricultural and urban NPS	B/C	N	NPS toxics, nutrients
Cranberry Pond	Fayette	W-197	DN-2306-197	Reference	A/A	Y	
Cupsuptic River	Upper Cupsuptic TWP	999	3034	Reference	AA/A	Y	
East Branch Wesserunsett River	Athens	486	3049	Long-term monitoring site	A/A	Y	
East Cathance Stream	Bowdoin	859	3033	Agricultural NPS	B/A	Y	
Frye Brook	Andover West Surplus TWP	1000	3050	Reference	A/A	Y	
Gully Brook	Auburn	695	3057	Urban NPS	B/B	Y	

Table 1 (continued)

Waterbody	Town	Station	Log	Potential sources of pollution[1]	Statutory Class / Final Determination	Attains Class?	Probable Cause
Horseshoe Pond	Andover	W-324	DN-2306-324	NPS/Forestry	A/A	Y	
Little Androscoggin	Paris	43	3045	Above POTW	C/A	Y	
Little Androscoggin	Paris	79	3046	Below POTW	C/A	Y	
Little Androscoggin River	Greenwood	1009	3038	Reference	A/A	Y	
Presumpscot River	Westbrook	72	3056	Urban NPS	C/C	Y	
Presumpscot River	Westbrook	295	3055	Urban NPS	C/C	Y	
Presumpscot River	Falmouth	802	3063	Urban NPS	C/B	Y	
Rangeley River	Rangeley	136	3048	Lake outlet/ Upstream of hatchery	A/C	N	Organic enrichment, lake outlet effect
Rangeley River	Rangeley	137	3047	Downstream of hatchery	A/A	Y	
Sabattus River	Lisbon	976	3065	Agricultural and urban NPS, below landfill	B/C	N	Nutrients, NPS toxics
Sheepscot River	N. Whitefield	74	3066	Agricultural NPS, Long-term monitoring site	AA/B	N	Unusually high flows
Spring Brook	Augusta	478	3031	Below hatchery	B/C	N	Nutrients, altered habitat
Stetson Brook	Lewiston	W-183	DN-2306-183	Urban NPS	B/B	Y	
Stetson Brook	Lewiston	356	3053	Urban NPS	B/A	Y	
Sunday River	Bethel	354	3036	NPS	A/A	Y	

Table 1 (continued)

Waterbody	Town	Station	Log	Potential sources of pollution[1]	Statutory Class / Final Determination	Attains Class?	Probable Cause
Sunday River	Newry	444	3041	Reference	A/A	Y	
Taylor Brook	Auburn	696	3059	Urban NPS	B/C	N	Nutrients
Temple Stream	Farmington	1242	3064	Urban and agricultural NPS, recent dam removal	B/A	Y	
Unnamed Stream (Brunswick 2)	Brunswick	1247	3030	Urban NPS	B/B	Y	
Unnamed Stream (Brunswick 3)	Brunswick	642	3060	Urban NPS	B/NA	N	NPS toxics (road salt), altered hydrology
Unnamed Stream (Topsham 2) Aka Topsham Fairgrounds	Topsham	633	3070	Urban NPS	B/C	N	NPS toxics (road salt), altered hydrology
Unnamed Stream (Topsham 4) Aka Topsham Fair Mall Stream	Topsham	634	3068	Urban NPS	B/NA	N	NPS toxics (road salt), altered hydrology
Unnamed Tributary to Little Brassua Lake	Sandwich Academy Grant TWP	1243	3069	Train derailment / Diesel fuel spill	A/NA	N	Acute toxic impact from diesel fuel
West Branch Sheepscot River	China	268	3067	Agricultural NPS, Long-term monitoring site	A/A	Y	
Whitney Brook	Canton	342	3058	Urban and agricultural NPS, lake outlet effect	B/C	N	Nutrients/organic enrichment, lake outlet effect
Wild River	Gilead	103	3054	Reference	AA/A	Y	
Wild River	Batchelder Grant TWP	674	3051	Reference	A/A	Y	

NPS = non-point source pollution.

Table 2. 2023 SWAT Field Data

Site	Station	Log	Sample Deployment					Sample Retrieval				
			Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU	Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU
Adams Brook	267	3043	7/25/2023	20.8	7.19	350.5	7.47	8/22/2023	17.9	7.42	284.5	6.88
Barkers Brook	873	3039	8/2/2023	14.6	10.09	113.7	6.70	8/29/2023	16.3	10.74	89.8	7.67
Bean Brook	349	3075	7/13/2023	18.7	9.24	95.2	6.50	8/10/2023	17.9	10.07	90.1	7.37
Bear River	866	3052	7/18/2023	17.0	9.94	22.2	5.36	8/15/2023	15.4	10.21	29.1	6.13
Bird Brook	340	3073	7/11/2023	21.6	4.21	89.4	6.51	8/8/2023	19.0	7.18	62.5	6.62
Bobbin Mill Brook	357	3032	7/19/2023	25.1	8.44	126.6	7.39	8/23/2023	21.2	9.14	221.4	7.40
Bull Branch Sunday River	659	3040	8/2/2023	15.4	10.37	17.4	5.88	8/29/2023	16.4	10.78	16.5	6.96
Cathance River	1240	3029	7/25/2023	24.2	2.71	126.6	5.81	8/30/2023	20.7	4.22	103.4	6.59
Cold Stream	484	3071	7/17/2023	22.9	8.22	36.0	6.48	8/14/2023	15.0	8.37	36.8	5.62
Cole Brook	317	3061	7/12/2023	18.6	8.35	222.4	7.08	8/9/2023	18.4	8.71	75.5	5.88
Cranberry Pond	W-197	2023-197	6/14/2023	19.9	8.95	28.6	5.26	--	--	--	--	--
Cupsuptic River	999	3034	7/24/2023	18.0	9.41	26.1	6.52	8/21/2023	16.4	9.82	24.0	6.11
East Branch Wesserunsett River	486	3049	7/17/2023	22.2	8.96	60.6	7.08	8/18/2023	18.0	9.63	63.4	7.10
East Cathance Stream	859	3033	7/25/2023	22.3	7.41	82.9	6.61	8/22/2023	18.3	9.62	79.4	7.27
Frye Brook	1000	3050	7/18/2023	16.3	9.80	14.8	5.94	8/15/2023	14.8	10.16	19.2	6.08
Gully Brook	695	3057	7/19/2023	17.2	8.59	627.0	7.53	8/16/2023	15.9	9.21	456.0	7.29
Horseshoe Pond	W-324	2023-324	6/20/2023	21.0	8.23	28.9	5.77	--	--	--	--	--
Little Androscoggin	43	3045	7/26/2023	21.1	9.60	67.6	7.29	8/23/2023	18.1	9.54	88.7	6.63
Little Androscoggin	79	3046	7/26/2023	21.2	9.61	72.8	7.14	8/24/2023	18.6	9.51	94.5	6.51
Little Androscoggin River	1009	3038	7/26/2023	20.2	10.00	44.2	7.34	8/23/2023	16.9	10.07	60.5	6.47

Table 2. 2023 SWAT Field Data (Continued)

Site	Station	Log	Sample Deployment					Sample Retrieval				
			Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU	Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU
Presumpscot River	72	3056	7/20/2023	25.0	8.9	78.5	6.62	8/17/2023	22.9	9.2	77.6	6.94
Presumpscot River	295	3055	7/20/2023	24.8	8.64	74.3	6.38	8/17/2023	22.9	9.16	73.9	6.95
Presumpscot River	802	3063	8/17/2023	22.8	9.00	83.8	6.87	9/13/2023	22.6	8.43	103	7.64
Rangeley River	136	3048	7/24/2023	22.4	8.71	53.1	6.68	8/21/2023	18.1	9.21	53.3	6.43
Rangeley River	137	3047	7/24/2023	22.9	8.58	52.8	6.86	8/21/2023	18.7	9.33	52.6	6.48
Sabattus River	976	3065	7/25/2023	25.2	8.05	173.6	7.44	9/11/2023	22.4	9.75	179	8.36
Sheepscot River	74	3066	7/10/2023	24.2	7.59	49.5	7.08	8/7/2023	22.1	8.85	75.8	6.86
Spring Brook	478	3031	8/7/2023	12.3	11.06	198.2	7.5	9/6/2023	12.9	10.12	195.2	7.8
Stetson Brook	W-183	2023-183	6/15/2023	19.4	9.15	163.2	7.08	8/25/2021	17.9	9.47	28.4	5.56
Stetson Brook	356	3053	7/19/2023	25.1	8.14	126.5	7.28	8/16/2023	19.7	8.97	113.9	6.98
Sunday River	354	3036	8/2/2023	15.5	9.38	35.4	5.56	8/29/2023	18.4	10.02	35	6.77
Sunday River	444	3041	8/2/2023	16.9	9.87	24.8	5.8	8/29/2023	18.7	10.26	24.4	6.89
Taylor Brook	696	3059	7/12/2023	25.6	7.66	167.3	7.23	8/16/2023	23	9.28	120.4	7.54
Temple Stream	1242	3064	7/17/2023	19.8	9.50	37.5	7.7	8/14/2023	18.2	10.38	51.9	7.72
Unnamed Str. (Brunswick 2)	1247	3030	8/11/2023	18.1	9.17	342.5	7.08	9/8/2023	17.7	8.78	738	6.95
Unnamed Str. (Brunswick 3)	642	3060	7/12/2023	15.9	9.24	640.0	7.46	8/9/2023	17.1	9.56	925	7.45
Unnamed Str. (Topsham 2)	633	3070	7/12/2023	16.0	9.48	492.0	6.93	8/9/2023	16.7	9.99	454.5	7.19
Unnamed Str. (Topsham 4)	634	3068	7/12/2023	16.7	8.96	1166.0	6.85	8/9/2023	17.1	9.45	990	7.07
Unnamed Tributary To Little Brassua Lake	1243	3069	7/14/2023	18.8	8.36	28.3	6.69	8/10/2023	17.1	9.01	34.4	6.13
West Branch Sheepscot River	268	3067	7/10/2023	22.8	8.2	80.7	7.63	8/7/2023	20.2	9.42	88.4	7.41
Whitney Brook	342	3058	7/11/2023	23.8	8.05	50.8	7.32	8/16/2023	22.7	9.6	48	7.59
Wild River	103	3054	7/18/2023	18.6	9.52	13.1	5.14	8/15/2023	17.4	10	17.5	5.93
Wild River	674	3051	7/18/2023	18.7	9.46	11.8	5.02	8/15/2023	17	9.87	15	5.55

Table 3. 2023 SWAT Water Chemistry Data

In 2023, TKN, NO2-NO3-N, Total P, SRP, Chloride and True Color were analyzed by the Health & Environmental Testing Laboratory, Augusta, ME. Alkalinity was analyzed by the Biomonitoring Unit.

Waterbody	**Station**	**Log**	**Sampling Date**	**TKN** *(MG/L)*	**NO2-NO3-N** *(MG/L)*	**Total P** *(UG/L)*	**SRP** *(UG/L)*	**True Color** *(PCU)*	**Alkalinity** *(MG/L)*	**Chloride** *(MG/L)*
Adams Brook	267	3043	7/25/2023	0.7	0.225	52	6	--	72	54
Barkers Brook	873	3039	8/2/2023	--	0.125	5	1	--	15	19
Bean Brook	349	3075	7/13/2023	--	0.085	12	3	--	15	15
Bear River	866	3052	7/18/2023	0.3	0.015	6	1	--	4	2
Bird Brook	340	3073	7/11/2023	0.8	0.015	50	6	--	26	8
Bobbin Mill Brook	357	3032	7/19/2023	0.3	0.035	21	3	--	21	20
Bull Branch Sunday River	659	3040	8/2/2023	--	<0.01	4	1	--	5	<1
Cathance River	1240	3029	7/25/2023	0.7	0.045	50	7	--	22.5	17
Cold Stream	484	3071	7/17/2023	0.3	0.015	10	2	--	8	3
Cole Brook	317	3061	7/12/2023	0.5	1.805	33	1	--	18	43
Cranberry Pond	W-197	2306-197	6/14/2023	0.535	--	16	--	176	2.5	4
Cupsuptic River	999	3034	7/24/2023	0.3	0.095	11	2	--	9	<1
East Branch Wesserunsett River	486	3049	7/17/2023	0.4	0.035	16	1	--	21	3
East Cathance Stream	859	3033	7/25/2023	0.5	0.055	25	2	--	19.5	9
Frye Brook	1000	3050	7/18/2023	NA	<0.01	5	2	--	4	<1
Gully Brook	695	3057	7/19/2023	0.9	1.41	18	7	--	79	110
Horseshoe Pond	W-324	2306-324	6/20/2023	0.355	--	19	--	81	6	1
Little Androscoggin	43	3045	7/26/2023	0.3	0.085	22	1	--	12.5	9
Little Androscoggin	79	3046	7/26/2023	0.3	0.085	25	1	--	11	10
Little Androscoggin River	1009	3038	7/26/2023	0.5	0.015	26	1	--	8.5	5
Presumpscot River	72	3056	7/20/2023	--	0.065	19	4	--	12.5	12
Presumpscot River	295	3055	7/20/2023	0.3	0.065	12	1	--	11.5	11

TKN = Total Kjeldahl-Nitrogen, NO_2-NO_3-N = Nitrite-Nitrate-Nitrogen, Total P = Total Phosphorus, SRP = Soluble Reactive Phosphorus (ortho-phosphate), PCU=Platinum-Cobalt Units, "<" = constituent not detected at the reporting limit.

Table 3. 2023 SWAT Water Chemistry Data (continued)

Waterbody	**Station**	**Log**	**Sampling Date**	**TKN** *(MG/L)*	**NO2-NO3-N** *(MG/L)*	**Total P** *(UG/L)*	**SRP** *(UG/L)*	**True Color** *(PCU)*	**Alkalinity** *(MG/L)*	**Chloride** *(MG/L)*
Presumpscot River	802	3063	7/20/2023	0.3	0.075	23	4	--	13	13
Rangeley River	136	3048	7/24/2023	--	<0.01	20	1	--	9	6
Rangeley River	137	3047	7/24/2023	--	<0.01	4	1	--	9	6
Sabattus River	976	3065	7/25/2023	0.6	0.165	46	2	--	33	25
Sheepscot River	74	3066	7/10/2023	0.4	0.035	15	2	--	13.5	7
Spring Brook	478	3031	7/10/2023	0.3	0.32	43	23	--	68	11
Stetson Brook	W-183	2306-183	6/15/2023	0.567	--	76	--	134	33	23
Stetson Brook	356	3053	7/19/2023	0.8	0.065	49	8	--	30	14
Sunday River	354	3036	8/2/2023	--	0.025	5	1	--	8	3
Sunday River	444	3041	8/2/2023	--	0.015	7	1	--	6	1
Taylor Brook	696	3059	7/12/2023	0.5	0.055	39	9	--	25.5	29
Temple Stream	1242	3064	7/17/2023	0.3	0.025	22	1	--	11.5	2
Unnamed Str. (Brunswick 2)	1247	3030	7/8/2021	--	--	--	--	--	--	--
Unnamed Str. (Brunswick 3)	642	3060	7/12/2023	0.4	0.955	13	3	--	37	300
Unnamed Str. (Topsham 2)	633	3070	7/12/2023	0.3	0.695	25	3	--	21	120
Unnamed Str. (Topsham 4)	634	3068	7/12/2023	0.3	0.395	10	2	--	28	280
Unnamed Tributary To Little Brassua Lake	1243	3069	7/13/2023	0.5	0.015	28	2	--	11	<1
West Branch Sheepscot River	268	3067	7/10/2023	0.4	0.055	14	2	--	23.5	6
Whitney Brook	342	3058	7/11/2023	0.4	0.015	9	1	--	10.5	6
Wild River	103	3054	7/18/2023	--	<0.01	6	1	--	3	<1
Wild River	674	3051	7/18/2023	--	<0.01	4	1	--	2	<1

TKN = Total Kjeldahl-Nitrogen, NO_2-NO_3-N = Nitrite-Nitrate-Nitrogen, Total P = Total Phosphorus, SRP = Soluble Reactive Phosphorus (ortho-phosphate), PCU=Platinum-Cobalt Units, "<" = constituent not detected at the reporting limit.

Table 4. Past Attainment History of 2023 Sampling Stations

The table below provides the attainment history for 2023 sampling stations that have been sampled in the past.

Waterbody	Station	Attained Class	Did not Attain Class	Indeterminate Result
Adams Brook	267	—	1995	—
Barkers Brook	873	2008	—	—
Bean Brook	349	1998, 2008	—	—
Bear River	866	2008, 2013	2018	—
Bird Brook	340	2008	1998, 2003, 2018	—
Bobbin Mill Brook	357	2003, 2008, 2013	1998	2018
Bull Branch Sunday River	659	2020, 2022, 2023	2021	—
Cathance River	1240	—	—	—
Cold Stream	484	2006, 2011, 2016, 2023	2001, 2021	—
Cole Brook	317	1997, 1998, 2010, 2015	1999, 2005	—
Cranberry Pond	W-197	2008, 2013	—	—
Cupsuptic River	999	2013, 2018	—	—
East Branch Wesserunsett River	486	2001, 2007, 2012-2023	—	—
East Cathance Stream	859	2013	—	—
Frye Brook	1000	2013	—	2018
Gully Brook	695	2003, 2008	2018	—
Horseshoe Pond	W-324	—	2018	—
Little Androscoggin	43	1983-1987, 1992, 1998, 2003, 2008, 2013, 2018	—	—
Little Androscoggin	79	1998, 2003, 2008, 2013, 2018	1984	—
Little Androscoggin River	1009	2018	—	—
Presumpscot River	72	2005, 2010, 2015	1984, 1994-1996	—
Presumpscot River	295	1996	—	—
Presumpscot River	802	2021, 2023	—	—
Rangeley River	136	2006	1989, 1990, 2003, 2018	—

Table 4. Past Attainment History of 2023 Sampling Stations (continued)

The table below provides the attainment history for 2023 sampling stations that have been sampled in the past.

Waterbody	Station	Attained Class	Did not Attain Class	Indeterminate Result
Rangeley River	137	1990, 2006, 2018	1989, 2003, 2013	—
Sabattus River	976	—	2011	—
Sheepscot River	74	1985, 1987-1990, 1992, 1995, 1996 1998-2017, 2019-2022	1984, 1986, 1991, 1993, 1994, 1997	—
Spring Brook	478	2001, 2013	2007, 2010	2012
Stetson Brook	W-183	2013	2008, 2018	—
Stetson Brook	356	1998, 2008, 2013, 2018	—	—
Sunday River	354	2000, 2003, 2008, 2013, 2018	1998	—
Sunday River	444	2008, 2013, 2018	2000, 2003	—
Taylor Brook	696	—	2003	—
Temple Stream	1242	—	—	—
Unnamed Stream (Brunswick 2)	1247	—	—	—
Unnamed Stream (Brunswick 3)	642	—	2002	—
Unnamed Stream (Topsham 2) Aka Topsham Fairgrounds	633	2006, 2013	2002	2008
Unnamed Stream (Topsham 4) Aka Topsham Fair Mall Stream	634	2002, 2006	2008, 2014, 2018	2013
Unnamed Tributary To Little Brassua Lake	1243	—	2023	—
West Branch Sheepscot River	268	1996-1999, 2001, 2002, 2005, 2007, 2009-2017, 2019, 2020, 2022	2000, 2003, 2004, 2006, 2008, 2018, 2021	1995
Whitney Brook	342	—	1998, 2008	—
Wild River	103	1987, 2008, 2013, 2018	—	—
Wild River	674	2021, 2022	2020	—

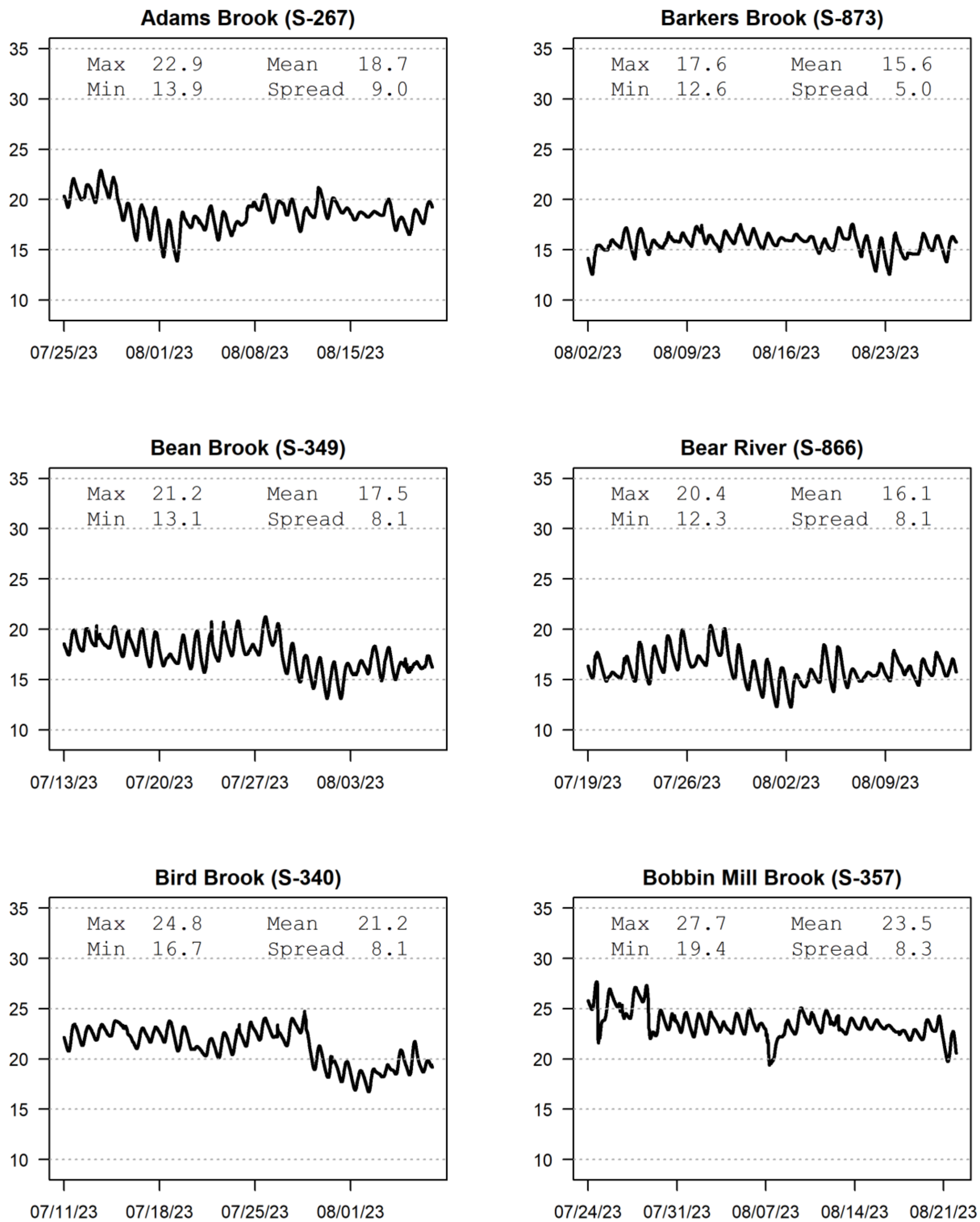

Figure 1. 2023 In-Stream Continuous Temperature Data

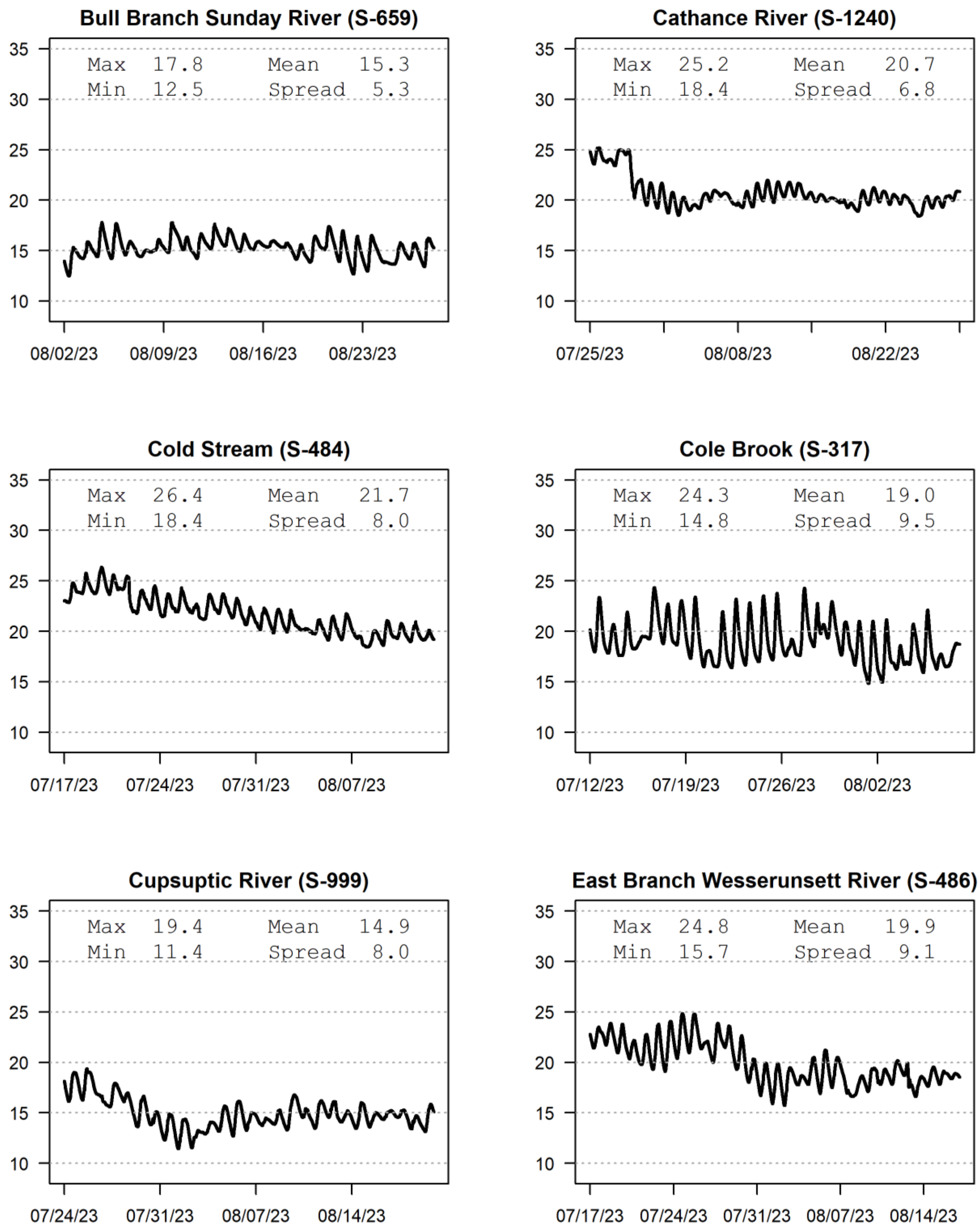

Figure 1. 2023 In-Stream Continuous Temperature Data (continued)

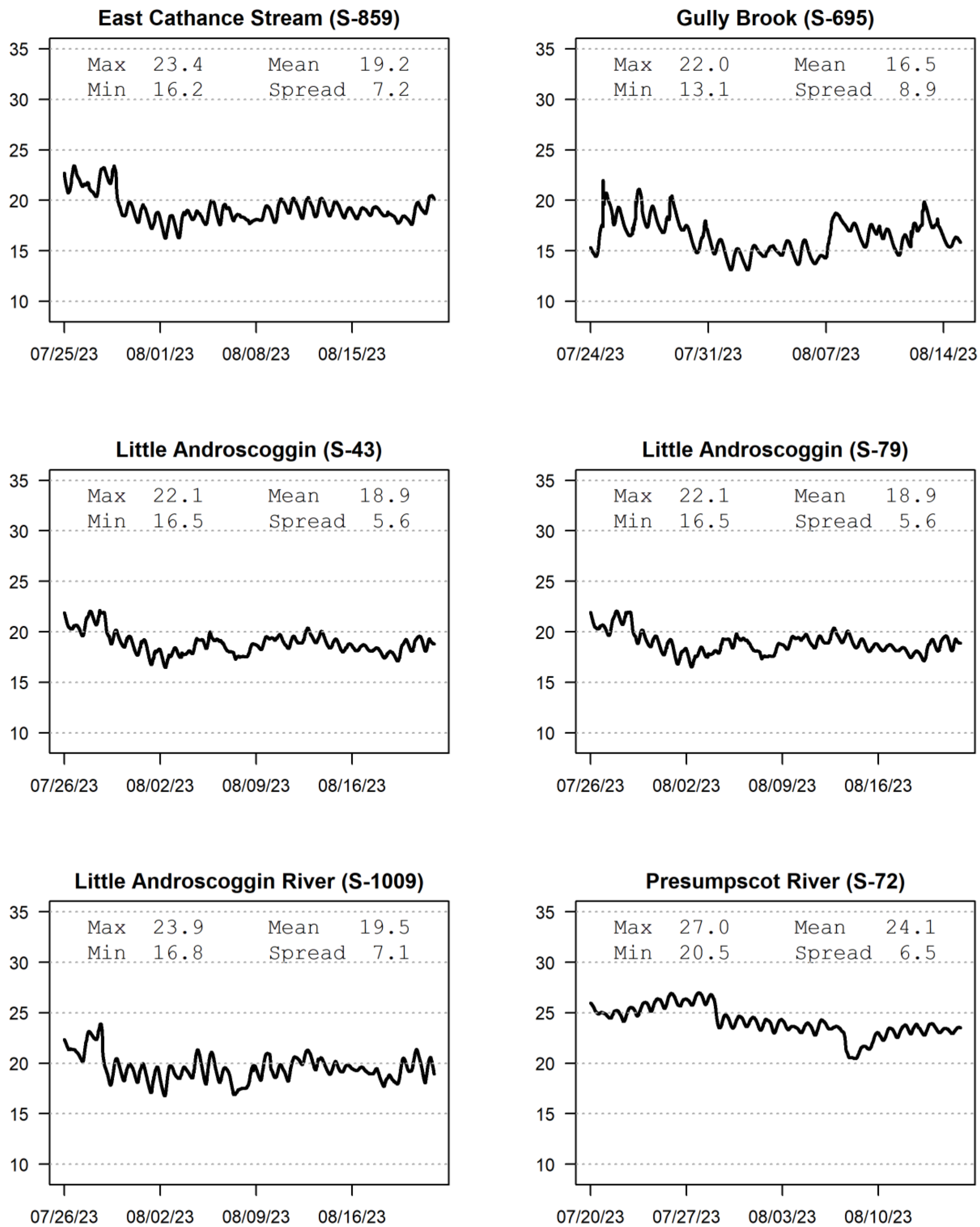

Figure 1. 2023 In-Stream Continuous Temperature Data (continued)

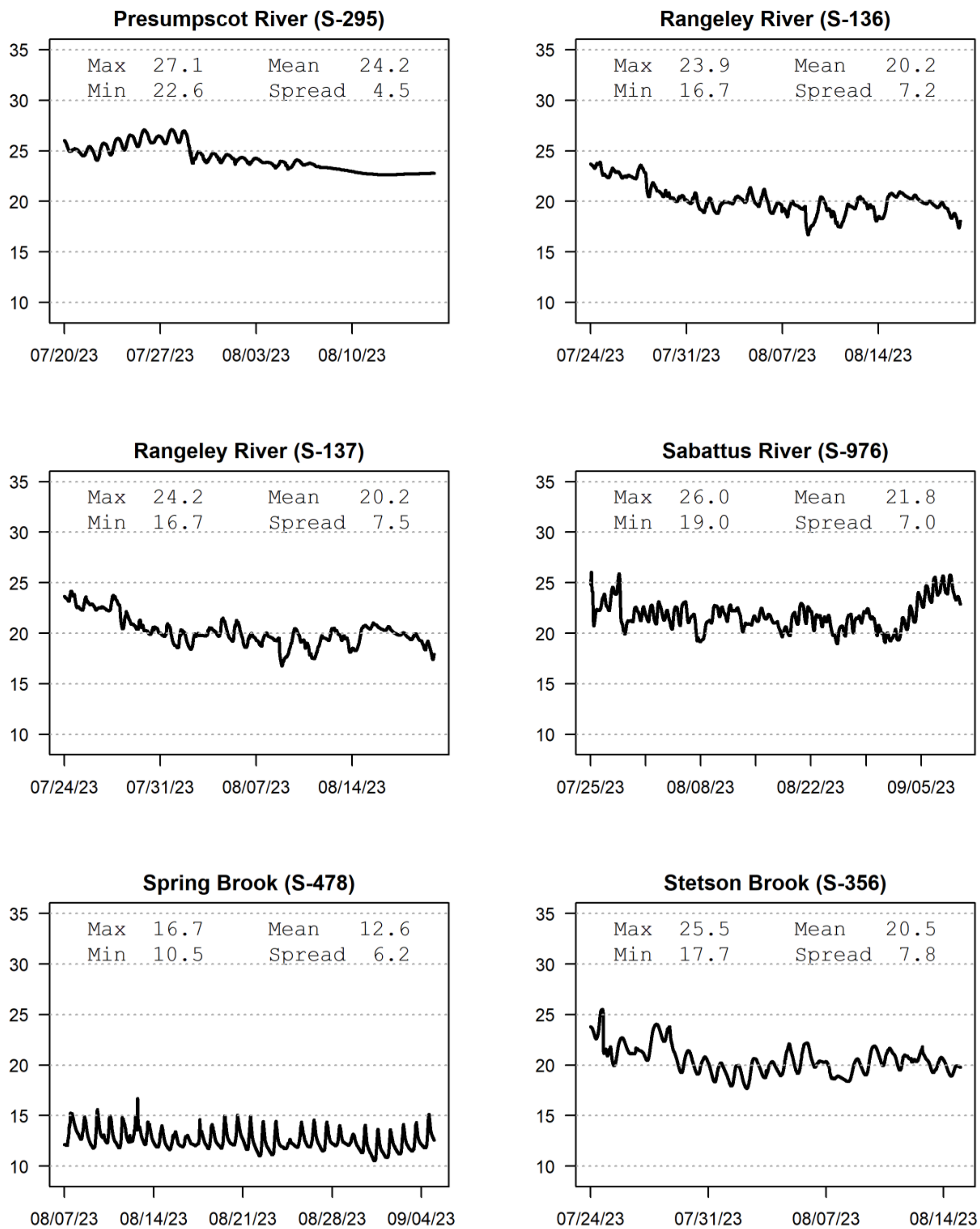

Figure 1. 2023 In-Stream Continuous Temperature Data (continued)

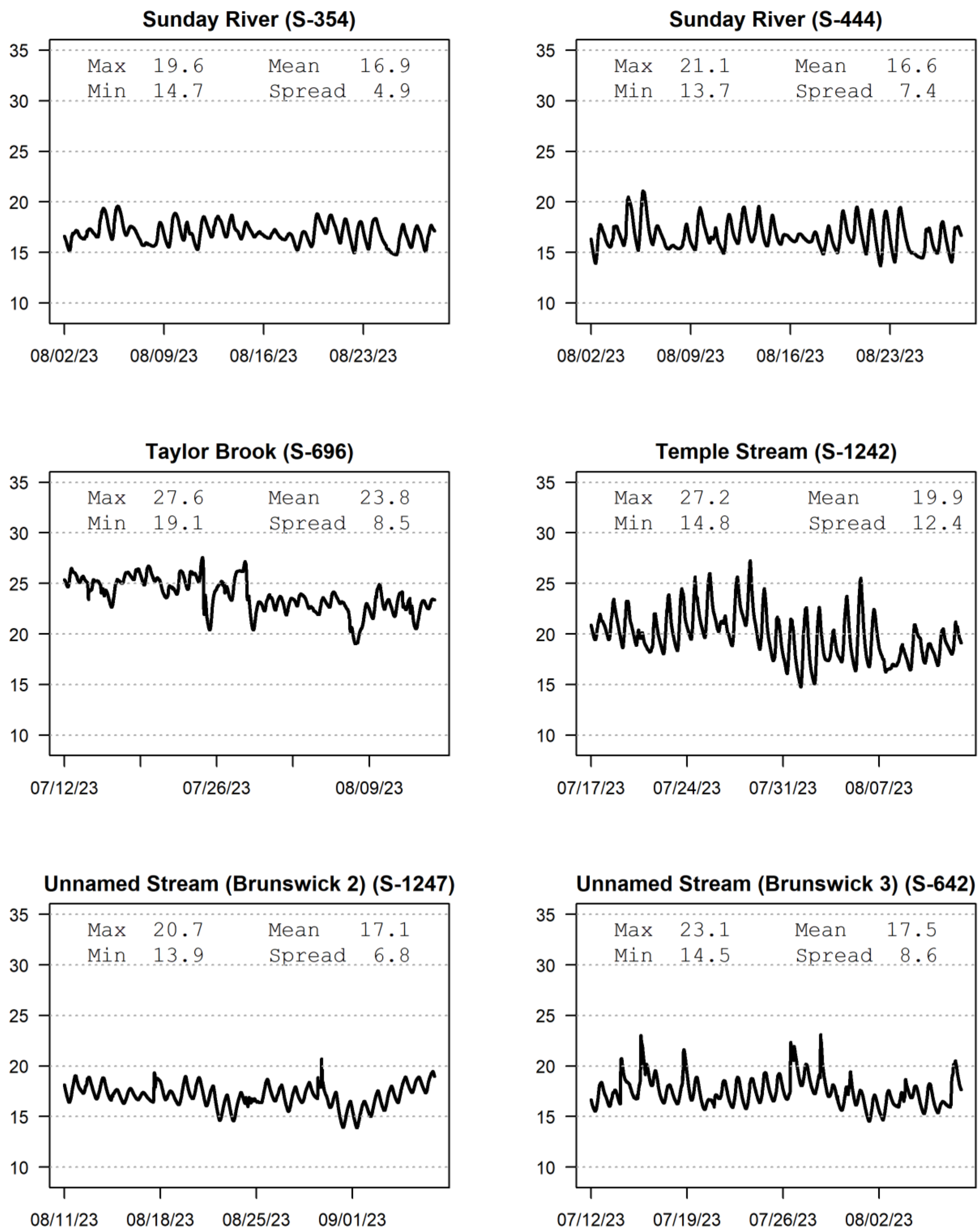

Figure 1. 2023 In-Stream Continuous Temperature Data (continued)

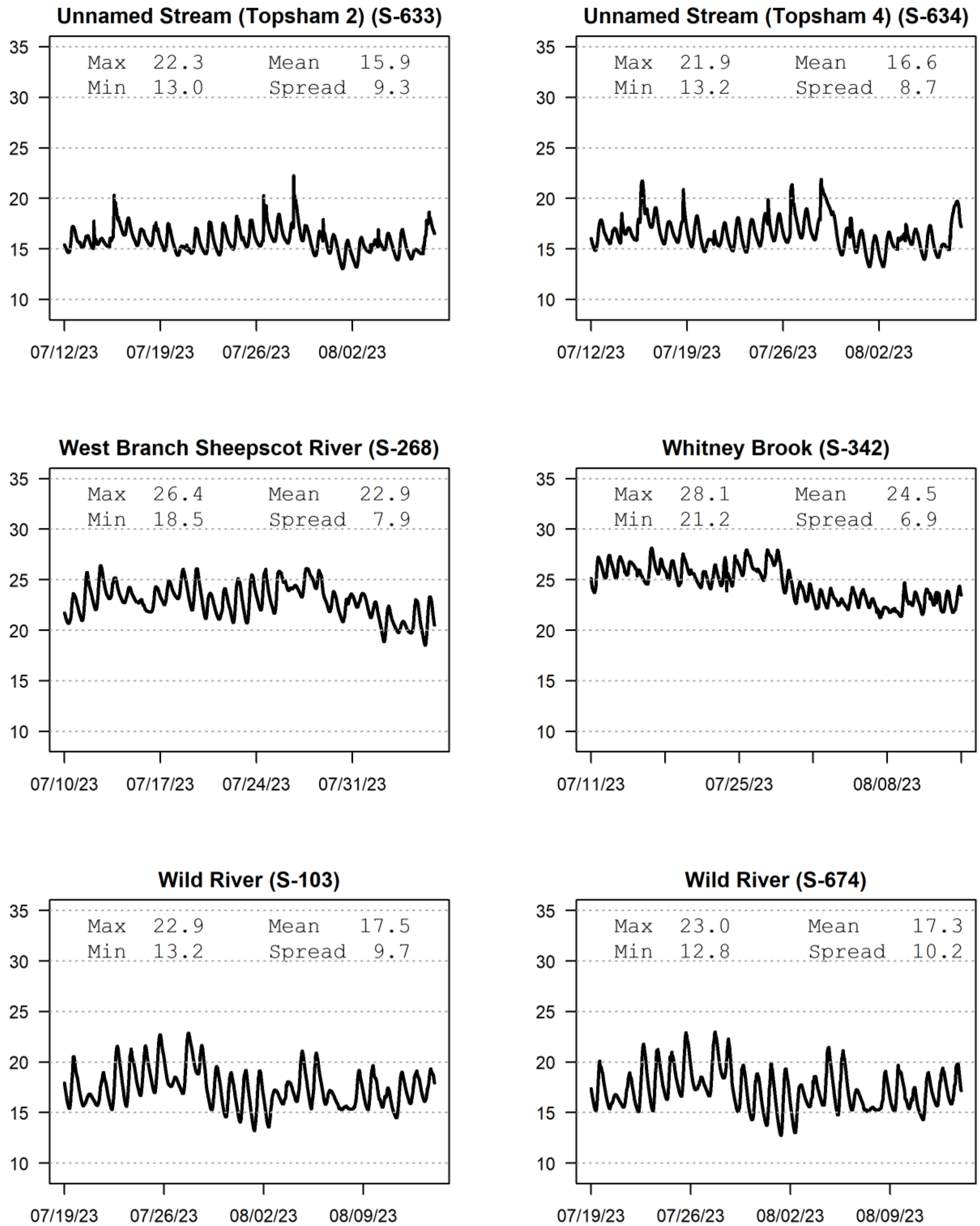

Figure 1. 2023 In-Stream Continuous Temperature Data (continued)

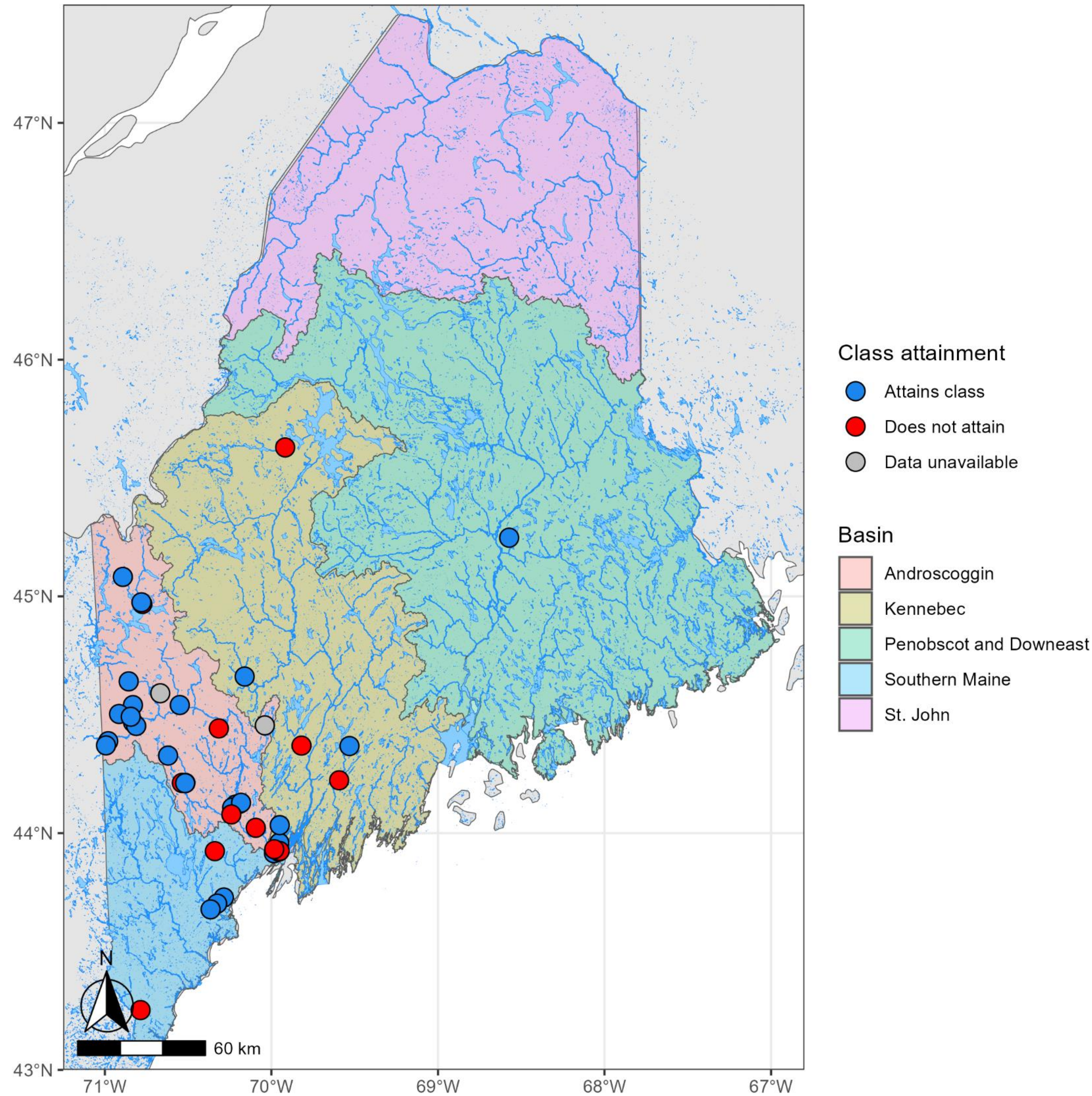

Figure 2. Map of 2023 sample locations and class attainment results.

4.3 2024 Results

The Biological Monitoring Unit concentrated its sampling in 2024 in the St John and Aroostook River basin. Thirty-five stations were sampled under the SWAT Program (Table 5). Taxonomic analysis of 2024 data is still ongoing. Results for 15 stations are currently available and are summarized in Table 5. Of these 15 stations, 3 did not attain criteria for their assigned class. Results for 20 additional stations are not yet available, however they will be added to this report as data are received back from our contractors, and the updated report will be reposted on the DEP webpage.

<u>Unnamed (Skanky) Stream – Presque Isle</u> Station 743

Unnamed (Skanky) Stream is a first order stream with a water quality goal of Class B which originates on the Presque Isle Airport and former Air Force base grounds, and flows into Presque Isle Stream. There is also residential development and agriculture in the watershed. Station 743 is located below Airport Drive. In 2024 the macroinvertebrate community met Class C aquatic life criteria, but not the assigned class of B. Total generic richness was fairly high (54), with a fair number of sensitive taxa present and an EPT richness of 15. There were no stoneflies present however and mayfly relative abundance was only 3%. The community was dominated by two tolerant genera of midges (Micropsectra 30.5 %; Parametriocnemus 11.5%). In addition to being pollution-tolerant, midges in the genus Micropsectra are able to quickly re-colonize following episodes of scouring and substrate disturbance, which may be a factor at this site due to altered hydrology. The specific conductance was very high (724 uS/cm at deployment and 820 uS/cm at retrieval), and chloride concentration was 80 mg/l at deployment. Nutrient levels were relatively high as well, with total phosphorus at 36 ug/l, and orthophosphate at 26 ug/l, and field observations indicate that the entire stream substrate was covered by an algal crust. The macroinvertebrate community is likely impacted by a combination of toxic runoff (road salt and possibly other de-icing and agricultural chemicals), nutrient and organic enrichment, and altered hydrology and habitat.

<u>Perkins Stream - Waterville</u> Station 977

Perkins Stream is a third order stream with a water quality goal of Class B. The stream flows through a highly developed watershed in Waterville, through Colby College, and finally to Messalonskee Stream. In 2024, the macroinvertebrate community at station 977 did not attain any aquatic life class (NA). There were few sensitive organisms present, with no stoneflies and only one mayfly individual present. EPT richness included only 4 genera, which is very low. The community consisted mostly of pollution tolerant midges (tolerant Chironomidae genera, 71.2% of sample). The specific conductance was very high (1054 uS/cm at deployment and 947 uS/cm at retrieval), as was chloride concentration (260 mg/l at deployment), indicating that the macroinvertebrate community is severely impacted by urban runoff including road salt and potentially other toxics. Sampling in 2012 and 2014 indicated similar results (non-attainment of aquatic life criteria for any water quality class). Results for 2022 sampling were indeterminate due to drought conditions that year.

Unnamed Tributary to Little Brassua Lake - Sandwich Academy Grant Township Station 1243

'Unnamed Tributary to Little Brassua Lake' is a first order stream that originates in Sandwich Academy Grant Township, and flows into Little Brassua Lake. It has a water quality goal of Class A. Station 1243 is located below the Canadian Pacific Railroad crossing, where there was a derailment and diesel fuel spill in 2023. In 2024, the macroinvertebrate community met Class C aquatic life criteria, but not Class A criteria. The final determination of class C was made using best professional judgement, from an initial statistical model result of I (indeterminate), due to low abundance and few sensitive taxa. Both total abundance and generic richness were low (39 and 28), with few sensitive organisms present, with only two stonefly individuals and a few sensitive mayflies (Paraleptophlebia, 8.5%of sample, Eurylophella, 0.9% of sample). The most abundant taxa was the moderately tolerant caddisfly Ptilostomis (43.39% of sample, Hilsenhoff tolerance value = 5). The community is still impoverished relative to what would be expected to be present given the high-quality habitat conditions, with a greater abundance and diversity of pollution-sensitive mayflies and stoneflies expected to be present. Total generic richness (28) was higher in 2024 compared with sampling conducted in 2023 (11), however there is still evidence of persistent toxic effects of diesel fuel in the stream on the aquatic macroinvertebrate community. Petroleum sheen on the water surface was observed at deployment and retrieval, and there was also a petroleum odor evident at the site on both dates. Annual monitoring is recommended to track continued impacts and potential long-term recovery of the macroinvertebrate community.

Table 5. 2024 SWAT Benthic Macroinvertebrate Biomonitoring Results

Some of the 2024 samples have not been processed yet. The table will be updated when the results are available.

Waterbody	Town	Station	Log	Potential sources of pollution[1]	Statutory Class / Final Determination	Attains Class?	Probable Cause
Alder Brook	Presque Isle	1016	3112	Urban and agricultural NPS	B/B	Y	
Amsden Brook	Ft. Fairfield	1018	3133	Agricultural NPS			
Aroostook River	Caribou	370	3150	Agricultural NPS; Below POTW			
Caribou Stream	Caribou	935	3152	Urban and agricultural NPS			
Coloney Brook	Ft. Fairfield	733	3132	Agricultural NPS			
Cowett Brook	Presque Isle	1021	3114	Urban and agricultural NPS			
Dudley Brook	Chapman	215	3125	Agricultural NPS			
East Branch Pleasant River	Brownville	1254	3142	Reference (salmon stream)	A/A	Y	
East Branch Wesserunsett River	Athens	486	3136	Annual reference site (Regional Monitoring Network)			
Everett Brook	Ft. Fairfield	924	3124	Agricultural NPS			
Fish River	Ft. Kent	371	3122	Urbanand agricultural NPS; Below POTW			
Frost Brook	Westfield	1022	3105	Agricultural NPS	A/A	Y	
Gardner Brook	Wade	689	3128	Reference			
Hammond Brook	Hamlin	1025	3131	Agricultural NPS			

Table 5. 2024 SWAT Benthic Macroinvertebrate Biomonitoring Results (continued)

Waterbody	Town	Station	Log	Potential sources of pollution[1]	Statutory Class / Final Determination	Attains Class?	Probable Cause
Meduxnekeag River	Houlton	1	3110	Agricultural NPS	A/A	Y	
Meduxnekeag River	Houlton	964	3115	Urban and agricultural NPS			
Meduxnekeag River	Houlton	364	3116	Urban and agricultural NPS			
Meduxnekeag River	Houlton	1028	3104	Agricultural NPS	B/B	Y	
Meduxnekeag River	Littleton	389	3111	Agricultural NPS	A/A	Y	
Merritt Brook	Presque Isle	742	3113	Agricultural NPS			
Middle Branch Pleasant River	Ebeemee TWP	667	3139	Reference (salmon stream)	A/A	Y	
N. Br. Presque Isle Stream	Mapleton	11	3127	Urban and agricultural NPS; Below POTW			
Perkins Stream	Waterville	977	3137	Urban NPS	B/NA	N	NPS toxics, road salt
Perley Brook	Fort Kent	727	3120	Urban and agricultural NPS, logging			
Presque Isle Stream	Presque Isle	197	3118	Urban and agricultural NPS; Below POTW			
Prestile Stream	Easton	734	3126	Urban and agricultural NPS			
Prestile Stream	Blaine	3	3103	Urban and agricultural NPS; Below POTW	A/A	Y	

Table 5. 2024 SWAT Benthic Macroinvertebrate Biomonitoring Results (continued)

Waterbody	Town	Station	Log	Potential sources of pollution[1]	Statutory Class / Final Determination	Attains Class?	Probable Cause
Sheepscot River	N. Whitefield	74	3109	Annual reference site (Regional Monitoring Network)	A/A	Y	
South Branch of Meduxnekeag River	Hodgdon	2	3102	Agricultural NPS	A/A	Y	
St. John River	Ft. Kent	8	3149	Urban and agricultural NPS, logging	AA/A	Y	
Unnamed (Skanky) Stream	Presque Isle	743	3119	Urban and agricultural NPS	B/C	N	NPS toxics, road salt, nutrients, altered hydrology
Unnamed Brook (Presque Isle)	Presque Isle	1267	3117	Agricultural NPS			
Unnamed Tributary to Little Brassua Lake	Sandwich Academy Grant TWP	1243	3135	Train derailment / Diesel spill	A/C	N	Toxic impact from diesel fuel
West Branch Sheepscot River	China	268	3108	Annual reference site (Regional Monitoring Network)	A/A	Y	
Williams Brook	Presque Isle	1031	3138	Agricultural NPS, logging			

Table 6. 2024 SWAT Field Data

Site	Station	Log	Sample Deployment					Sample Retrieval				
			Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU	Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU
Alder Brook	1016	3112	07/11/2024	13.90	9.11	528.0	7.88	08/05/2024	8.02	603.0	9.99	15.10
Amsden Brook	1018	3113	07/10/2024	17.00	9.76	470.0	8.23	08/06/2024	8.18	469.0	10.29	16.30
Aroostook River	370	3150	08/14/2024	20.10	9.29	160.1	7.93	09/10/2024	8.83	163.4	11.94	17.20
Caribou Stream	935	3152	08/14/2024	17.50	9.88	359.0	8.02	09/10/2024	7.93	357.5	10.81	14.10
Coloney Brook	733	3132	07/10/2024	19.00	10.15	394.4	8.33	08/06/2024	8.29	426.1	11.17	16.90
Cowett Brook	1021	3114	07/08/2024	9.70	11.22	49.8	7.87	08/05/2024	7.97	503.0	10.69	11.30
Dudley Brook	215	3125	07/10/2024	22.60	8.12	154.9	7.70	08/06/2024	8.05	245.0	7.96	24.20
East Branch Pleasant River	1254	3142	07/16/2024	26.55	7.82	27.1	6.43	08/13/2024	6.86	22.3	8.66	23.86
East Branch Wesserunsett Stream	486	3136	07/15/2024	22.10	8.91	55.7	7.68	08/12/2024	7.88	52.5	9.54	19.60
Everett Brook	924	3124	07/17/2024	18.40	8.45	438.6	7.80	08/14/2024	8.05	475.0	9.26	19.20
Fish River	371	3122	07/16/2024	24.70	8.96	73.3	7.49	08/13/2024	7.67	78.4	9.21	23.20
Frost Brook	1022	3105	07/17/2024	19.90	8.66	411.7	7.86	08/12/2024	8.08	455.0	9.01	19.40
Gardner Brook	689	3128	07/09/2024	16.70	9.87	51.7	7.07	08/06/2024	7.99	122.3	10.15	15.00
Hammond Brook	1025	3131	07/09/2024	21.50	9.56	142.0	8.21	08/06/2024	7.32	97.3	9.77	18.50
Meduxnekeag River	1	3110	07/08/2024	24.00	10.19	165.1	8.44	08/05/2024	8.35	227.1	10.60	25.20
Meduxnekeag River	1028	3104	07/15/2024	23.80	7.77	158.9	7.48	08/12/2024	7.87	180.3	9.02	23.30
Meduxnekeag River	364	3116	07/08/2024	24.80	10.36	155.8	8.35	08/05/2024	8.31	213.2	9.59	25.60
Meduxnekeag River	389	3111	07/08/2024	25.50	10.47	169.8	8.64	08/05/2024	8.22	232.8	9.48	25.10
Meduxnekeag River	964	3115	07/08/2024	23.60	9.94	148.4	8.20	08/05/2024	8.26	215.1	9.21	23.80
Merritt Brook	742	3113	07/08/2024	22.20	9.09	343.5	8.22	08/05/2024	8.47	403.3	9.76	20.60
Middle Branch Pleasant River	667	3139	07/16/2024	20.48	8.81	19.6	6.68	08/13/2024	7.13	22.4	9.58	18.90
North Branch Presque Isle Stream	11	3127	07/10/2024	23.00	9.47	151.8	8.07	08/07/2024	8.06	243.8	9.41	20.20
Perkins Stream	977	3137	07/16/2024	21.80	8.11	1054.0	7.99	08/13/2024	8.06	947.0	9.33	17.50
Perley Brook	727	3120	07/16/2024	22.40	9.18	169.9	7.79	08/13/2024	8.41	185.9	10.58	20.70

Table 6. 2024 SWAT Field Data (continued)

Site	Station	Log	Sample Deployment					Sample Retrieval				
			Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU	Date	Temperature Deg C	Dissolved Oxygen MG/L	Specific Conductance US/CM	pH STU
Presque Isle Stream	197	3118	07/10/2024	22.80	8.73	99.0	7.36	08/06/2024	8.28	188.2	9.34	25.50
Prestile Stream	3	3103	07/15/2024	22.50	10.92	340.5	8.37	08/12/2024	8.52	382.0	12.42	22.90
Prestile Stream	734	3126	07/10/2024	25.00	7.95	335.2	7.91	08/07/2024	7.81	322.7	7.16	19.40
Sheepscot River	74	3109	07/16/2024	27.00	7.92	65.2	7.24	08/13/2024	7.46	69.5	9.00	22.40
South Branch Meduxnekeag River	2	3102	07/15/2024	25.20	8.85	94.0	7.31	08/12/2024	8.15	167.4	10.25	23.10
St John River	8	3149	08/13/2024	22.20	9.18	67.2	7.40	09/11/2024	7.79	95.5	10.74	20.00
Unnamed (Skanky) Stream (Presque Isle)	743	3119	07/08/2024	18.30	9.37	724.0	8.12	08/05/2024	8.10	820.0	10.04	18.00
Unnamed Brook (Presque Isle)	1267	3117	07/09/2024	16.60	9.79	396.3	8.31	08/06/2024	8.26	402.3	10.46	15.20
Unnamed Stream (Tributary To Little Brassua Lake)	1243	3135	07/15/2024	16.10	8.85	61.5	7.30	08/12/2024	7.34	63.6	9.12	13.90
West Branch Sheepscot River	268	3108	07/16/2024	24.40	9.01	100.2	7.77	08/13/2024	7.76	103.1	9.77	19.50
Williams Brook	1031	3138	07/11/2024	18.40	8.58	290.7	7.80	08/07/2024	8.33	438.5	9.86	15.90

Table 7. 2024 SWAT Water Chemistry Data

In 2024, TKN, Total P, SRP, and Chloride were analyzed by the Health & Environmental Testing Laboratory, Augusta, ME.

Waterbody	Station	Log	Sampling Date	TKN (MG/L)	Total P (UG/L)	SR P (UG/L)	Chloride (MG/L)
Alder Brook	1016	3112	07/11/2024	0.5	76	30	47
Amsden Brook	1018	3113	07/10/2024	0.3	30	7	11
Aroostook River	370	3150	08/14/2024	0.4	15	1	5
Caribou Stream	935	3152	08/14/2024	0.3	11	< 1	14
Coloney Brook	733	3132	07/10/2024	0.4	65	44	11
Cowett Brook	1021	3114	07/08/2024	< 0.3	10	9	17
Dudley Brook	215	3125	07/10/2024	0.5	32	7	5
East Branch Wesserunsett Stream	486	3136	07/15/2024	0.3	12	1	3
Everett Brook	924	3124	07/17/2024	0.5	58	23	13
Fish River	371	3122	07/16/2024	0.3	7	< 1	1
Frost Brook	1022	3105	07/17/2024	0.4	24	7	14
Gardner Brook	689	3128	07/09/2024	0.5	19	1	< 1
Hammond Brook	1025	3131	07/09/2024	0.5	21	3	4
Meduxnekeag River	1	3110	07/08/2024	0.5	12	2	8
Meduxnekeag River	1028	3104	07/15/2024	0.4	13	1	6
Meduxnekeag River	364	3116	07/08/2024	0.5	13	1	7
Meduxnekeag River	389	3111	07/08/2024	0.5	12	1	8
Meduxnekeag River	964	3115	07/08/2024	0.4	11	1	7
Merritt Brook	742	3113	07/08/2024	0.4	26	8	10
North Branch Presque Isle Stream	11	3127	07/10/2024	0.5	27	4	5
Perkins Stream	977	3137	07/16/2024	< 0.3	16	3	260
Perley Brook	727	3120	07/16/2024	< 0.3	12	4	9

TKN = Total Kjeldahl-Nitrogen, Total P = Total Phosphorus, SRP = Soluble Reactive Phosphorus (ortho-phosphate), “<” = constituent not detected at the reporting limit.

Table 7. 2024 SWAT Water Chemistry Data (continued)

Waterbody	Station	Log	Sampling Date	TKN (MG/L)	Total P (UG/L)	SR P (UG/L)	Chloride (MG/L)
Presque Isle Stream	197	3118	07/10/2024	0.6	27	2	4
Prestile Stream	3	3103	07/15/2024	0.4	19	6	11
Prestile Stream	734	3126	07/10/2024	0.5	37	10	23
Sheepscot River	74	3109	07/16/2024	0.4	19	3	7
South Branch Meduxnekeag River	2	3102	07/15/2024	0.6	21	2	3
St John River	8	3149	08/13/2024	0.5	13	2	2
Unnamed (Skanky) Stream (Presque Isle)	743	3119	07/08/2024	0.3	36	26	81
Unnamed Brook (Presque Isle)	1267	3117	07/09/2024	0.3	35	17	13
Unnamed Stream (Tributary To Little Brassua Lake)	1243	3135	07/15/2024	0.3	17	3	< 1
West Branch Sheepscot River	268	3108	07/16/2024	0.4	16	2	10
Williams Brook	1031	3138	07/11/2024	1	120	14	6

TKN = Total Kjeldahl-Nitrogen, Total P = Total Phosphorus, SRP = Soluble Reactive Phosphorus (ortho-phosphate), “<” = constituent not detected at the reporting limit

Table 8. Past Attainment History of 2024 Sampling Stations

The table below provides the attainment history for 2024 sampling stations that have been sampled in the past.

Waterbody	**Station**	**Attained Class**	**Did not Attain Class**	**Indeterminate Result**
Alder Brook	1016	—	2014	—
Amsden Brook	1018	2019	2014	—
Aroostook River	370	1999, 2009, 2012	—	—
Caribou Stream	935	2009	—	—
Coloney Brook	733	2004, 2019	2009	—
Cowett Brook	1021	—	2014, 2019	—
Dudley Brook	215	2009	1994, 1999	—
East Branch Wesserunsett Stream	486	2001, 2007, 2011-2017, 2018-2023	—	—
Everett Brook	924	2009	—	—
Fish River	371	1999, 2009	—	—
Frost Brook	1022	2014, 2019	—	—
Gardner Brook	689	2004, 2009	—	—
Hammond Brook	1025	—	2014	—
Meduxnekeag River	1	1983, 1991, 1998-2000, 2004	—	—
Meduxnekeag River	364	1998-2000, 2004, 2014	—	—
Meduxnekeag River	389	1999, 2000	—	—
Meduxnekeag River	649	1983, 1991, 1998-2000, 2004	—	—
Meduxnekeag River	964	2004	—	—
Meduxnekeag River	1028	2014	—	—
Merritt Brook	742	—	2009	2004
North Branch Presque Isle Stream	11	1983, 1993, 2004	—	—
Perkins Stream	977	—	2012, 2014	2022

Table 8. Past Attainment History of 2024 Sampling Stations (continued)

Waterbody	Station	Attained Class	Did Not Attain Class	Indeterminate Result
Perley Brook	727	2009	—	—
Presque Isle Stream	197	1993, 1994, 2014	—	—
Prestile Stream	3	1994, 1999, 2014	1983, 2009	—
Prestile Stream	734	—	1999, 2004, 2009	—
Sheepscot River	74	1985, 1987-1990, 1992, 1995, 1996 1998-2017, 2019-2022	1984, 1986, 1991, 1993, 1994, 1997, 2023	—
South Branch Meduxnekeag River	2	1983, 1991, 1999, 2000, 2004	—	—
St. John River	8	1983, 1985, 2009	1999	—
Unnamed (Skanky) Stream (Presque Isle)	743	2009	2004	—
Unnamed Stream (Tributary to Little Brassua Lake)	1243	—	2023	—
West Branch Sheepscot River	268	1996-1999, 2001, 2002, 2005, 2007, 2009-2017, 2019, 2020, 2022	2000, 2003, 2004, 2006, 2008, 2018, 2021	1995
Williams Brook	1031	2014, 2019	—	—

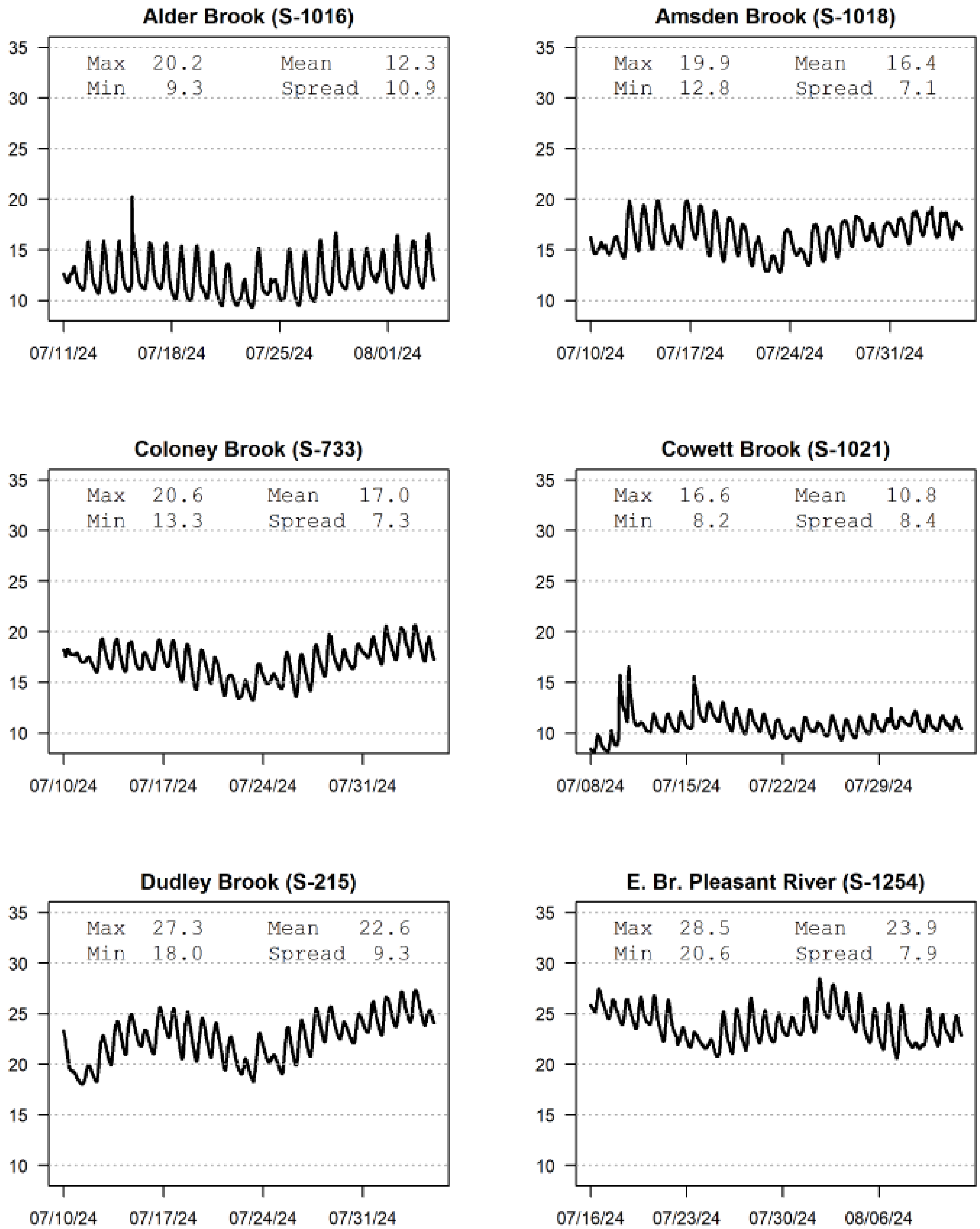

Figure 3. 2024 In-Stream Continuous Temperature Data

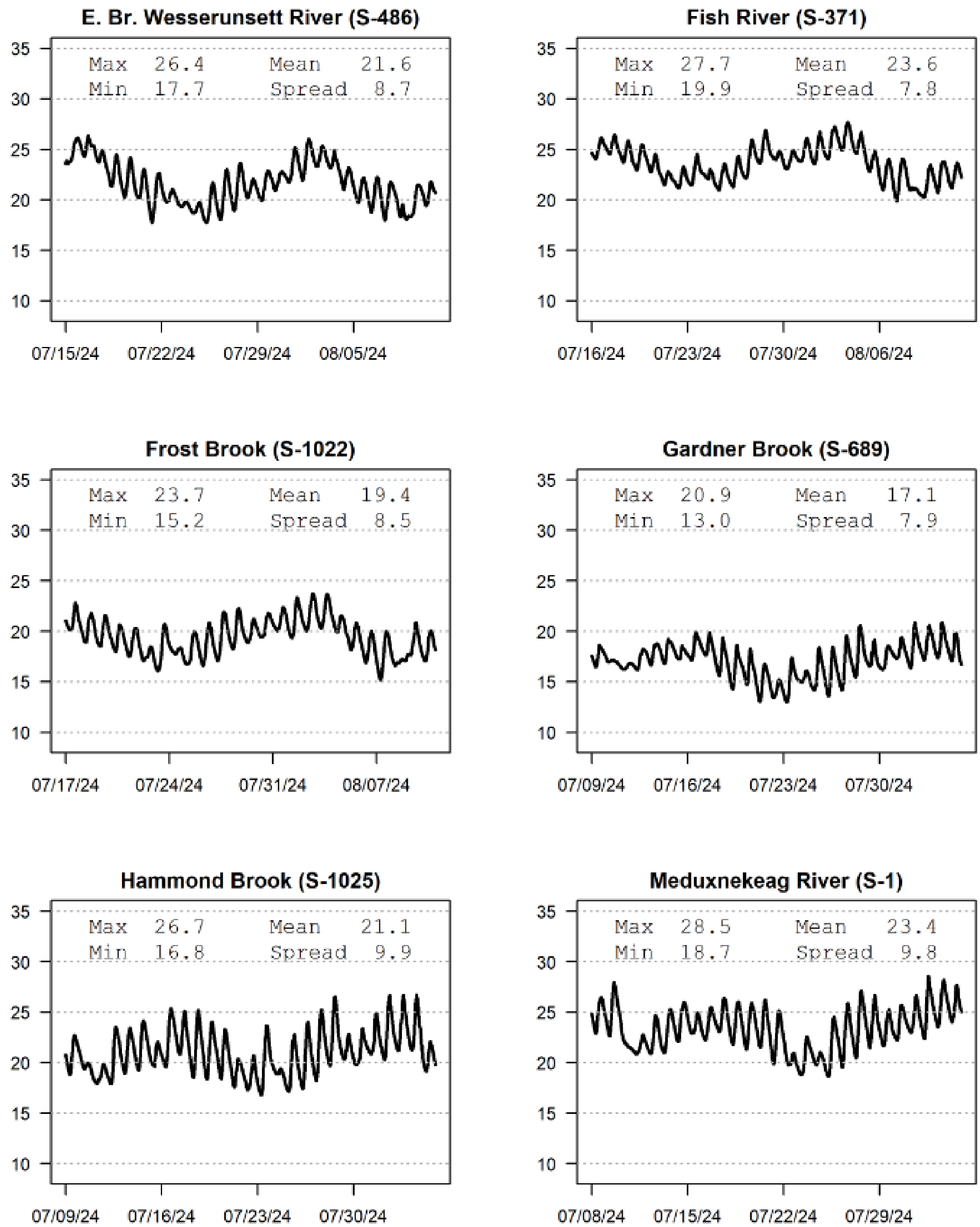

Figure 3. 2024 In-Stream Continuous Temperature Data (continued)

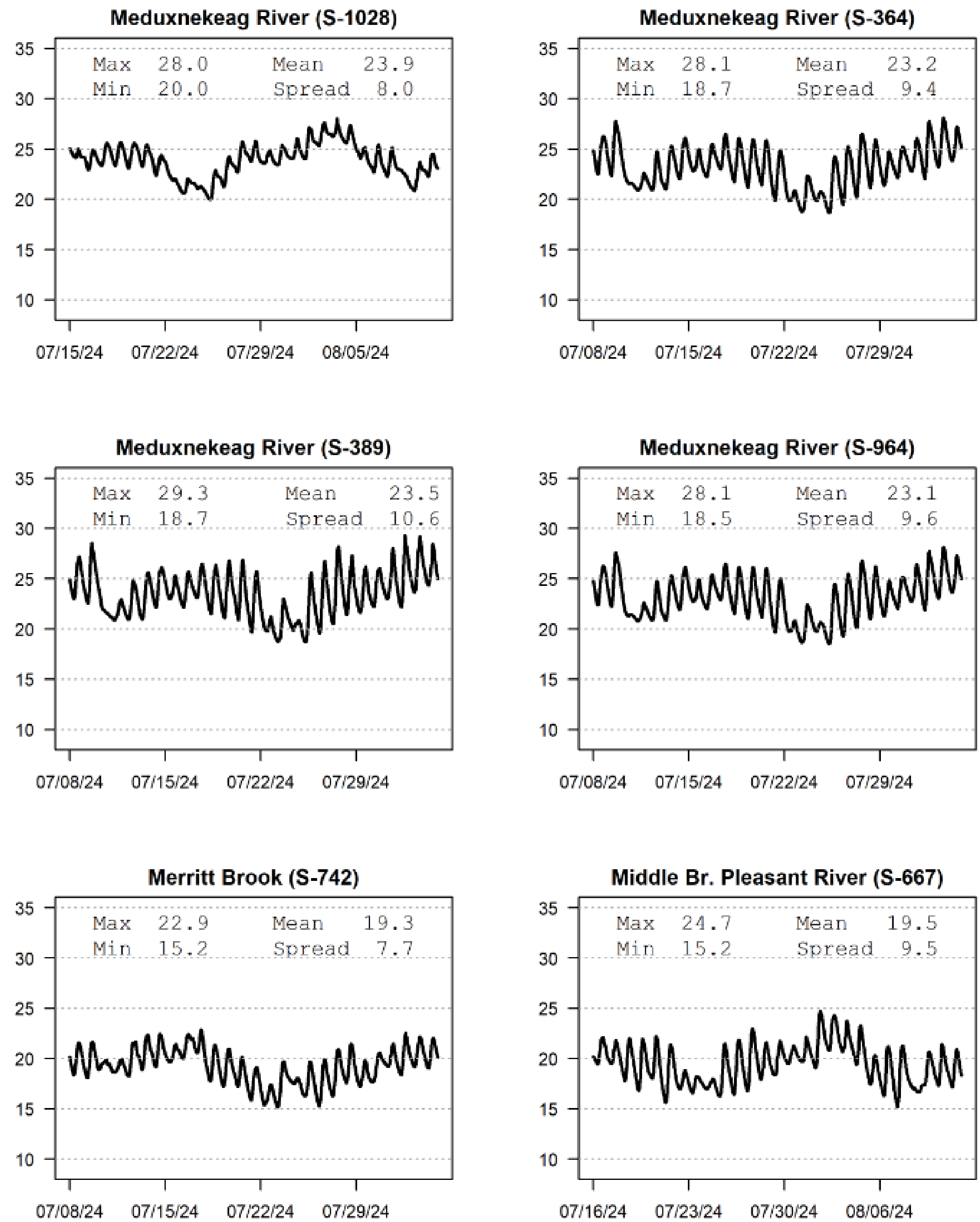

Figure 3. 2024 In-Stream Continuous Temperature Data (continued)

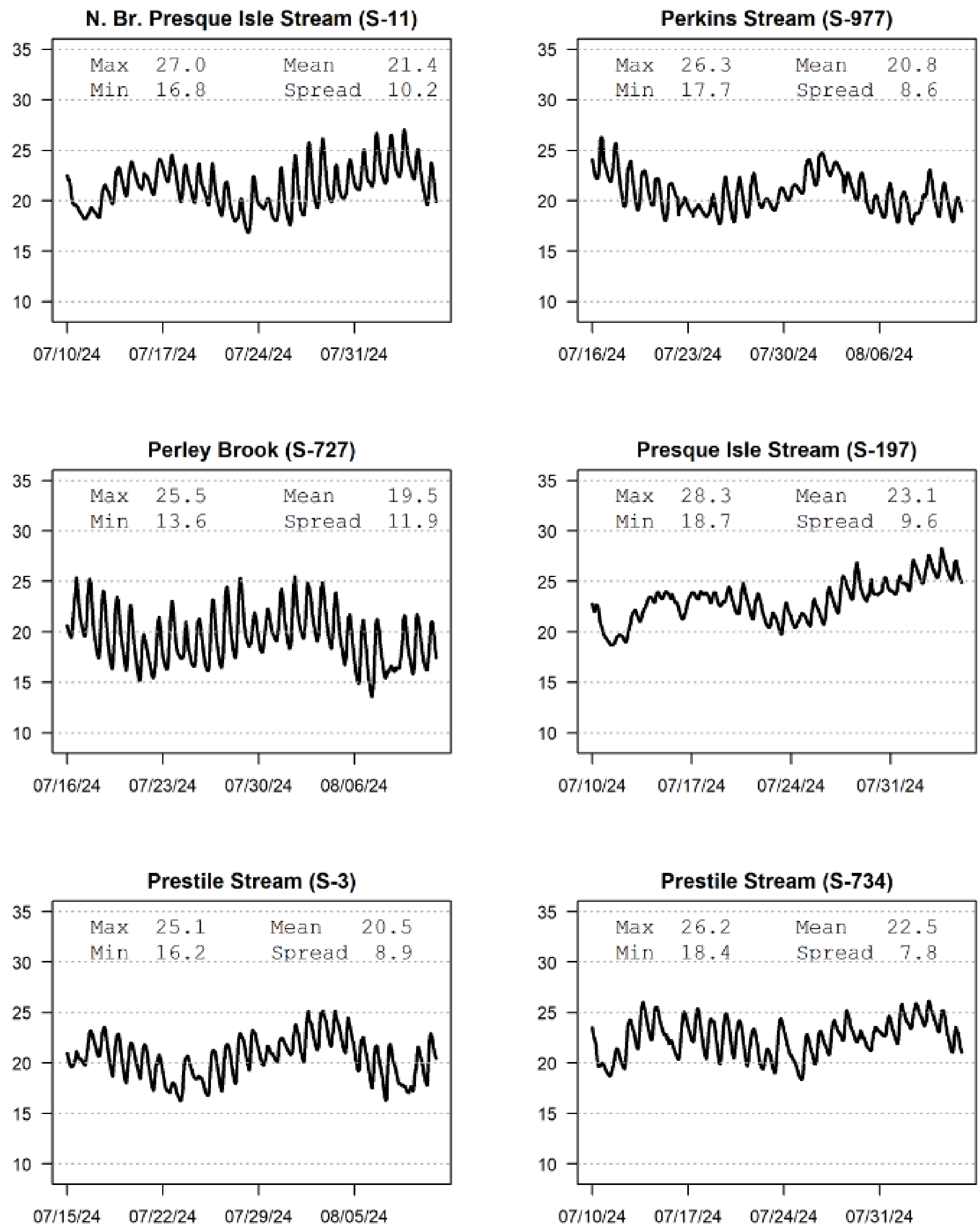

Figure 3. 2024 In-Stream Continuous Temperature Data (continued)

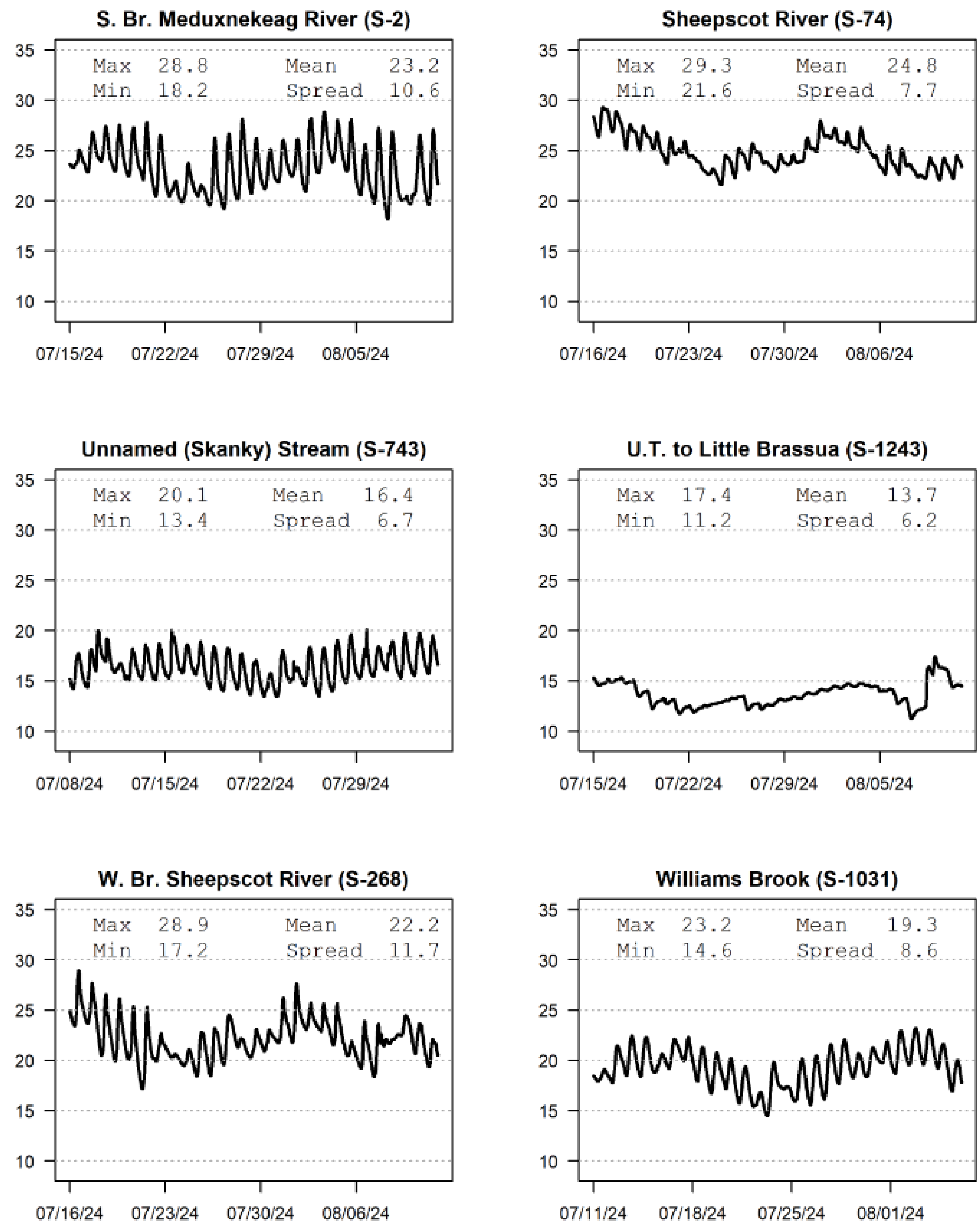

Figure 3. 2024 In-Stream Continuous Temperature Data (continued)

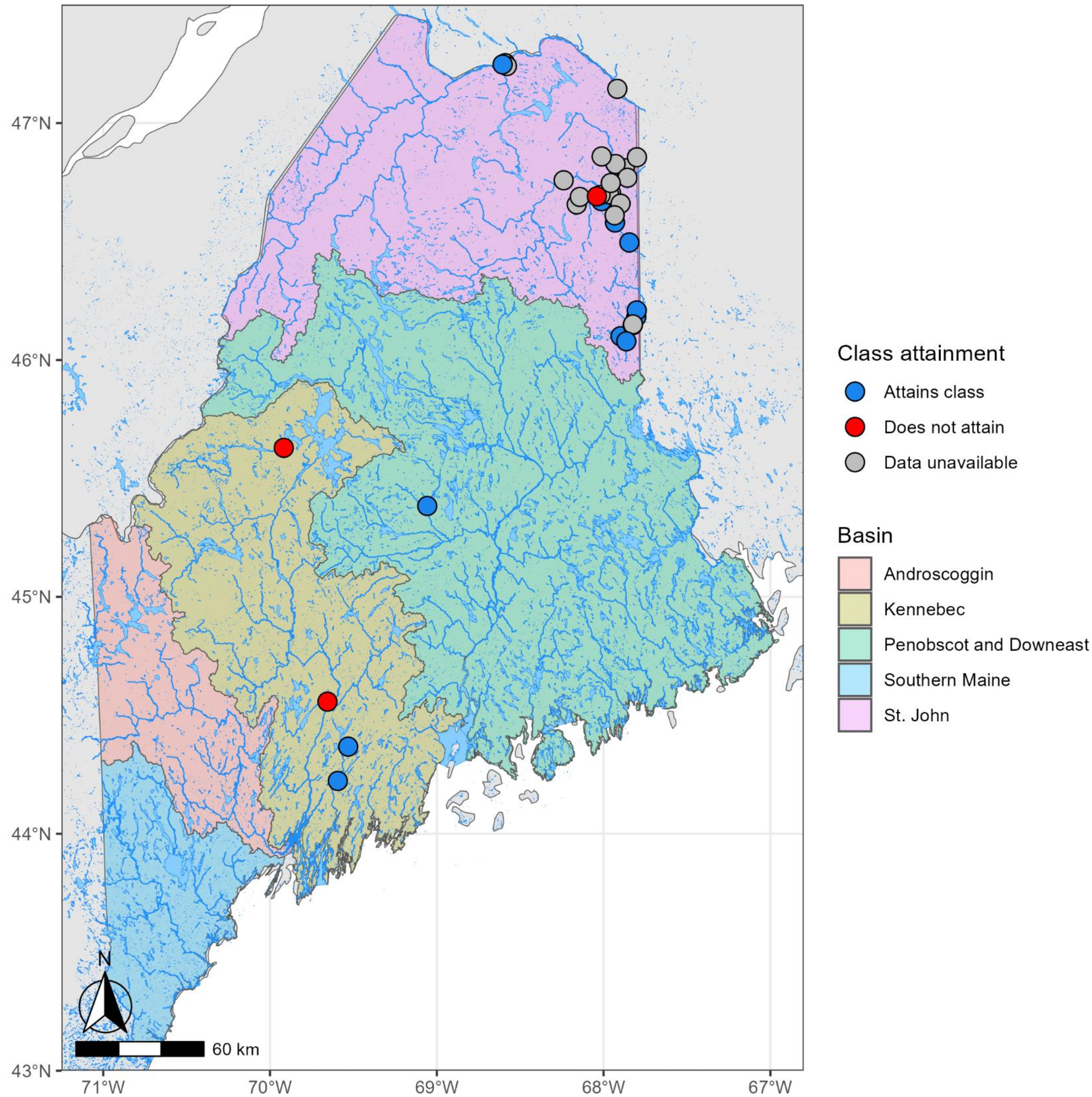

Figure 4. Map of 2024 sample locations and class attainment results.