**Report to the Joint Standing Committee on Environment and Natural Resources**
**130th Legislature, First Session**

# Surface Water Ambient Toxics Monitoring Program 2019-2020

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## Introduction

This 2019-2020 Surface Water Ambient Toxic (SWAT) monitoring program final report is organized into an Executive Summary, Introduction and 3 modules:
1. Marine and Estuarine
2. Lakes
3. Rivers and Streams

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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| | |
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Collection of samples was conducted by the principal investigators and technical assistants listed (DEP staff unless otherwise specified). Chemical analyses were performed by SGS AXYS, Sidney, British Columbia, or other laboratories as listed in reports in individual sections.

## 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 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 Department of Environmental Protection (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 modules: 1) Marine and Estuarine, 2) Lakes, 3) Rivers and Streams, and 4) Special Studies. This biennial report follows the goals of the 2019-2023 five-year conceptual plan, which are generally to continue to monitor previously identified and new toxic issues in the marine environment, lakes and ponds, and rivers and streams, including but not limited to providing baseline data for use by the Department of Marine Resources (DMR) in evaluating and assessing shellfish harvesting areas; providing fish and shellfish contaminants data to the Maine Center for Disease Control and Prevention (MECDC) for use in revising Maine's fish consumption advisories; and continuing biological assessment of rivers' and streams' attainment of Maine's Water Quality Standards.

This report more specifically presents the findings of the 2019 and 2020 annual work plans recommended by the SWAT TAG in meetings May 30, 2019 and May 20, 2020. The 2019 and 2020 work plans focused on monitoring of contaminants in shellfish from known or suspected contaminated marine areas, cyanotoxins in Harmful Algal Blooms, perflourinated alkyl substances (PFAS) in rivers below industrial treatment plants and biosolids spreading sites as requested by MECDC, biomonitoring of aquatic life in rivers and streams in the St. John River watershed and in Southern Maine. Following is a summary of key findings from the 2019 and 2020 SWAT programs for each of the modules.

- **MARINE AND ESTUARINE**
    - Blue mussels collected from all ten sites had mean mercury, nickel, zinc, silver, cadmium, and lead concentrations below Maine Center for Disease Control (MCDC) fish tissue action levels (FTALs).
    - Softshell clams collected from all five sites had mean mercury, nickel, zinc, silver, cadmium, and lead concentrations below MCDC FTALs in edible clam tissue. Testing of clams from Pottle and Hilton coves, Wiscasset, and Holbrook and Ram islands, Castine, (areas requested by Maine Dept. of Marine Resources (DMR) indicate metals concentrations in edible clam tissue support human consumption within limits of existing FTALs.
    - Softshell clam edible tissue from the one site tested, Dennys River, Edmunds Twp., contained no detectable perfluorinated alkyl substances (PFAS) (33 compounds included in analysis). No PFAS were detected in clam tissue at any site in previous testing.
    - Blue mussel tissue from several sites tested contained very low levels of ten different PFAS (just above reporting limits).
    - Blue mussel tissue from nine of 23 sites tested had perfluorooctanesulfonamide (PFOSA) concentrations in all replicates at very low levels (just above reporting limits). PFOSA remains the most commonly detected PFAS in mussel tissue.
    - Blue mussel tissue from inner Fore River, Portland/S. Portland, had perfluorooctanesulfonate (PFOS) concentrations in all replicates above the reporting limit but at a level approximately two orders of magnitude below the MCDC FTAL for PFOS. No other mussel sites tested had detectable levels of PFOS.

- **LAKES**
    - Since 2014, 382 samples have been tested from 126 lakes in a probability-based study of lakes >150 acres in surface area located in populated regions of the state, and, 487 samples have been tested from 12 lakes in the time-series study of lakes known to support algal blooms.
    - Maine DEP has established the capacity to analyze microcystin using the enzyme-linked immunosorbent assay (ELISA) Method.
    - The time-series results and results from the probabilistic study suggest that relatively few Maine lakes produce microcystin concentrations that exceed EPA guidelines, but those few lakes that support severe, chronic algal blooms are very likely to exceed EPA guidelines.
    - Algal scums that accumulate on downwind shorelines may have very high concentrations of microcystin.

- **RIVERS AND STREAMS**

  - In 2019, the Biological Monitoring Unit sampled macroinvertebrate communities at forty-two stations focusing in the Aroostook and St. John basins to determine attainment of Maine's aquatic life use criteria. Thirty-two stations met the aquatic life criteria for their legislatively assigned water quality class, 9 stations did not attain criteria for their assigned class, and one station had an indeterminate result.
  - In 2020, the Biological Monitoring Unit focused macroinvertebrate sampling in the Southern Maine basin. A total of forty-six stations were sampled. Due in part to contractor delays related to the COVID-19 pandemic, data for 2020 samples are not yet all available. Attainment results for available macroinvertebrate data are summarized in Table 3.1.1b. Samplers at two stations were disturbed and no macroinvertebrate data were obtained, however field data are included in this report.
  - In 2019, study of perfluorinated alkyl substances (PFAS) in fish from the Androscoggin River, Kennebec River, Halfmoon Stream, and Kennebunk River above and below industrial treatment plants found primarily perfluorooctanesulfonate (PFOS) at measurable levels. Concentrations were elevated below some industrial discharges and biosolids spreading sites but well below the Maine Center for Disease Control (MeCDC) and Prevention's Fish Tissue Action Level (FTAL).
  - In 2020 study of PFAS in fish from the Penobscot River and the St Croix River above and below former or current industrial treatment plants found primarily PFOS at barely measurable levels. Concentrations were elevated below farm biosolids spreading sites on Halfmoon Stream and the Kenduskeag River and below a municipal wastewater treatment plant on the Salmon Falls River, but well below the MeCDC FTAL. PFOS was also elevated in white perch and more so in smallmouth bass from China Lake, still well below the MeCDC FTAL. PFOS exceeded the MeCDC FTAL in fish from the Presumpscot River below Westbrook. Repeat study of fish from the Mousam River confirmed previous results showing negligible PFOS in the headwaters in Mousam Lake, elevated levels in Number One Pond in downtown Sanford, and levels exceeding the MeCDC FTAL in both largemouth bass and white perch from Estes Lake in the Mousam River below Sanford.

## 1.0 MARINE MODULE

| | |
|---|---|
| PRINCIPAL INVESTIGATOR | Jim Stahlnecker |
| TECHNICAL ASSISTANTS | Joseph Glowa<br>Josh Noll |
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## 1.1 INTRODUCTION

Maine's coastline lies within and lends its name to the Gulf of Maine, a diverse and productive ecosystem. The Maine coast and the larger 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 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.

### 1.1.1 Blue Mussels and Softshell Clams

Blue mussels (*Mytilus edulis*) have been relied upon extensively by the SWAT program (since its inception in 2003) and other monitoring programs as an indicator of exposure of marine environments to chemical pollutants. Mussels have been ubiquitous and readily collected across the Maine coast, as well as throughout the entire Gulf of Maine, although their recent abundance has been more variable. Published information about contaminants in mussels provides some historical context and allows comparisons between geographic areas and over time. Since blue mussels are consumed as food by humans, they can be used to understand potential human exposure to contaminants. Mussels are sessile, allowing attribution of their contaminant burdens to the environment where they were collected. Mussels filter large volumes of water as they feed, allowing them to concentrate many chemicals from the water column or from sediments suspended in the water column. This allows detection in mussel tissue of contaminants that may be present below detection limits in particulate matter, sediment, or water. Use of mussels also provides insight into the biologically available portion of contaminants, which may not readily be discerned from background sediment or water concentrations.

This report presents and summarizes contaminant data from the collection and analysis of blue mussel tissue collected from ten sites along the Maine coast in 2019 and another 14 sites in 2020. All mussel tissue sites were analyzed for perfluoronated compounds (PFAS), and tissue from ten of 14 sites collected in 2020 was also analyzed for heavy metals (including mercury). To provide comparability of results from the 2020 metals sample analyses, blue mussel contaminant levels from the SWAT program are compared to blue mussel contaminant levels in other programs including the Gulfwatch program ("Gulfwatch": Gulf of Maine Council on the Marine Environment) and the National Status & Trends Mussel Watch Program ("NS&T": National Oceanographic and Atmospheric Administration). This analysis provides a regional and national context to the Maine SWAT data.

Like blue mussels, softshell clams (*Mya arenaria*) are consumed as food by humans and can be used to understand potential human exposure to contaminants. Clams are sessile, allowing attribution of their contaminant burdens to the environment where they were collected. Like mussels, clams filter large volumes of water as they feed, allowing them to concentrate many chemicals from the water column or from sediments suspended in the water column. Softshell clam stations sampled by the SWAT program in recent years have been selected to characterize contaminant concentrations specifically in clam tissue, as opposed to blue mussel tissue which may or may not have been sampled previously in the same general area. Gulfwatch blue mussel and SWAT softshell clam tissue contaminant concentrations differ, indicating that clams have very different concentrations of some contaminants than blue mussel tissue taken from the same stations. This is an important point when considering the contaminant concentrations to which humans are exposed when consuming clams. Site selection for clam testing is typically driven by human consumption and exposure, and clams are used less than blue mussels in SWAT (or Gulfwatch) as a general environmental monitor or sentinel. This report presents and summarizes contaminant data from the analysis of softshell clam tissue samples collected in 2019 from five different sites on the Maine coast.

### 1.1.2 American Eel

This report presents data from sub-adult (yellow) American eel (*Anguilla rostrata*) muscle tissue collected in 2019 at the request of the DMR to determine if mercury is present in eel meat at a level that would preclude safe human consumption. The primary interest was the Penobscot River, whose sub-adult eels are typically harvested commercially in a baited trap (or "pot") fishery. Eels were collected from four locations (two replicates at each location) on the Penobscot River and additional eels were collected from two sites (two replicates at each location) on the Kennebec River for comparison. Eels were collected from the Penobscot River in baited pots in a collaborative project between DMR and DEP SWAT staff. Collection of eels on the Kennebec River was accomplished by electrofishing in cooperation with Chris Yoder (Center for Applied Bioassessment and Biocriteria, Midwest Biodiversity Institute).

## 1.2 METHODS

### 1.2.1 Blue Mussels and Softshell Clams

Softshell clam tissue was sampled from Hilton Cove and Pottle Cove, Wiscasset, at the request of the Maine Dept. of Marine Resources (DMR) to determine if clam tissue was suitable for human consumption based on the contaminant content. Samples were analyzed for metals (including mercury) and for PFAS to augment existing data from clam tissue for these newer contaminants.

Softshell clam tissue was collected at Holbrook Island and Ram Island, Castine, at the request of the DMR to examine the potential spatial extent of contaminants from the nearby Goose Falls former mine outfall. Tissues were analyzed for metals (including mercury) to assess if metals documented historically in mussel tissue at Goose Falls were also present in clam tissue in nearby coves with a clam resource capable of supporting a commercial harvest. Holbrook and Ram Islands were the closest significant clam resources to the Goose Falls site and so clams were collected in 2019.

The fifth softshell clam site sampled in 2019, Dennys River, was collected to follow up on earlier metals levels documented in blue mussel tissue by the SWAT program. Blue mussels were originally slated for collection, but the lack of mussels in the area in 2019 necessitated the collection of softshell clams to interpret metals contamination at the site. Dennys River clam tissue samples collected in 2019 were analyzed for metals (including mercury).

Previous years of SWAT clam analysis indicated that metals apportioned differentially between the edible portion of the clam and the skin, which is removed both for fried clams and steamed clams. Each softshell clam sample was dissected to remove the skin, producing an edible portion. In previous years, a second sample of whole tissue, with no skin tissue removed, was analyzed to compare to the edible portion with the skin removed. For 2019, only edible tissue was analyzed, since this represents what DMR believes is consumed by humans as either steamed clams or fried clams, since the skin portion is removed in either case.

Blue mussel sites sampled in recent years within the context of this program can be divided into three types based on the goals outlined above that drive the need for information. These types are Spatial, Temporal, and Follow-Up sites.

- Spatial Sites

  Sites that have never been sampled (or that have not been sampled for eight or more years), have been sampled for only one analyte type, or have been sampled with no replication are classified as "Spatial" sites. The primary reason for sampling these sites is to provide data required to fill geographic gaps. Spatial sites enable a more complete picture of how contaminants vary along the Maine coastline, and provide screening data that can be used in assessing interest in testing these sites again in the future. Testing sites with low contaminant levels, which can only be determined post-sampling, still provides valuable data on background contaminant levels and provides a baseline with which to compare more heavily contaminated sites.

- Temporal Sites

  "Temporal sites" are locations where there is an interest in obtaining data to assess contaminant levels over time. These sites will be sampled on an accelerated schedule, with sampling occurring as often as biennially. More frequent data collection will provide more closely spaced data over time, which may permit trend analysis when sufficient data are acquired. Relatively few temporal sites will be sampled to minimize costs associated with higher frequency sampling.

- Follow-up Sites

  "Follow-up" sites are those where previous SWAT contaminant levels (or results from another program like Gulfwatch) at the site or nearby indicate that additional sampling and analysis are warranted. Repeat sampling may occur at the same location to confirm earlier results, or sampling of additional nearby sites might be used to determine local contaminant distribution. Follow-up sites may include sites in the Temporal or Spatial categories as well based on their historical sampling and data needs.

Resampling in subsequent years at Temporal or Follow-up sites does not occur at the exact sub-site replicate coordinates sampled previously but varies somewhat due to distribution and quantity of mussels available in the target size range from year to year. To conserve funding, the SWAT Technical Advisory Group in May 2020, suggested that replicates be reduced from four to three per location sampled, and this was implemented in 2020 blue mussel sampling. Site mean concentrations of contaminants in 2020 blue mussel tissue were based on three replicates.

Blue mussel samples have been analyzed from more than 90 distinct locations sampled over the past 30 years. Blue mussels were collected from 9 and 14 sites in 2019 and 2020, respectively. All sites but one had been sampled previously as part of the SWAT program, although many had not been analyzed for per- and polyfluoroalkyl substances (PFAS) in previous years. In 2019, Little Machias Bay in Cutler was the one site sampled for the first time. Blue mussel sites for 2019-20 are shown in Table 1.2.1.1 and Figure 1.2.1.1.

Methodology of field collection, morphometric measurement, and laboratory preparation of mussel samples have been provided in previous SWAT reports and in the Gulfwatch field manual (Sowles et al., 1997) and will be summarized here. SWAT mussel sampling is planned and conducted to control as much as possible any variability in factors that might cause a sample to be non-representative of the overall data being collected. Variations in mussel shell size, seasonal timing of collections relative to spawning, location within the intertidal zone, and sample location were all minimized to reduce conflicting signals in the contaminant data.

In order to characterize the contaminants present in a general area at the sampling site, mussels were collected along the shoreline from three distinct replicates (intra-site locations) whenever possible. Gauges were used to sort mussels by shell length in the field, and mussels within a size range of 50-60 mm were selected for analysis. For metals analysis, a minimum of 20 mussels within the target size range were selected from each of the three replicates and placed in separate containers. For organics analysis including PFCs, a minimum of 30 mussels were collected for each replicate. Mussels were washed in ambient sea water in a mesh or open bucket at the collection site to remove external debris and attached sediments. Mussel replicates were then transported to the laboratory in coolers (supplemented with ice packs in warmer weather). Mussels were not depurated prior to shucking to remove tissue for analysis.

**TABLE 1.2.1.1: SWAT Softshell Clam and Blue Mussel Sites: 2019-2020**

| **2019 Softshell Clam** Site Name | Municipality | Station Code | West Longitude | North Latitude | Date Sampled | Site Type[1] |
|---|---|---|---|---|---|---|
| Pottle Cove Sheepscot R | Wiscasset | MCSHPC | -69.672883 | 43.998003 | 9/11/2019 | S |
| Hilton Cove Sheepscot R | Wiscasset | MCSHHC | -69.674581 | 43.992519 | 9/11/2019 | S |
| Holbrook Island Penobscot Bay | Castine | PBCRHI | -68.80885 | 44.36359 | 10/3/2019 | S |
| Ram Island Penobscot Bay | Castine | PBCRRI | -68.80298 | 44.36588 | 10/3/2019 | S |
| Dennys Bay Dennys River | Edmunds Twp. | PMCKDR | -67.21445 | 44.91292 | 9/24/2019 | S |
| **2019 Blue Mussel** Site Name | Municipality | Station Code | West Longitude | North Latitude | Date Sampled | Site Type[1] |
| Portland Harbor Casco Bay | Portland | CBFROR | -70.2513 | 43.64376 | 9/4/2019 | F |
| Fore R. (inner) Casco Bay | Portland | CBFRIR | -70.28341 | 43.64277 | 9/4/2019 | F |
| East End Beach Casco Bay | Portland | CBEEEE | -70.24132 | 43.67108 | 9/18/2019 | F |
| Presumpscot R. Casco Bay | Falmouth | CBPRMT | -70.2455 | 43.69128 | 9/4/2019 | F |
| Perkins Island Kennebec R. | Georgetown Twp. | MCKNPI | -69.78506 | 43.78502 | 9/9/2019 | F |
| Boothbay Harbor Town Cove | Boothbay Harbor | MCBBTC | -69.62448 | 43.85079 | 9/6/2019 | F |
| Rockland Crockett Point | Rockland | PBRKCP | -69.10668 | 44.10482 | 9/5/2019 | F |
| Sandy Point Penobscot Bay | Searsport | PBSPSP | -68.80547 | 44.50452 | 9/10/2019 | F |
| Cutler L. Machias Bay | Cutler | ECMCLM | -67.25471 | 44.66611 | 9/19/2019 | S |

1 S = Spatial, T = Temporal, F = Follow Up

**TABLE 1.2.1.1 (continued): SWAT Softshell Clam and Blue Mussel Sites: 2019-2020**

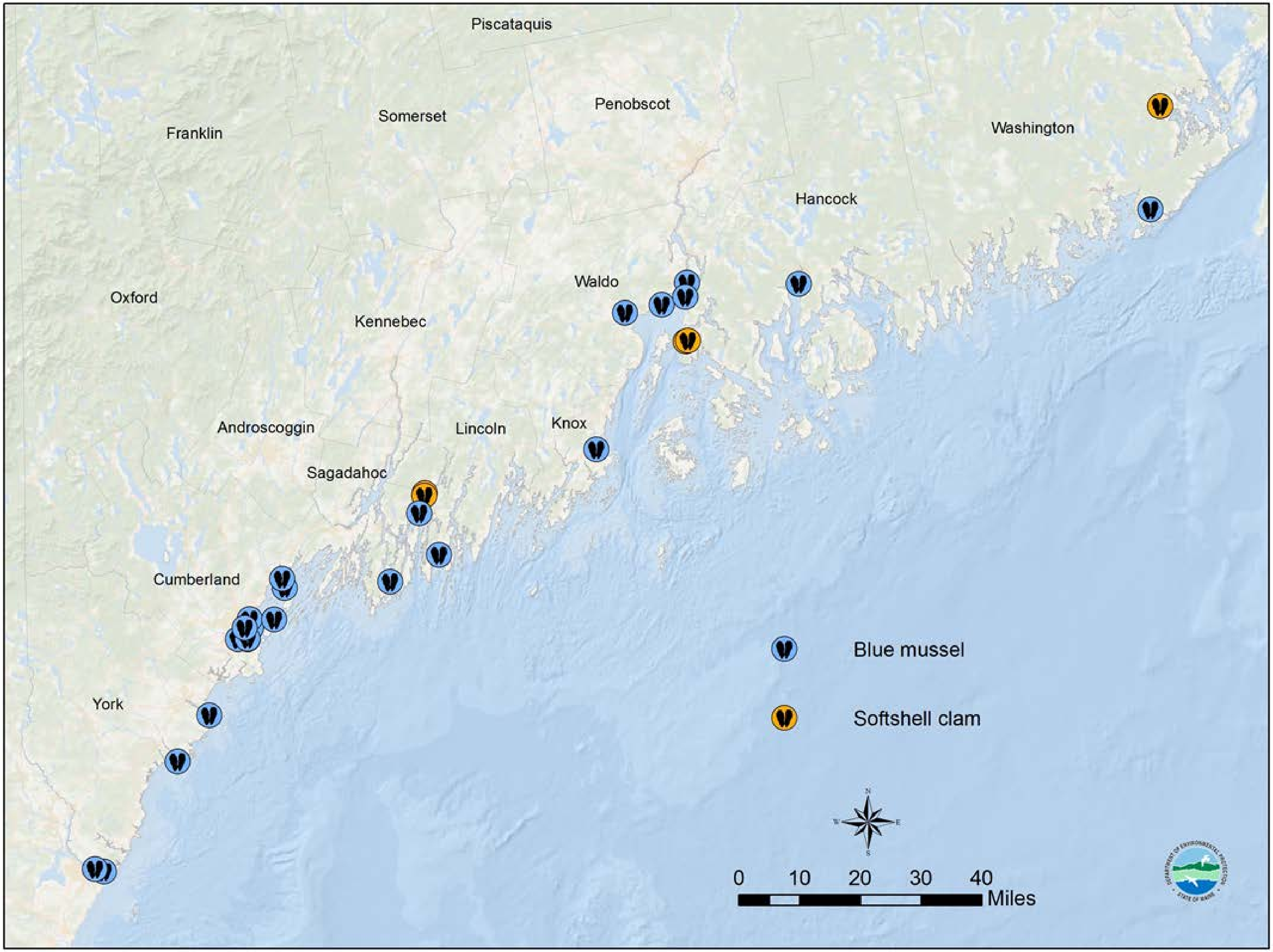
| **2020 Blue Mussel** Site Name | Municipality | Station Code | West Longitude | North Latitude | Date Sampled | Site Type[1] |
|---|---|---|---|---|---|---|
| Pepperell Cove Piscataqua R. | Kittery | PQPCPC | -70.70883 | 43.0811 | 9/14/2020 | F |
| Back Channel Piscataqua R. | Kittery | PQBCBC | -70.73681 | 43.08607 | 9/14/2020 | F |
| Kennebunk R. Jetty | Kennebunkport | SCKBMT | -70.47473 | 43.3475 | 9/23/2020 | F |
| Saco River Jetty | Biddeford | SCSAJY | -70.37305 | 43.45995 | 9/10/2020 | F |
| Fore R. (middle) Casco Bay | South Portland | CBFRMR | -70.25219 | 43.64439 | 9/9/2020 | F |
| Back Cove Casco Bay | Portland | CBBBBB | -70.26196 | 43.67039 | 9/9/2020 | F |
| Long Island Fuel Terminal | Long Island | CBLNFT | -70.1651 | 43.69163 | 9/22/2020 | F |
| Cousins Island Thorofare | Yarmouth | CBTHTH | -70.1325 | 43.7673 | 9/8/2020 | F |
| Royal River Mouth | Yarmouth | CBRYMT | -70.14059 | 43.78974 | 9/8/2020 | F |
| Maine Yankee Sheepscot R. | Wiscasset | MCSHMY | -69.69162 | 43.95001 | 9/21/2020 | F |
| Belfast Harbor Town Dock | Belfast | PBBFTD | -69.01129 | 44.43218 | 9/10/2020 | F |
| Sears Island West Side | Searsport | PBSIWS | -68.88897 | 44.45079 | 9/15/2020 | F |
| Fort Point Penobscot R. | Stockton Springs | PBFPFP | -68.81099 | 44.47013 | 9/21/2020 | F |
| Union River Mouth | Surry | BFURMT | -68.43208 | 44.50043 | 9/15/2020 | F |

1 S = Spatial, T = Temporal, F = Follow Up

Tissue sample processing was accomplished within 24 hours of field collections at all sites. All soft tissue was removed and combined with the soft tissue from mussels within the same replicate. Total soft tissue wet weights per replicate were recorded. Tissue composites were immediately placed in pre-cleaned glass jars and capped. Pre-labeled and filled jars were stored at -5$^{o}$ C for up to two months until analysis.

Contaminant concentration on a dry weight basis is used to compare spatially, temporally, and to data from other programs, which use the same dry wt. basis (Gulfwatch and NS&T). Much of the metals analyses in softshell clam and blue mussel tissue is presented on a dry weight basis, with the exception of the examination of human consumption of tissue

Figure 1.2.1.1: SWAT 2019-20 Blue Mussel and Softshell Clam Sites



and for comparison to a fish tissue action level (FTAL). The concentrations of PFAS compounds in softshell clam and blue mussel tissues are presented on a wet weight basis to facilitate comparison to human health thresholds, including the FTAL for PFOS. Contracted laboratories provide percent solids measured in each sample analyzed, allowing wet to dry weight calculation via the following formula:

$$\text{Concentration (wet wt.)} = \frac{\text{Concentration (dry wt.)}}{\%\ \text{solids}} \times 100$$

Frozen blue mussel tissue was shipped overnight to the appropriate laboratory for analysis. Mussel tissue tested for PFAS was analyzed by AXYS Analytical Services Ltd., Sidney, British Columbia. Mussel tissue tested for metals was analyzed by Battelle Marine Sciences Laboratory, Sequim, Washington.

Softshell clams were collected from five sites along the Maine coast in 2019 (Table 1.2.1.1; Figure 1.2.1.1) and four replicates (intra-site sublocations) were sampled at each overall site. A minimum of ten clams were collected at each replicate. Clam samples were dissected to remove the skin covering the exterior of the clam, including the skin on the siphon, leaving an edible portion which was then shucked to remove the shell and composited to construct a sample of ten clams. Whole clam tissue and this edible portion are known to show different concentrations of several heavy metals (Maine Department of Environmental Protection, 2017). Softshell clam tissues from all five 2019 SWAT sites were analyzed for metals, including mercury. Tissue from Dennys River, Edmunds Township, was analyzed for PFAS in addition to metals.

Methodologies of field collection, morphometric measurement, and laboratory preparation of mussel samples have been provided above, in previous SWAT reports, and in the Gulfwatch field manual (Sowles et al., 1997). To characterize the contaminants present in a general area at the sampling site, softshell clams were collected from four replicates (distinct areas) along the shoreline at each site whenever possible. Whenever possible, clams at or above the commercial legal length of two inches (50.8 mm) were dug from each replicate location. For metals analysis, a minimum of ten clams within the target size range were selected from each of the four replicate locations and placed in separate containers. Clams were not depurated prior to shucking to remove tissue for analysis.

Tissue sample processing was accomplished within 24 hours of field collections. All soft tissue was removed and combined with the soft tissue from the ten clams within the same replicate. Total soft tissue wet weights for each ten-clam replicate were recorded. Edible tissue was all soft tissue excepting the skin or membrane on the siphon and the perimeter of the clam adjacent to the shell opening and opposite the hinge.

Softshell clam tissues tested for metals in 2019 were analyzed by Pacific Northwest National Laboratory operated by Battelle, Sequim, Washington, while PFCs were analyzed by SGS AXYS Analytical Services Ltd., Sidney, British Columbia, Canada.

### 1.2.2 American Eels

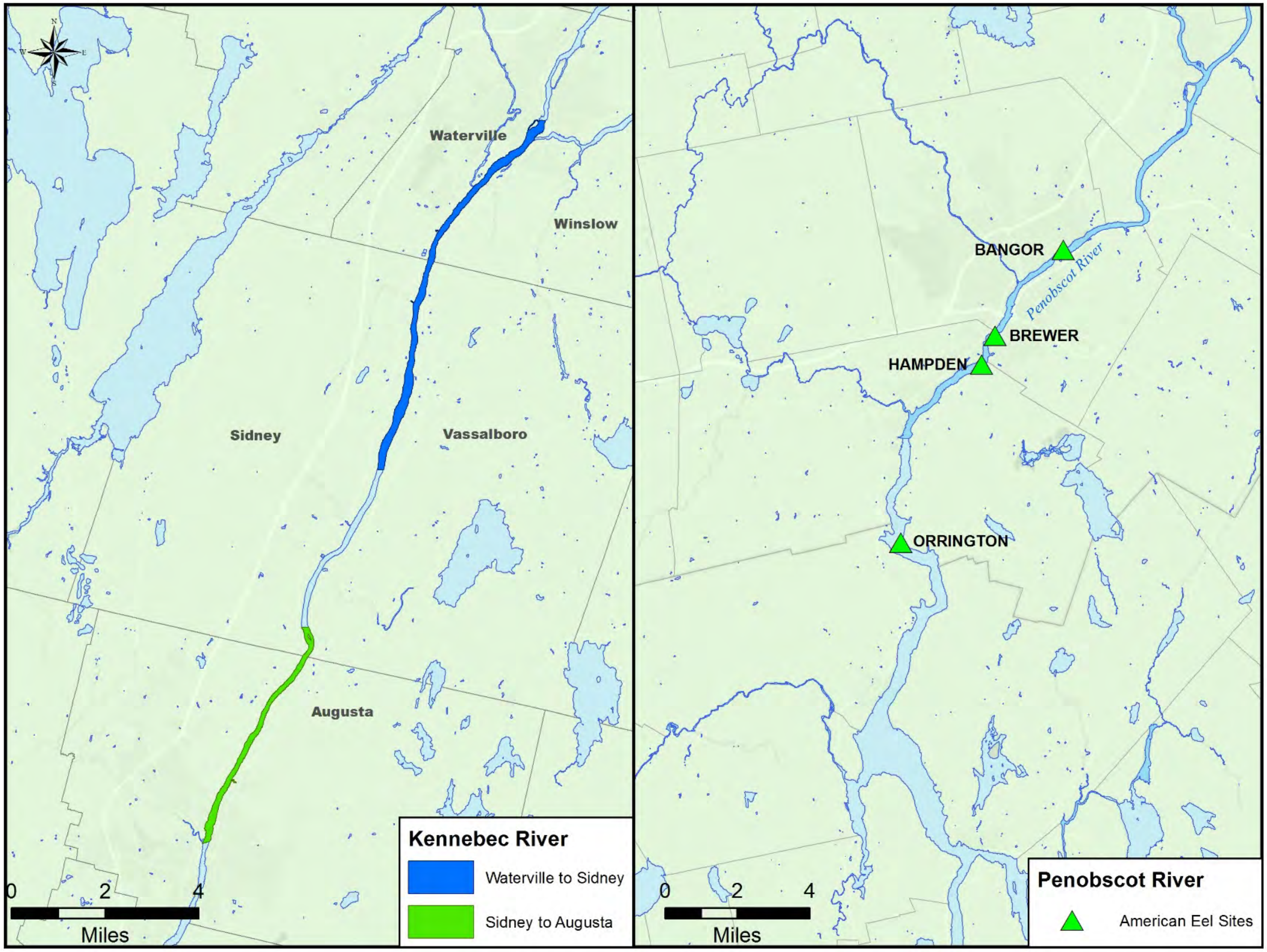
American eels (*Anguilla rostrata*) of the sub-adult, yellow eel life stage were collected to test skinless filet for total mercury concentrations in 2019. Eels were collected due to a request from DMR to determine mercury concentrations in relation to safe human consumption of yellow eels, primarily from the tidal portion of the Penobscot River. Eels were collected via baited traps, also known as pots, in the Penobscot River at four locations: Bangor, Brewer, Hampden, and Orrington. Pots were fished collaboratively with DMR biologist, Jason Bartlett.

For comparison and because of a similar yellow eel commercial fishery, two sites on the Kennebec River were added to the analysis. Kennebec eels were captured opportunistically by electrofishing conducted by Chris Yoder (Center for Applied Bioassessment and Biocriteria, Biodiversity Research Institute) as part of a fish population survey and samples were picked up and stored by DMR's Jason Bartlett. Eels were collected in two river reaches, from Waterville to Sidney, and just to the south, from Sidney to Augusta, representing the area of the Kennebec downstream of the first dam on the river in Waterville, Maine. Sampling locations of the six yellow eel sites are shown in Figure 1.2.2.1.

Eel skinless filet tissue was sampled by using a stainless-steel punch to remove a plug of tissue from the eel muscle after the skin was removed to allow access. Tissue plugs from five eels were composited together for analysis, and two composites were constructed from each location sampled to assess variability in the results. Ten eels per site were measured and rank ordered by total length, with alternate ranks assigned to one of each of the two composites such that tissue in each composite came from similarly sized eels. American eel tissue tested for total mercury in 2019 was analyzed via the cold vapor atomic absorption method by Pacific Northwest National Laboratory operated by Battelle, Sequim, Washington.

American eel mercury results are presented on a wet weight basis to facilitate comparison to human health thresholds, including FTALs, which are expressed on a wet wt. basis.

Figure 1.2.2.1: SWAT 2019 American Eel (Yellow Eel) Sites



## 1.3 RESULTS AND DISCUSSION

### 1.3.1 Metals

#### 1.3.1.1 Blue Mussels and Softshell Clams

Mussel tissue samples were analyzed for 11 metals: Silver (Ag), aluminum (Al), arsenic (Ar), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn). Results were compared to national NS&T (Kimbrough et al., 2008) and Gulf of Maine (Gulfwatch) (LeBlanc et al., 2009) blue mussel monitoring program data (collected through 2008, the most recent available) to place Maine SWAT data in a broader geographic context. From an environmental monitoring perspective, the concentration of an analyte in SWAT mussel tissue was considered elevated when that concentration exceeded the NS&T 85$^{th}$ percentile. This approach is consistent with the Gulfwatch program (LeBlanc et al., 2009).

Only edible softshell clam tissues were analyzed for 11 metals: Silver (Ag), aluminum (Al), arsenic (Ar), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), nickel (Ni), selenium (Se), and zinc (Zn). Edible and whole portions were separated based on previously demonstrated differences in the concentrations of some metals when the skin or membrane tissue is included (whole) and excluded (edible).

##### 1.3.1.1.1 Silver (Ag)

Silver was detected at all five softshell clam sites sampled in 2019 (Figure 1.3.1.1.1.1). Silver levels measured in edible clam tissue ranged from a low mean concentration of 0.468 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 2.71 µg/g dry wt. at Pottle Cove, Wiscasset.

Silver was detected in all ten blue mussel sites sampled in 2020 (Figure 1.3.1.1.1.2). Silver levels measured in mussel tissue ranged from a low mean concentration of 0.015 µg/g dry wt. at Belfast Harbor to a high mean concentration of 0.085 µg/g dry wt. at Back Cove, Portland. The silver concentration at five of ten sites fell below the 2008 Gulfwatch median, while the concentration at three sites exceeded the Gulfwatch median but not the Gulfwatch 85$^{th}$ percentile. The silver concentrations at Pepperell Cove, Kittery, and Back Cove, Portland, exceeded the 2008 Gulfwatch 85$^{th}$ percentile (Figure 1.3.1.1.1.2). Silver concentrations in blue mussel tissue at all ten sites fell below both the NS&T median and 85$^{th}$ percentile (Figure 1.3.1.1.1.3) (Kimbrough et al., 2008). Please note the different scale used in Figure 1.3.1.1.1.3, which allows comparison to the NS&T median and 85$^{th}$

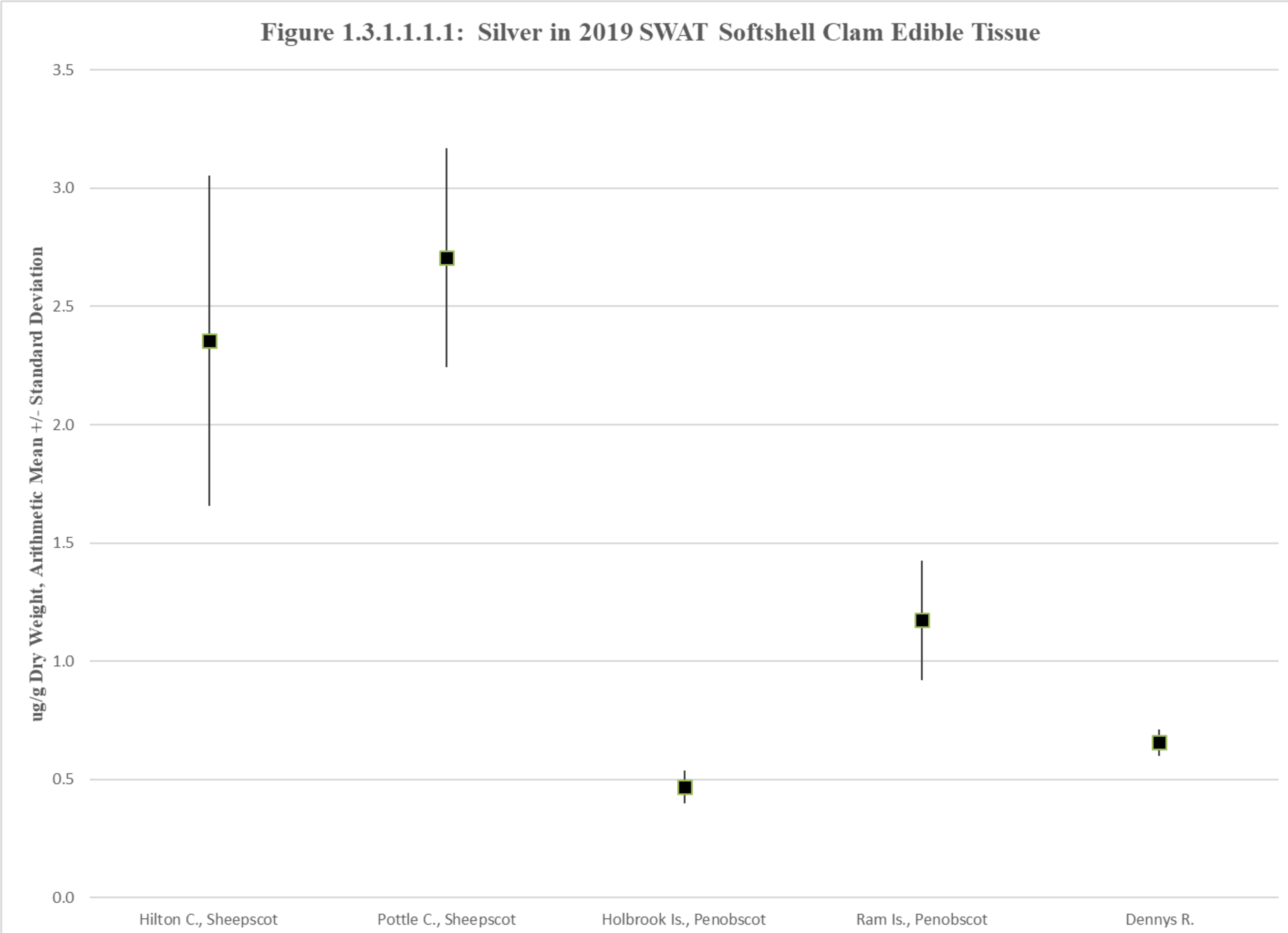


Figure 1.3.1.1.1.1: Silver in 2019 SWAT Softshell Clam Edible Tissue
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Hilton C., Sheepscot
Pottle C., Sheepscot
Holbrook Is., Penobscot
Ram Is., Penobscot
Dennys R.

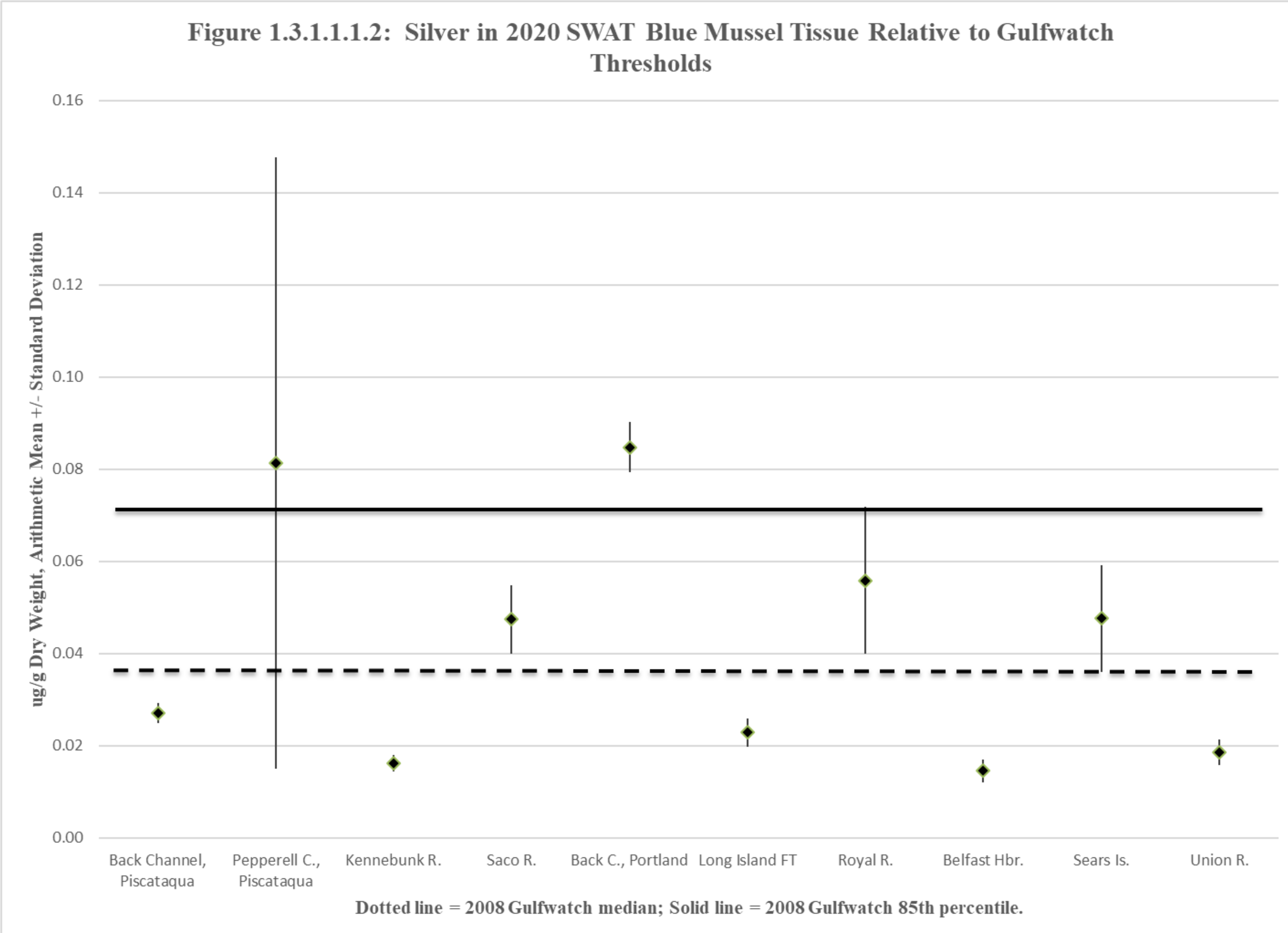


Figure 1.3.1.1.1.2: Silver in 2020 SWAT Blue Mussel Tissue Relative to Gulfwatch Thresholds
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Back Channel, Piscataqua
Pepperell C., Piscataqua
Kennebunk R.
Saco R.
Back C., Portland
Long Island FT
Royal R.
Belfast Hbr.
Sears Is.
Union R.
Dotted line = 2008 Gulfwatch median; Solid line = 2008 Gulfwatch 85th percentile.

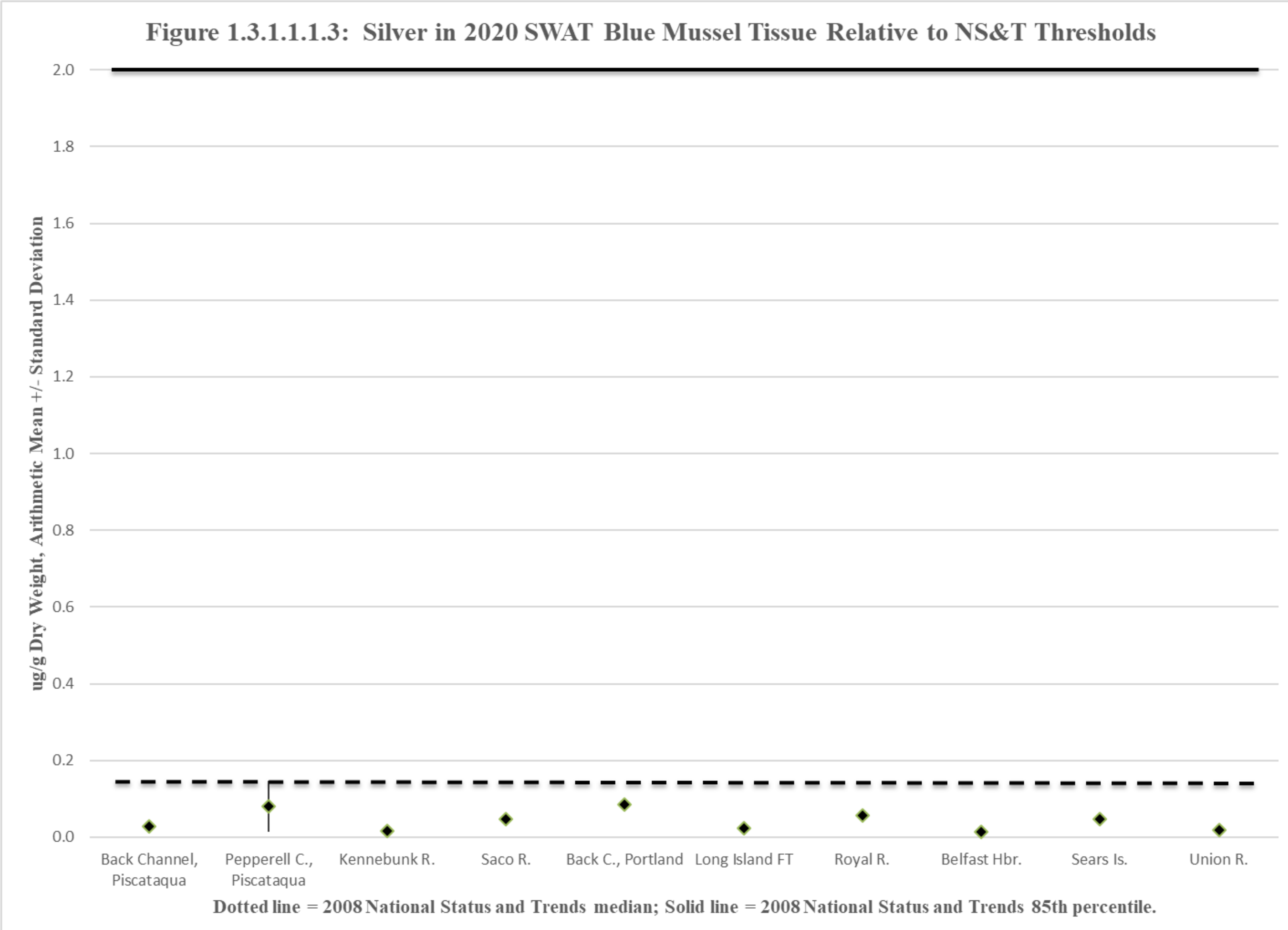


Figure 1.3.1.1.1.3: Silver in 2020 SWAT Blue Mussel Tissue Relative to NS&T Thresholds
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Back Channel, Piscataqua
Pepperell C., Piscataqua
Kennebunk R.
Saco R.
Back C., Portland
Long Island FT
Royal R.
Belfast Hbr.
Sears Is.
Union R.
Dotted line = 2008 National Status and Trends median; Solid line = 2008 National Status and Trends 85th percentile.

percentile. Since tissue silver concentrations did not exceed the NS&T 85th percentile, no sites were considered elevated for silver.

Higher silver concentrations in water and sediments have been shown to coincide with municipal sewage discharge (Sanudo-Wilhelmy and Flegal, 1992; Buchholtz ten Brink et al., 1997), and the SWAT mussel tissue data show the highest silver concentrations in tissue collected near densely populated urban areas, like Kittery on the Piscataqua River, Back Cove in Portland, and in previous years at East End Beach, Portland, which is adjacent to the largest municipal sewage discharge within the state. The increasing use of silver, including nanosilver, in products like paints, caulking, and clothing makes monitoring silver of interest at present and in the future. Overall, silver concentrations in mussels from sampled locations appear to be relatively low. The highest historic Gulfwatch program values, which came from sites in the Neponset River and Sandwich, Massachusetts exceeded the NS&T median but were below the NS&T 85th percentile.

The MCDC silver non-cancer FTAL is 11 µg/g wet wt. for non-commercially caught finfish. In prior sampling, the highest SWAT blue mussel tissue mean silver concentration, when expressed on a wet weight basis, was approximately three orders of magnitude below the 11 µg/g wet wt. FTAL. Edible softshell clam tissue is also more than an order of magnitude lower than the MCDC FTAL.

**1.3.1.1.2 Arsenic (As)**

Arsenic was detected at all five softshell clam sites sampled in 2019 (Figure 1.3.1.1.2.1). Total arsenic levels measured in edible clam tissue ranged from a low mean concentration of 9.53 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 11.66 µg/g dry wt. at nearby Ram Island, Castine.

Arsenic was detected in mussel tissue at all ten locations sampled in 2020 (Figure 1.3.1.1.2.1). Arsenic levels measured in mussels ranged from a low mean concentration of 10.2 µg/g dry wt. at Long Island (fuel terminal) in Casco Bay to a high mean concentration of 17.2 µg/g dry wt. at Sears Island, Searsport. While Gulfwatch does not monitor arsenic concentrations, they are tracked regionally and nationally by NS&T. In blue mussels, NS&T considers less than 12 parts per million dry wt. (directly comparable to SWAT µg/g data) to be in the lowest of three ranges of arsenic concentration nationally (Kimbrough et al., 2008). Five blue mussel sites sampled in 2020 had total arsenic concentrations which fell into the lowest range of the three NS&T ranges. Five mussel sites had total arsenic concentrations that fell into the low end of middle range of the three NS&T ranges (>12 ppm dry wt.).

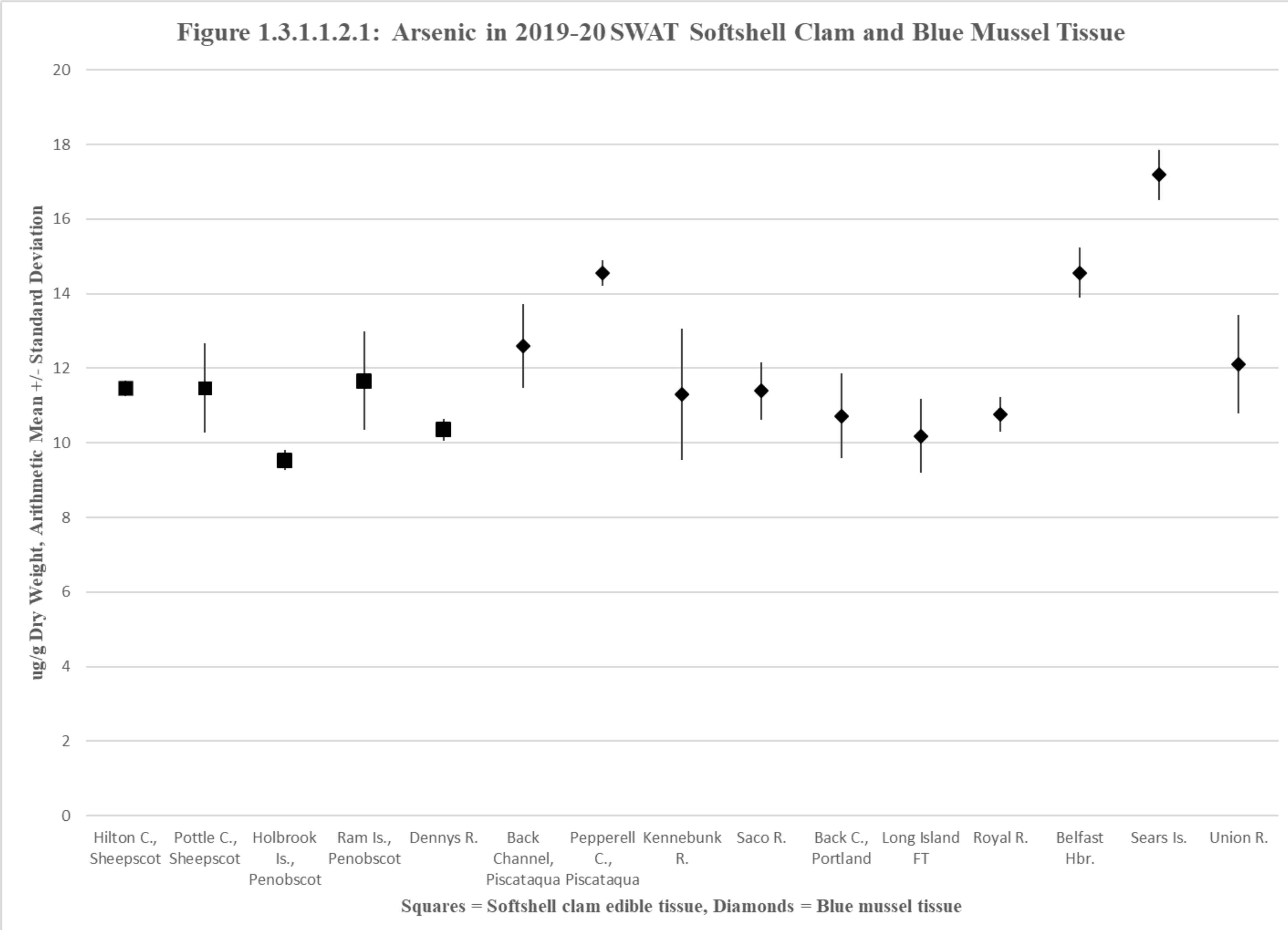


Figure 1.3.1.1.2.1: Arsenic in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
0
2
4
6
8
10
12
14
16
18
20
Hilton C., Sheepscot
Pottle C., Sheepscot
Holbrook Is., Penobscot
Ram Is., Penobscot
Dennys R.
Back Channel, Piscataqua
Pepperell C., Piscataqua
Kennebunk R.
Saco R.
Back C., Portland
Long Island FT
Royal R.
Belfast Hbr.
Sears Is.
Union R.
Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue

Nationally, the primary source for elevated levels of arsenic is crustal rock. In addition to natural sources, industrial pollution can contribute arsenic to the environment from preserved wood, semiconductors, pesticides, defoliants, pigments, antifouling paints, and veterinary medicines. Atmospheric sources include smelting, fossil fuel combustion, power generation, and pesticide application (Kimbrough et al., 2008).

For non-commercially caught finfish, MCDC 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 blue mussel and softshell clam tissue data are analyzed for total arsenic, not inorganic arsenic. MCDC uses FDA's 1993 assumption that 10% of total arsenic in finfish is inorganic arsenic. Using this assumption and applying it to bivalves, approximate inorganic arsenic concentrations for SWAT blue mussels were calculated by dividing wet weight concentrations by a factor of 10. Therefore, 2020 SWAT blue mussel inorganic arsenic concentrations are estimated to range from 0.14 µg/g wet wt. to 0.29 µg/g wet wt. All ten sites exceeded the MCDC cancer FTAL of 0.014 µg/g wet wt.

Comparing recent data from all 60+ mussel sites sampled from 2007-18, the calculated inorganic arsenic concentrations in SWAT blue mussel tissue ranged from a low of 0.11 µg/g wet wt. (Bar Harbor, 2007) to a high of 0.33 µg/g wet wt. (Turnip Island, Georgetown, 2012). All SWAT sites sampled from 2007-18 had calculated blue mussel tissue inorganic arsenic concentrations exceeding the MCDC cancer action level of 0.014 µg/g wet wt. None of the 60 mussel stations sampled from 2007-18 were calculated to have exceeded the MCDC non-cancer action level of 0.6 µg/g wet wt. for inorganic arsenic. Similarly, none of the ten sites sampled in 2020 were calculated to have exceeded the MCDC non-cancer FTAL. The MCDC non-commercially caught finfish FTALs applied here assume an 8 oz. meal eaten by the consumer on a weekly basis. Maine SWAT data indicate that this 8 oz. meal size would translate to approximately 45-50 mussels per meal.

Approximate inorganic arsenic concentrations for SWAT softshell clam edible tissue samples were calculated by dividing wet weight concentrations by a factor of 10. The 2019 SWAT softshell clam edible inorganic arsenic concentrations are estimated to range from 0.18 µg/g wet wt. to 0.21 µg/g wet wt. All five sites exceeded the MCDC cancer FTAL of 0.014 µg/g wet wt. Similar to blue mussel tissue concentrations, softshell clam edible tissue calculated inorganic arsenic concentrations from all sites sampled since 2015 (first analysis of edible tissue) exceeded the MCDC cancer action level of 0.014 µg/g wet wt. None of the softshell clam stations sampled in recent years had calculated inorganic arsenic concentrations that approached or exceeded the MCDC non-cancer action level of 0.6 µg/g wet wt. for inorganic arsenic. Similarly, none of the five clam sites sampled in 2019 were calculated to have exceeded the MCDC non-cancer FTAL. The MCDC non-commercially caught finfish FTALs applied here assume an 8 oz. meal eaten by the consumer on a weekly basis.

**1.3.1.1.3 Cadmium (Cd)**

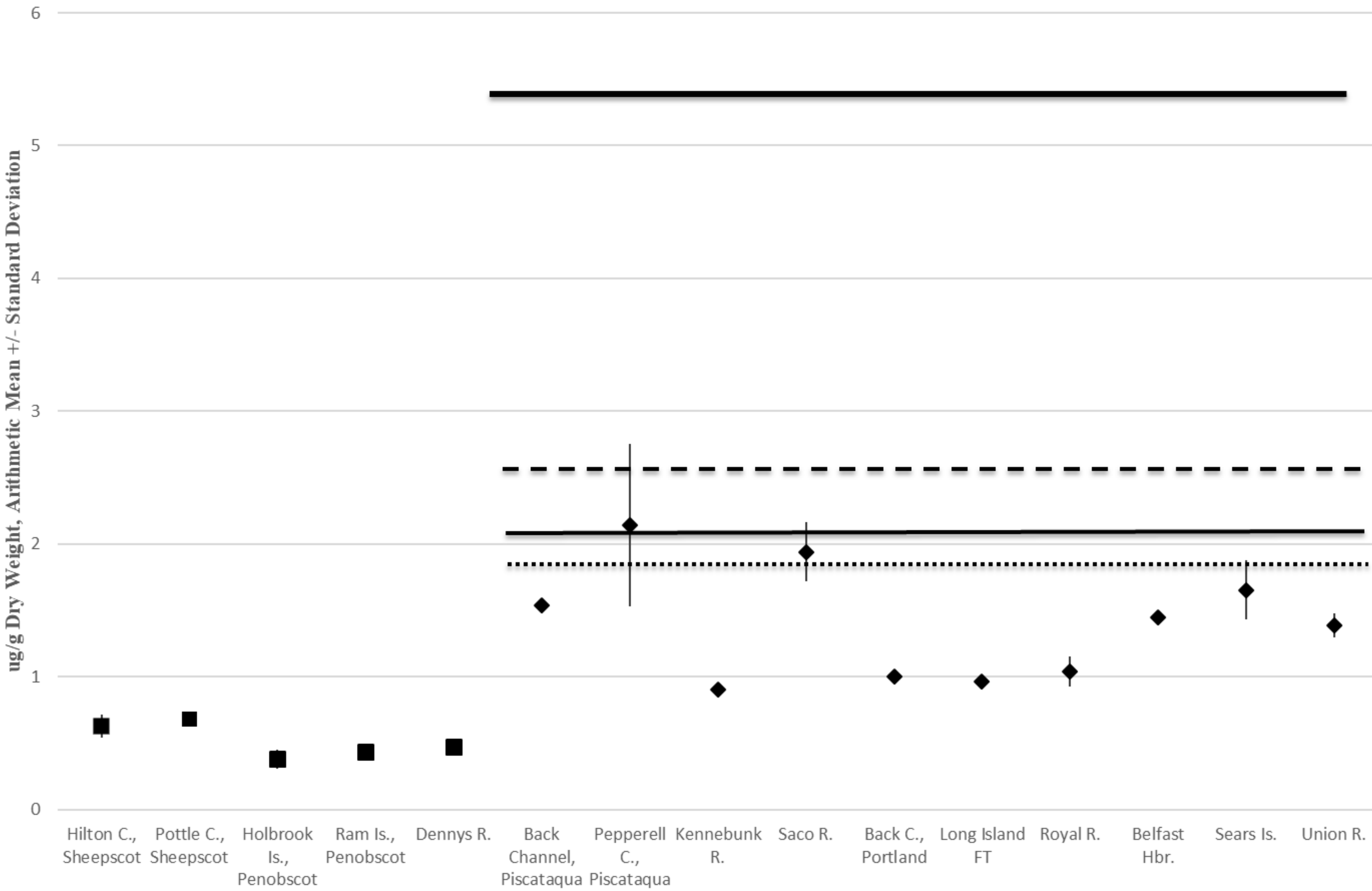
Cadmium was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.3.1). Cadmium levels measured in clam edible tissue ranged from a low mean concentration of 0.38 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 0.68 µg/g dry wt. at Pottle Cove, Wiscasset.

Cadmium was detected in blue mussel tissue taken at all ten locations sampled in 2020 (Figure 1.3.1.1.3.1). Cadmium levels measured in mussels ranged from a low mean concentration of 0.90 µg/g dry wt. at Kennebunk River, Kennebunkport, to a high mean concentration of 2.15 µg/g dry wt. at Pepperell Cove, Kittery. The cadmium concentrations at Pepperell Cove, Kittery, and Saco River, Saco, were above the Gulfwatch blue mussel tissue median concentration. Cadmium in Pepperell Cove, Kittery, also exceeded the NS&T median. None of the ten mussel sites sampled had cadmium concentrations that exceeded the Gulfwatch or NS&T 85$^{th}$ percentiles (Figure 1.3.1.1.3.1) (Kimbrough et al., 2008). Since tissue cadmium concentrations did not exceed the NS&T 85$^{th}$ percentile, no sites were considered elevated for cadmium.

Cadmium originates from crustal elements as rocks weather and is transported seaward by rivers, which account for approximately half of all cadmium sources worldwide. Cadmium is also released through forest fires and volcanic activity, with anthropogenic sources including manufacturing, fossil fuel combustion, and agriculture. Industrial sources include manufacture of batteries, plating, stabilizers, and nuclear power (Kimbrough et al., 2008).

From a human health perspective, the MCDC 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). The highest scoring 2019 SWAT softshell clam site, Pottle Cove, Wiscasset, had a mean cadmium concentration of 0.11 µg/g wet wt., which is below the MCDC and FDA action levels. The highest scoring 2020 SWAT blue mussel site, Pepperell Cove, Kittery, had a mean cadmium concentration of 0.35 µg/g wet wt., which is below the MCDC and FDA action levels.

Figure 1.3.1.1.3.1: Cadmium in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue




Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.

**1.3.1.1.4 Chromium (Cr)**
Chromium was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.4.1). Chromium levels measured in clam edible tissue ranged from a low mean concentration of 0.88 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 2.83 µg/g dry wt. at Hilton Cove, Wiscasset.

Chromium was detected in samples taken at all ten blue mussel sites sampled in 2020. Chromium ranged from a low concentration of 0.88 µg/g dry wt. at Kennebunk River, Kennebunkport, to a high of 1.86 µg/g dry wt. at Belfast Harbor. The chromium concentration at Back Channel, Kittery, and Belfast Harbor exceeded the 2008 Gulfwatch median, while the concentrations at the remaining eight sites were both below the Gulfwatch median. None of the sites sampled had chromium concentrations that exceeded the Gulfwatch 85$^{th}$ percentile (Figure 1.3.1.1.4.1). The chromium concentration at seven sites exceeded the NS&T median, and none of the sites exhibited concentrations that exceeded the NS&T 85$^{th}$ percentile (Figure 1.3.1.1.4.1) (Kimbrough et al., 2008). Since tissue chromium concentrations did not exceed the NS&T 85$^{th}$ percentile, no sites were considered elevated for chromium.

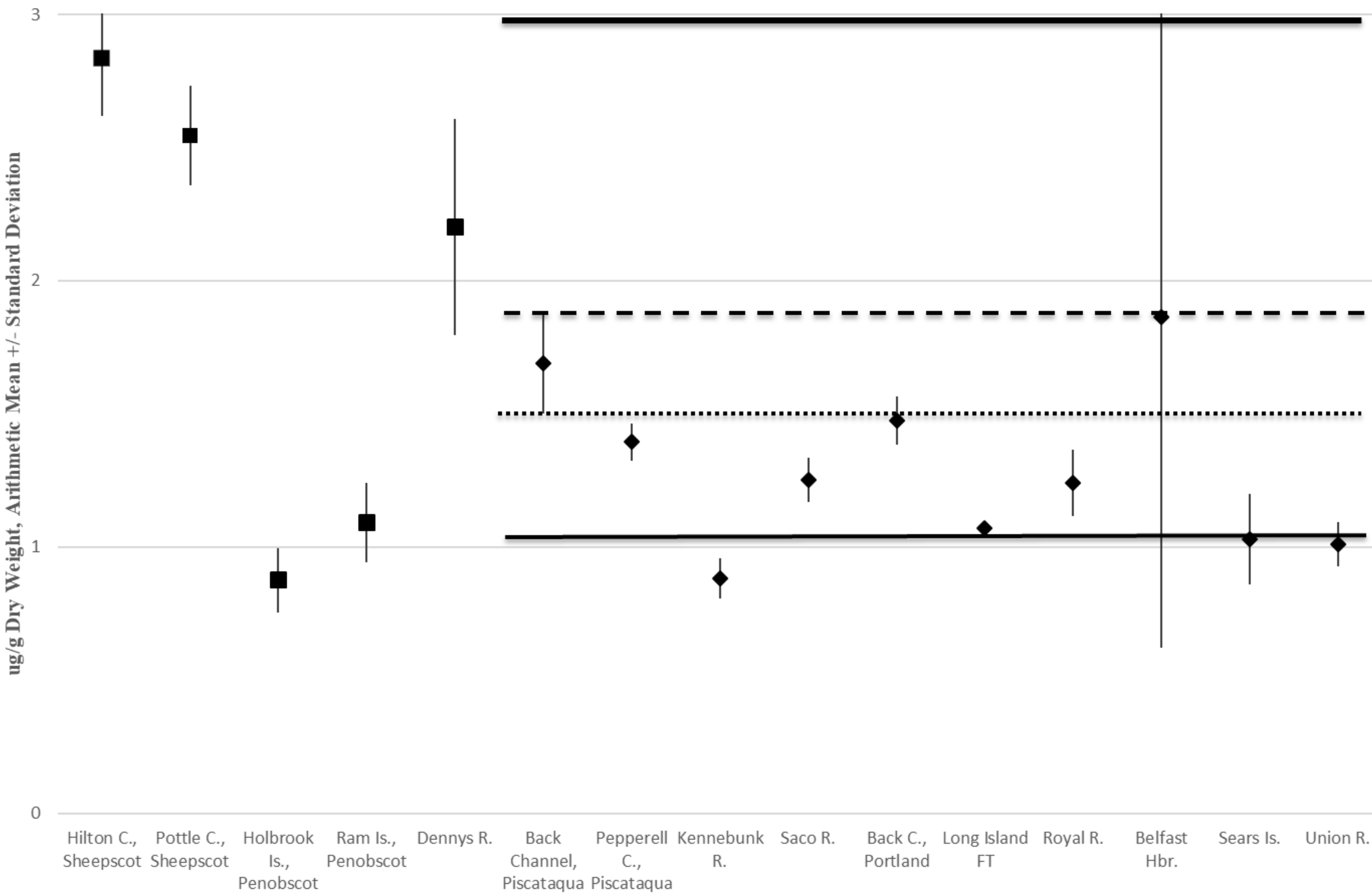
Natural sources of chromium include leaching from soil and rock into surface waters. Chromium is released from textile, electroplating, and leather tanning industries. Chromium is used extensively in tanning leather and was frequently discharged with untreated tannery effluent during the last two centuries. Chromium persists in the marine environment in sediments near anthropogenic sources (Kimbrough et al., 2008).

From a human health perspective, the MCDC 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 from softshell clam or blue mussel tissue data, which measure total chromium (less toxic Cr III and more toxic Cr VI, combined).

**1.3.1.1.5 Copper (Cu)**
Copper was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.5.1). Chromium levels measured in clam edible tissue ranged from a low mean concentration of 11.9 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 17.3 µg/g dry wt. at Dennys River, Edmunds Township.

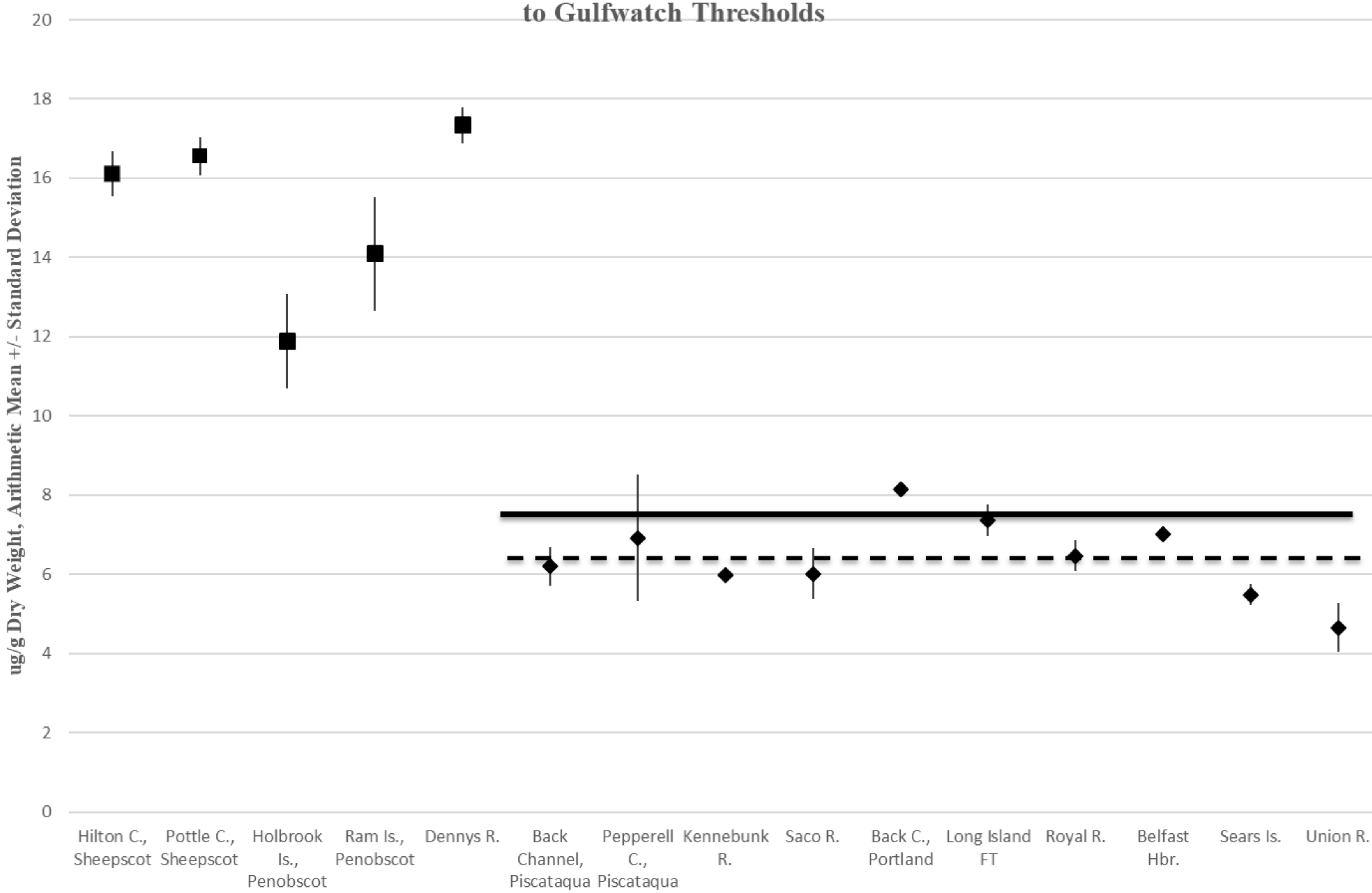
Copper was detected in tissue taken at all ten SWAT mussel sites sampled in 2020 (Figure 1.3.1.1.5.1). Copper levels measured in mussels ranged from a low mean concentration of 4.65 µg/g dry wt. at Union River, Surry, to a high mean concentration of 8.16 µg/g dry wt.

**Figure 1.3.1.1.4.1: Chromium in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue**




**Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.**

**Figure 1.3.1.1.5.1: Copper 2019-20 SWAT Softshell Clam and Blue Mussel Tissue Relative to Gulfwatch Thresholds**




**Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted line = 2008 Gulfwatch median; Solid line = 2008 Gulfwatch 85th percentile.**

at Back Cove, Portland. Copper concentrations in mussel tissue at five sites exceeded the Gulfwatch median and only one site, Back Cove, Portland, exceeded the Gulfwatch the 85$^{th}$ percentile (LeBlanc et al., 2009). The remaining five sites had copper concentrations below the Gulfwatch median. SWAT copper concentrations at all ten sites sampled in 2020 fell below the NS&T median and 85$^{th}$ percentile (Figure 1.3.1.1.5.2) (Kimbrough et al., 2008). None of the ten sites sampled in 2020 was considered elevated for copper.

Copper occurs naturally and is ubiquitous throughout the marine environment. Copper in trace amounts is considered to be an important nutrient for plant and animal growth. Elevated copper concentrations can occur due to contributions from anthropogenic sources including mining, agriculture, sewage sludge, antifouling paint, fungicides, wood preservatives, and brake pads. With the reduction of the use of chromated copper arsenate (CCA) wood preservative subsequent to its being phased out by EPA, newer wood preservatives utilizing even higher levels of copper have come into use, including quaternary copper. Similarly, tributyltin marine bottom paint use was reduced in the 1980s, resulting in increased use of copper-based antifouling paints, and removal of asbestos from the manufacture of brake pads has been offset by increased usage of copper in their manufacture (Kimbrough et al., 2008).

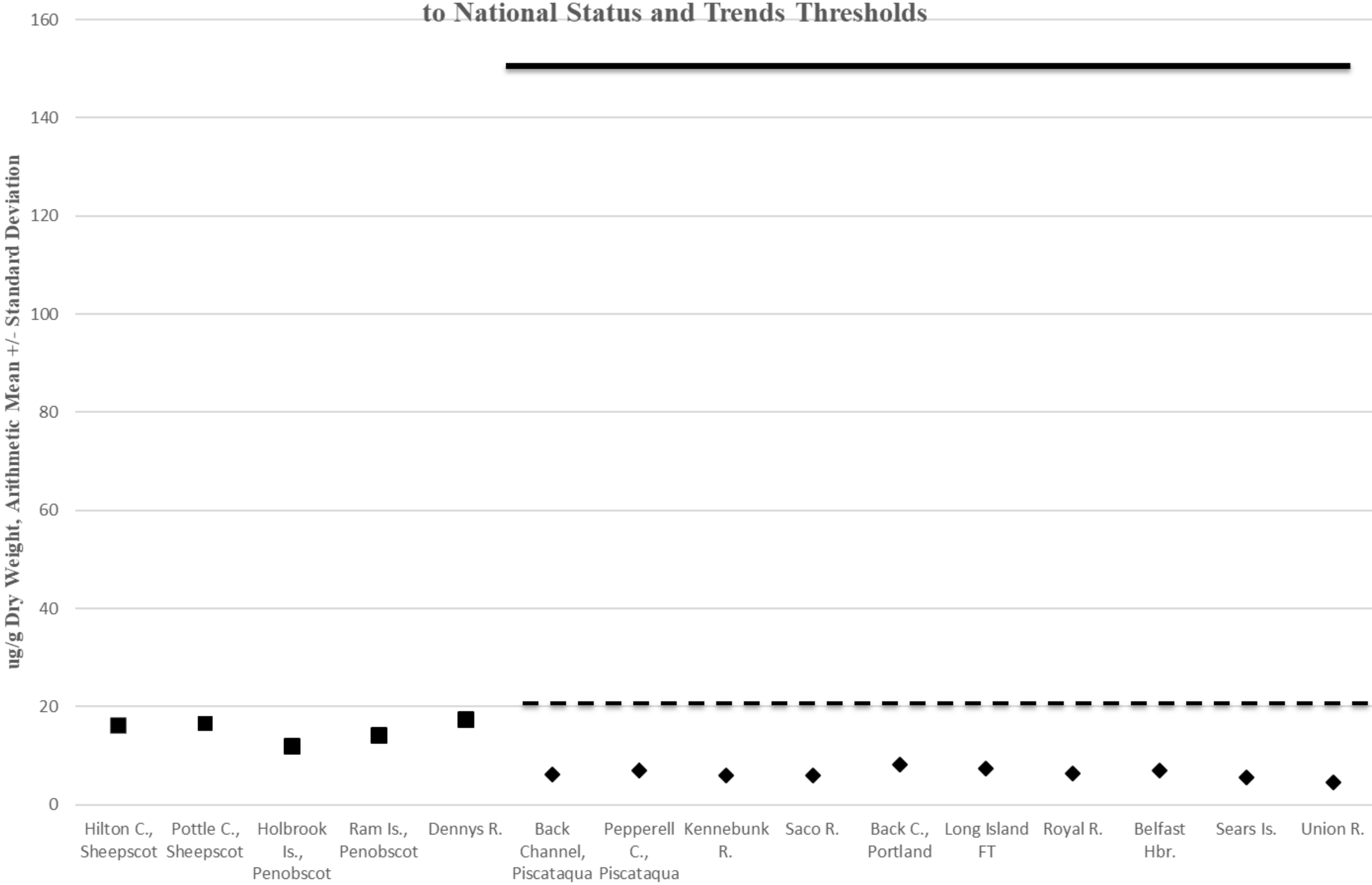
Copper is not highly toxic to humans, though exposure can lead to some chronic effects. There is no recommended FDA safety level for human consumption for copper in fish or shellfish (Kimbrough et al., 2008), and MCDC does not report a FTAL for copper in non-commercially caught sportfish.

**1.3.1.1.6 Iron (Fe) and Aluminum (Al)**

Iron was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.6.1). Iron levels measured in clam edible tissue ranged from a low mean concentration of 624 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 2,318 µg/g dry wt. at Hilton Cove, Wiscasset. Higher iron concentrations at Hilton and Pottle coves and Dennys River may be related to sediment in the clam gut, as clams are not depurated.

Iron was detected in tissue from all ten SWAT blue mussel sites sampled in 2020 (Figure 1.3.1.1.6.1). Iron concentrations measured in mussels ranged from a low mean concentration of 206 µg/g dry wt. at Kennebunk River, Kennebunkport, to a high mean concentration of 655 µg/g dry wt. at Belfast Harbor. The mean iron concentration in samples from three sites exceeded the Gulfwatch median, and one site, Belfast Harbor, exceeded the Gulfwatch 85$^{th}$ percentile. Four sites exceeded the NS&T median but no sites exceeded the NS&T 85$^{th}$ percentile. Since none of the sites sampled had an iron

**Figure 1.3.1.1.5.2: Copper 2019-20 SWAT Softshell Clam and Blue Mussel Tissue Relative to National Status and Trends Thresholds**




**Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted line = 2008 National Status and Trends median; Solid line = 2008 National Status and Trends 85th percentile.**

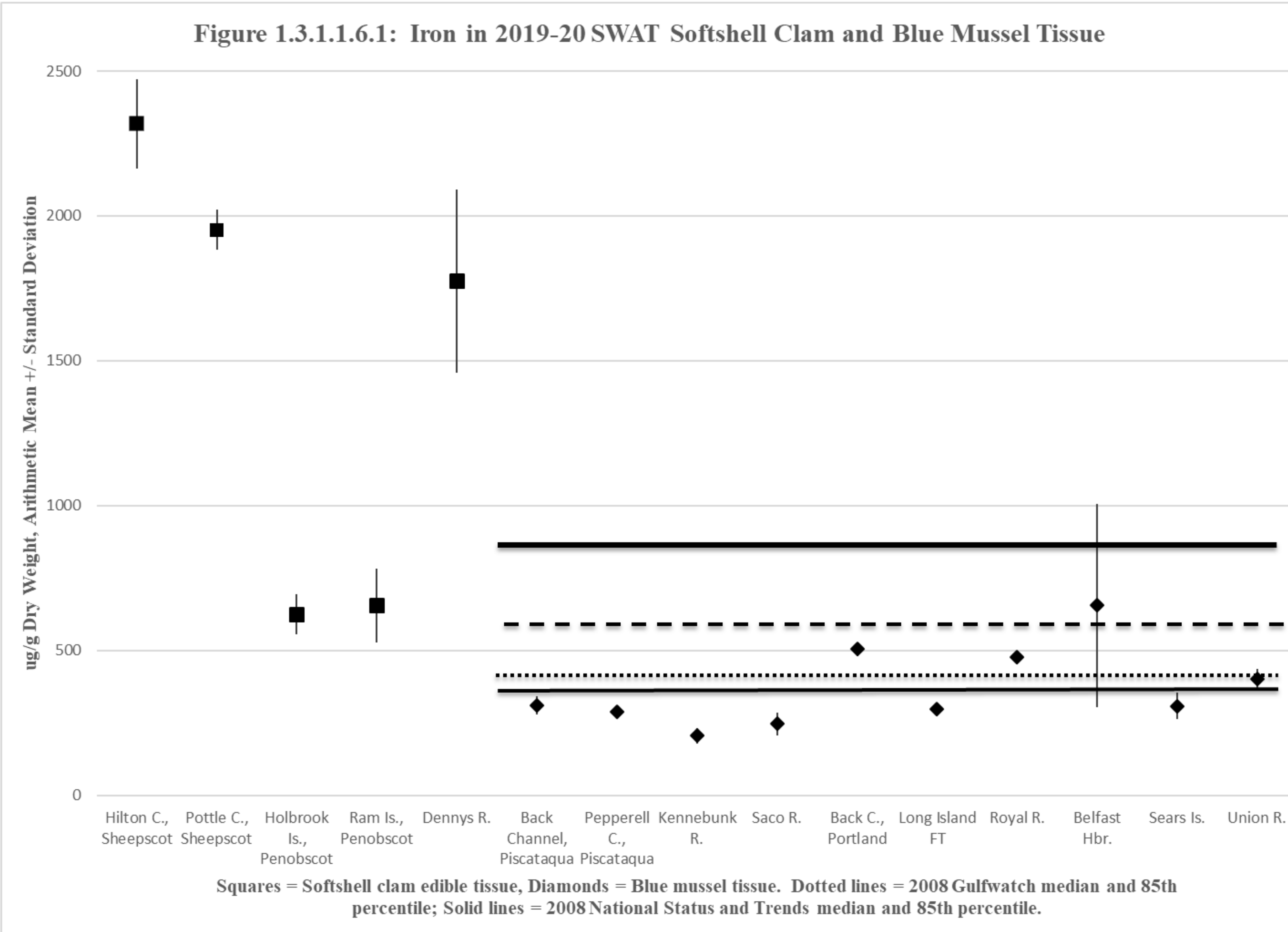


Figure 1.3.1.1.6.1: Iron in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
2500
2000
1500
1000
500
0
Hilton C., Sheepscot
Pottle C., Sheepscot
Holbrook Is., Penobscot
Ram Is., Penobscot
Dennys R.
Back Channel, Piscataqua
Pepperell C., Piscataqua
Kennebunk R.
Saco R.
Back C., Portland
Long Island FT
Royal R.
Belfast Hbr.
Sears Is.
Union R.
Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.

concentration exceeding the NS&T 85$^{th}$ percentile, no site was considered elevated for iron (Figure 1.3.1.1.6.1).

Aluminum was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.6.2). Aluminum concentrations measured in clam edible tissue ranged from a low mean concentration of 418 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 1,248 µg/g dry wt. at Dennys River, Edmunds Township. Higher aluminum concentrations at Hilton and Pottle coves and Dennys River may be related to sediment in the clam gut, as clams are not depurated.

Aluminum was detected in tissue taken at all ten SWAT mussel sites sampled in 2020 (Figure 1.3.1.1.6.2). Aluminum levels measured in mussels ranged from a low mean concentration of 89 µg/g dry wt. at Saco River, Saco, to a high mean concentration of 468 µg/g dry wt. at Back Cove, Portland. Aluminum concentrations at four sites exceeded the Gulfwatch median, but only Back Cove, Portland, exceeded the Gulfwatch 85$^{th}$ percentile. Six sites exceeded the lower, NS&T median and none of the ten mussel sites had an aluminum concentration that exceeded the NS&T 85$^{th}$ percentile (Kimbrough et al., 2008; LeBlanc et al., 2009). No sites were considered to be elevated for aluminum.

High iron and aluminum concentrations are usually associated with the intake of high levels of suspended sediments by mussels at sampled sites, with both metals being common components of crustal rocks and coastal sediments. This correlation has also been shown with gut depuration experiments conducted as part of Gulfwatch monitoring in previous years, indicating that some of the iron and aluminum is associated with gut contents and not bioaccumulated loads (Leblanc et al., 2009). Monitoring for iron and aluminum provides an important reference to gauge sediment intake by mussels, allowing iron and aluminum levels to be referenced if other more toxic metals or contaminants are detected in mussel tissue.

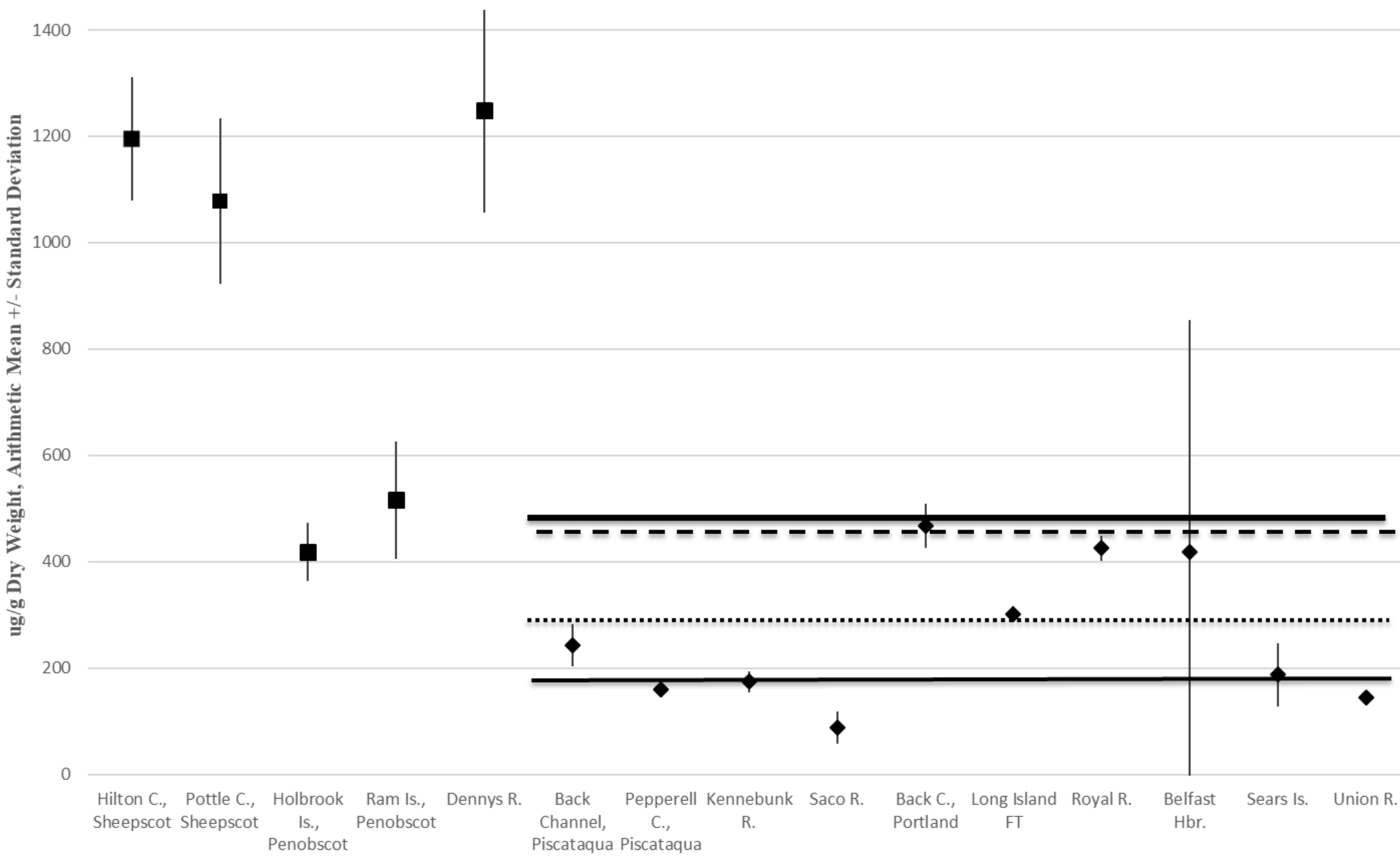
From a human health perspective, MCDC does not report FTALs for iron and aluminum.

**1.3.1.1.7 Nickel (Ni)**

Nickel was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.7.1). Nickel levels measured in clam edible tissue ranged from a low mean concentration of 0.89 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 1.96 µg/g dry wt. at Dennys River, Edmunds Township.

Nickel was detected in tissue from all ten SWAT blue mussel sites sampled in 2020 (Figure 1.3.1.1.7.1). Nickel levels measured in mussels ranged from a low mean concentration of

**Figure 1.3.1.1.6.2: Aluminum in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue**




**Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.**

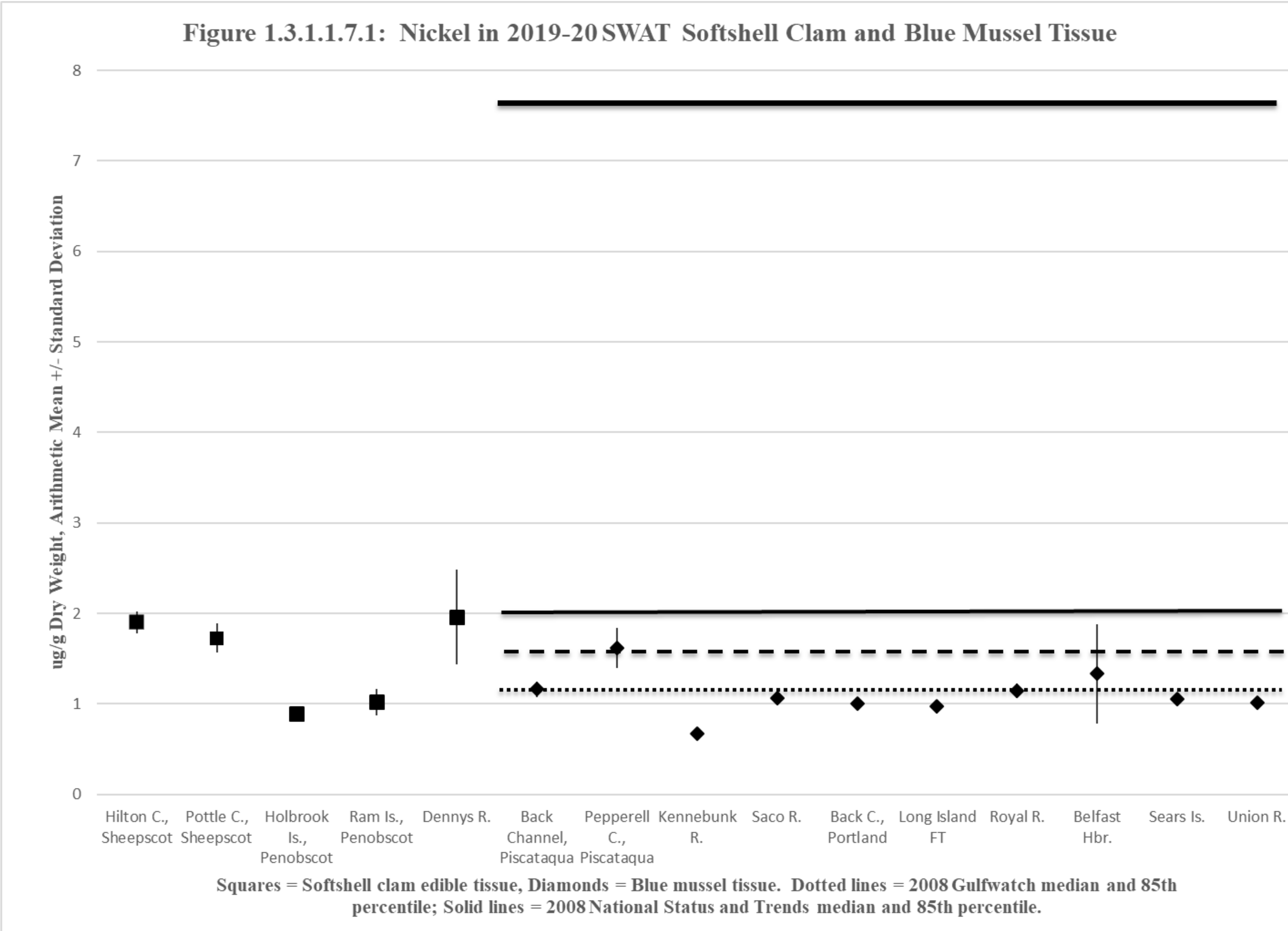


Figure 1.3.1.1.7.1: Nickel in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
8
7
6
5
4
3
2
1
0
Hilton C., Sheepscot
Pottle C., Sheepscot
Holbrook Is., Penobscot
Ram Is., Penobscot
Dennys R.
Back Channel, Piscataqua
Pepperell C., Piscataqua
Kennebunk R.
Saco R.
Back C., Portland
Long Island FT
Royal R.
Belfast Hbr.
Sears Is.
Union R.
Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.

0.68 µg/g dry wt. at Kennebunk River, Kennebunkport, to a high mean concentration of 1.61 µg/g dry wt. at Pepperell Cove, Kittery. Back Channel, Kittery, and Royal River, Yarmouth, had nickel concentrations approximating the Gulfwatch median while Belfast Harbor and Pepperell Cove, Kittery, had nickel concentrations that exceeded the Gulfwatch median. Only Pepperell Cove, Kittery, exceeded the Gulfwatch 85$^{th}$ percentile. None of the sites had concentrations of nickel in tissue that exceeded the NS&T median or NS&T 85$^{th}$ percentile (Kimbrough et al., 2008; LeBlanc et al., 2009). None of the SWAT sites were considered to be elevated for nickel. Higher nickel concentrations are probably associated with sediment ingestion, similar to iron and aluminum concentrations.

Nickel occurs naturally in the environment and is essential to biological processes as a trace element. Nickel from soil and weathering of rocks enters rivers and provides the largest source of nickel to coastal waters. Nickel occurs in stainless steel, nickel-cadmium batteries, pigments, computers, wire, coins, and is used in electroplating. Elevated nickel concentrations occur in the Great Lakes and speculation about sources centers on air deposition from a large nickel smelting operation in Ontario, Canada (Kimbrough et al., 2008).

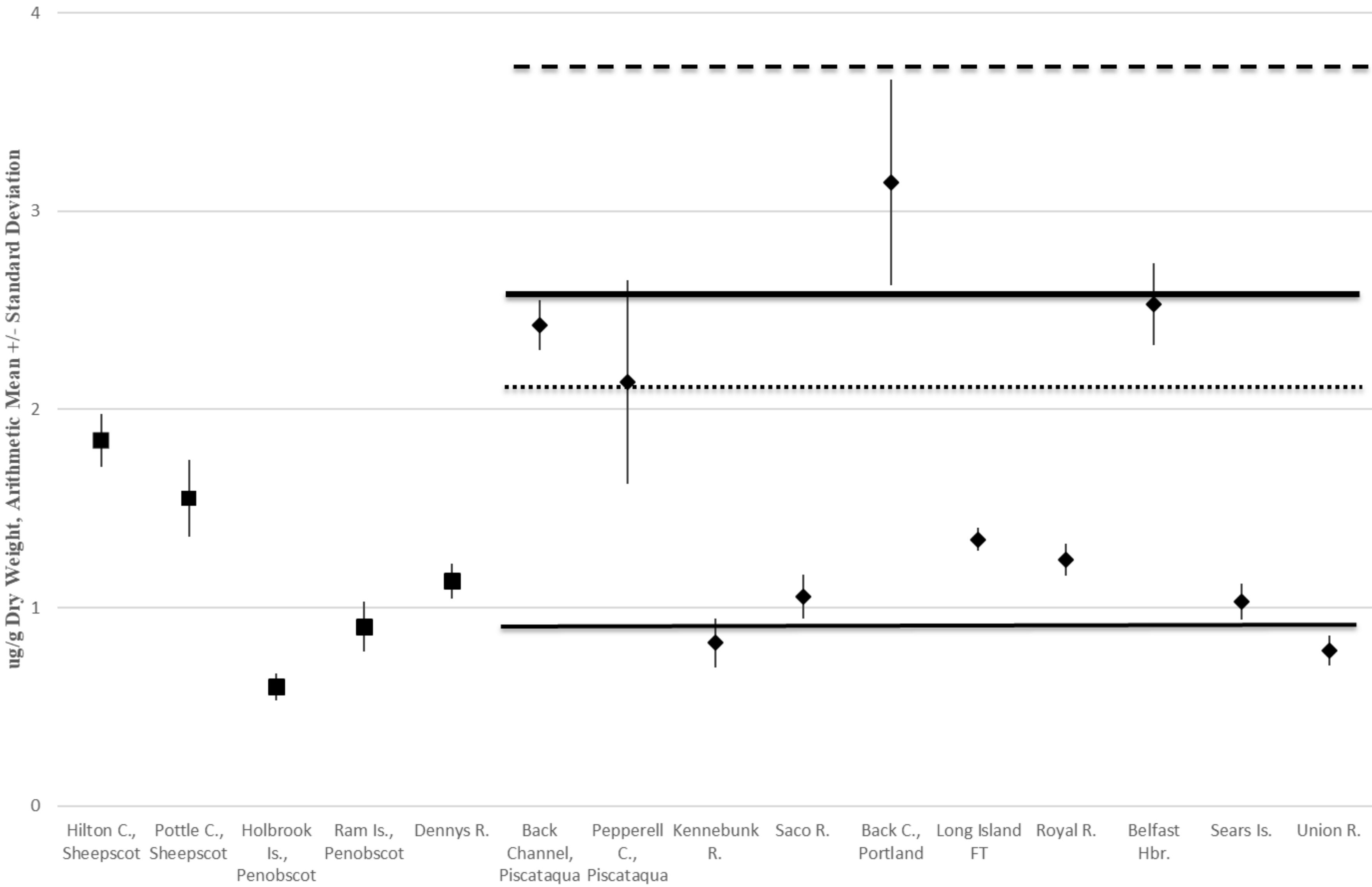
Nickel is not thought to bioaccumulate in the food chain; however, nickel can be harmful to humans in large doses, inducing effects including bronchitis and even cancer from long term exposure (Kimbrough et al., 2008). The MCDC reports a non-cancer FTAL for nickel in non-commercially caught finfish of 43 µg/g wet wt., which is more conservative than the FDA action level for shellfish of 80 µg/g wet weight. The maximum mean concentrations detected by SWAT in 2019-20 of 0.28 µg/g wet wt. in edible clam tissue at Dennys River, Edmunds Township, and 0.24 µg/g wet wt. in mussel tissue at Pepperell Cove, Kittery, are two orders of magnitude below the more conservative MCDC action level. MCDC does not report a cancer action level for nickel.

#### 1.3.1.1.8 Lead (Pb)

Lead was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.8.1). Lead levels measured in clam edible tissue ranged from a low mean concentration of 0.60 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 1.84 µg/g dry wt. at Hilton Cove, Wiscasset.

Lead was detected in tissue from all ten SWAT blue mussel sites sampled in 2020 (Figure 1.3.1.1.8.1). Lead levels measured in mussels ranged from a low mean concentration of 0.82 µg/g dry wt. at Kennebunk River, Kennebunkport, to a high mean concentration of 3.14 µg/g dry wt. at Back Cove, Portland. Four sites had lead concentrations exceeding the Gulfwatch median, with Pepperell Cove, Kittery, just exceeded the median. Eight sites

**Figure 1.3.1.1.8.1: Lead in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue**




**Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.**

had lead concentrations exceeding the NS&T median. Only Back Cove, Portland, had a lead concentration exceeding the NS&T 85$^{th}$ percentile and so was considered elevated based on criteria in the SWAT and Gulfwatch programs. The lead concentration in Back Cove mussel tissue did not approach the Gulfwatch 85$^{th}$ percentile (Figure 1.3.1.1.8.1).

Lead occurs naturally in the earth's crust; however, global lead concentrations in the environment have increased in the last century due to the use of leaded gasoline. Reduction in lead loading through regulation of leaded gasoline and lead paints has occurred in recent decades. Elevated lead levels in the environment also occur due to manufacturing, paints, lead solder, ammunition, plumbing, incineration and burning of fossil fuels. Lead loading in coastal waters is related to wastewater discharge, river runoff, atmospheric deposition, and natural weathering of crustal rock (Kimbrough et al., 2008).

From a human health perspective, the FDA action level for lead in clams, oysters, and mussels (molluscan shellfish) had been 1.7 µg/g wet wt. (Kimbrough et al., 2008). Use of this limit was discontinued at the 2007 Interstate Shellfish Sanitation Conference. The outdated, more conservative MCDC lead FTAL in non-commercially caught sportfish was 0.6 µg/g wet wt., which is based on a blood lead concentration model. This MCDC FTAL is no longer in use, but a new lead FTAL has not yet been developed. The highest mean concentration in the 2019 Maine SWAT softshell clam edible tissue data, 0.32 µg/g wet wt. at Hilton Cove, Wiscasset, is about half of the outdated MCDC lead FTAL. The highest mean concentration in the 2020 Maine SWAT blue mussel tissue data, 0.52 µg/g wet wt. at Back Cove, Portland, was below the outdated MCDC, lead FTAL.

Review of the 2007-17 SWAT blue mussel sampling data from 62 sites indicates that mean lead concentrations at eight sites equaled or exceeded the former MCDC lead FTAL. Sites sampled in those years equaling or exceeding the MCDC FTAL for lead are presented in Table 1.3.1.1.8.1. Previously sampled Back Channel, Kittery, had a concentration of 0.6 µg/g wet wt. in 2008, equal to the outdated MCDC FTAL. Note that the lead concentration in tissue from this site in 2020 was 0.52 µg/g wet wt. (Figure 1.3.1.1.8.1), which is slightly less than the 2008 concentration. Blue mussel tissue previously sampled just below Goose Falls, Brooksville, in 2007 had a mean lead concentration of 1.1 µg/g wet wt., above the outdated MCDC FTAL. In 2020, SWAT softshell clam edible tissue results from nearby and just offshore Holbrook Island and Ram Island, both in Castine, showed lead concentrations of 0.12 and 0.16 µg/g wet wt., respectively. Lead concentrations in these two edible clam tissues are approximately 1/5 to less than 1/3, respectively, of the outdated MCDC lead FTAL. These were the closest significant softshell clam resources to the Goose Falls, Brooksville, mine outfall that SWAT could locate and sample. The MCDC lead FTAL is based on the consumer eating an 8 oz. meal. Maine SWAT data indicate that an 8 oz. meal would include approximately 45-50 mussels of the size tested by the SWAT program.

**Table 1.3.1.1.8.1: Lead Concentrations in Blue Mussel Tissue Exceeding 0.6 mg/g wet Wt.**

| Site | Municipality | Years Sampled | Concentration or Mean (Wet wt.) | Standard Deviation |
|---|---|---|---|---|
| Piscataqua River Back Channel | Kittery | 2008 | 0.6* | |
| Spring Point | S. Portland | 2007, 2010, 2012, 2015 | 0.7 | 0.096 |
| Middle Fore River | Portland | 2007 | 0.6* | |
| East End Beach | Portland | 2007, 2009, 2011, 2013, 2015, 2017 | 1.1 | 0.559 |
| Turnip Island | Georgetown | 2012 | 1.4* | |
| Crockett Point | Rockland | 2007, 2010, 2011, 2016 | 1.2 | 0.100 |
| Ocean Pursuits Boat Yard | Rockland | 2013 | 0.6* | |
| Town Landing | Rockland | 2013 | 0.9* | |
| Camden Harbor | Camden | 2007 | 0.7* | |
| Goose Falls | Brooksville | 2007 | 1.1* | |

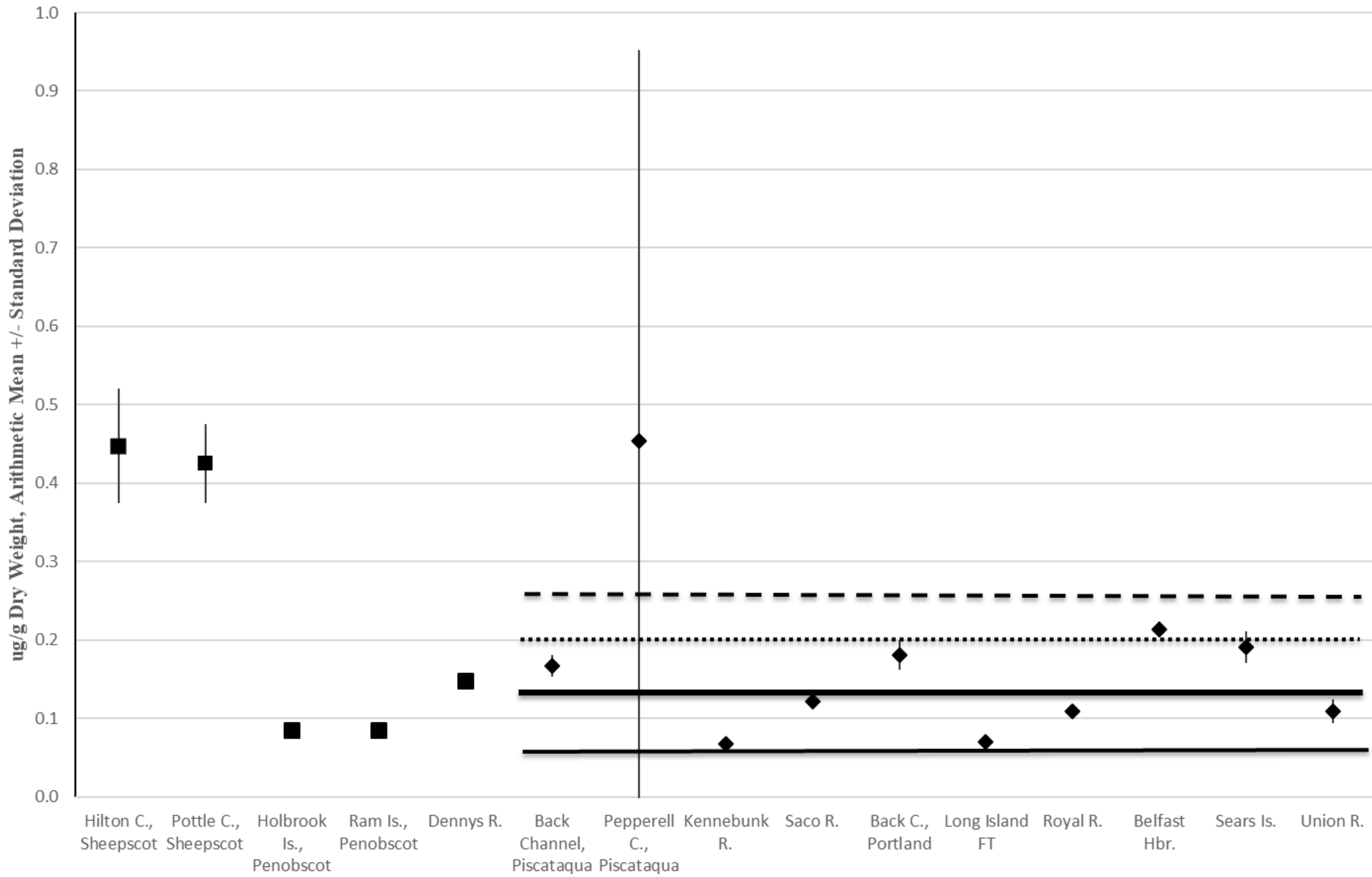
* Site only sampled in one year

**1.3.1.1.9 Mercury (Hg)**

Mercury was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.9.1). Mercury levels measured in clam edible tissue ranged from a low mean concentration of 0.084 µg/g dry wt. at Ram Island, Castine, to a high mean concentration of 0.45 µg/g dry wt. at Hilton Cove, Wiscasset.

Mercury was detected in tissue from all ten blue mussel sample locations tested in 2020 (Figure 1.3.1.1.9.1). Mercury levels measured in mussels ranged from a low mean concentration of 0.068 µg/g dry wt. at Kennebunk River, Kennebunkport, to a high mean concentration of 0.45 µg/g dry wt. at Pepperell Cove, Kittery. Mercury concentrations at Belfast Harbor and Pepperell Cove, Kittery, exceeded the 2008 Gulfwatch median, while only Pepperell Cove, exceeded the Gulfwatch 85$^{th}$ percentile. Figure 1.3.1.1.9.1 also compares 2019-20 SWAT blue mussel mercury concentrations to NS&T Mussel Watch median and 85$^{th}$ percentile values. The reader should note that Gulfwatch median and 85$^{th}$ percentile values actually exceed NS&T Mussel Watch median and 85$^{th}$ percentile values, respectively, since the northeastern US has relatively high mercury levels due to deposition of airborne mercury from a wide range of sources in the US

**Figure 1.3.1.1.9.1: Mercury in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue**




**Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted lines = 2008 Gulfwatch median and 85th percentile; Solid lines = 2008 National Status and Trends median and 85th percentile.**

Midwest. Based on the Gulfwatch and SWAT criteria of “elevated” contaminants being those above the NS&T 85$^{th}$ percentile, five SWAT sites tested in 2020 would be considered elevated for mercury despite the more typical magnitude of their scores when compared to other northeast US samples from the Gulf of Maine. The five remaining sites had mercury concentrations in mussel tissue below the NS&T 85$^{th}$ percentile.

Mercury occurs naturally in the environment; however, elevated levels are associated with anthropogenic sources. United States sources of mercury to the air include coal fired electrical power generation, incinerators, mining, landfills, and sewage sludge (Kimbrough et al., 2008).

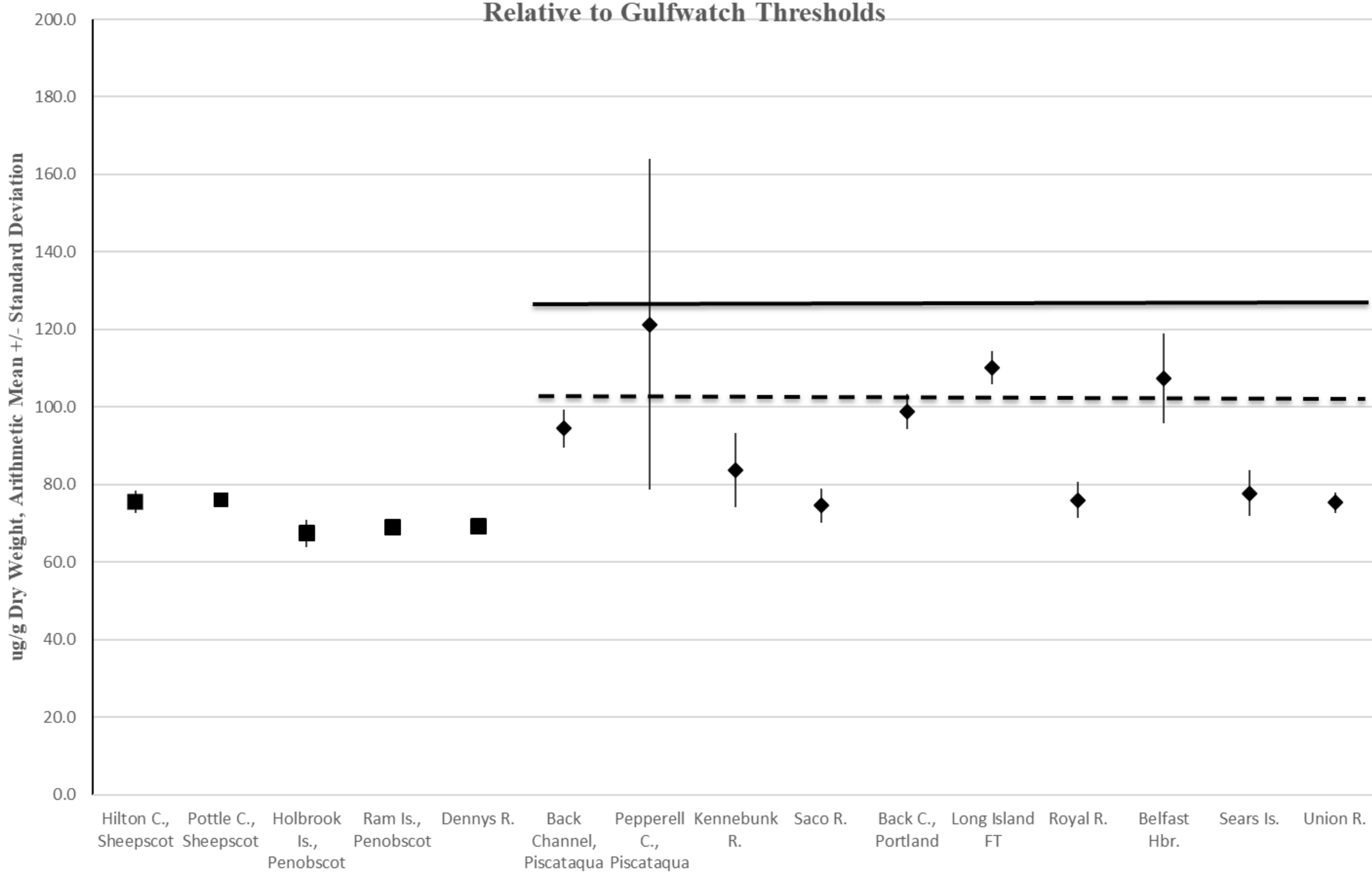
From a human health perspective, the developmental methylmercury FTAL (more protective) used by the MCDC is 0.2 µg/g wet wt. for non-commercially caught finfish (fish filet). This FTAL assumes an 8 oz. meal size is consumed weekly. Maine SWAT data uses a total mercury value, which is a more complete measure of mercury than the methylmercury concentration but includes this more toxic form. The highest mean blue mussel total tissue mercury concentration measured in Maine in 2020 was 0.068 µg/g wet wt. at Pepperell Cove, Kittery. This mean concentration, as well as those from the other blue mussel sites sampled, compares favorably with the MCDC methylmercury developmental FTAL of 0.2 µg/g, assuming a similar meal size and frequency. To consume approximately 8 oz. of blue mussel tissue the consumer would need to eat approximately 45-50 mussels based on the mean mass per mussel collected by the SWAT program. Similarly, the softshell clam site with the highest mean edible tissue mercury concentration was Hilton Cove, Wiscasset, which was 0.078 µg/g wet wt. This is well below the MCDC FTAL.

**1.3.1.1.10 Zinc (Zn)**

Zinc was detected in samples taken at all five softshell clam locations sampled in 2019 (Figure 1.3.1.1.10.1). Zinc levels measured in clam edible tissue ranged from a low mean concentration of 67.4 µg/g dry wt. at Holbrook Island, Castine, to a high mean concentration of 76.0 µg/g dry wt. at Pottle Cove, Wiscasset.

Zinc was detected in mussel tissue taken from all ten locations sampled in 2020 (Figure 1.3.1.1.10.1). Zinc levels measured in mussels ranged from a low mean concentration of 74.6 µg/g dry wt. at Saco River to a high mean concentration of 121.0 µg/g dry wt. at Pepperell Cove, Kittery. Zinc concentrations in mussel tissue from three sites exceeded the 2008 Gulfwatch median and no sites had concentrations that exceeded the 2008 Gulfwatch 85$^{th}$ percentile. Figure 1.3.1.1.10.2 shows 2020 Maine SWAT blue mussel zinc concentrations were all below the NS&T Mussel Watch median and 85$^{th}$ percentile (note different scale).

**Figure 1.3.1.1.10.1: Zinc in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue Relative to Gulfwatch Thresholds**




Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted line = 2008 Gulfwatch median; Solid line = 2008 Gulfwatch 85th percentile.

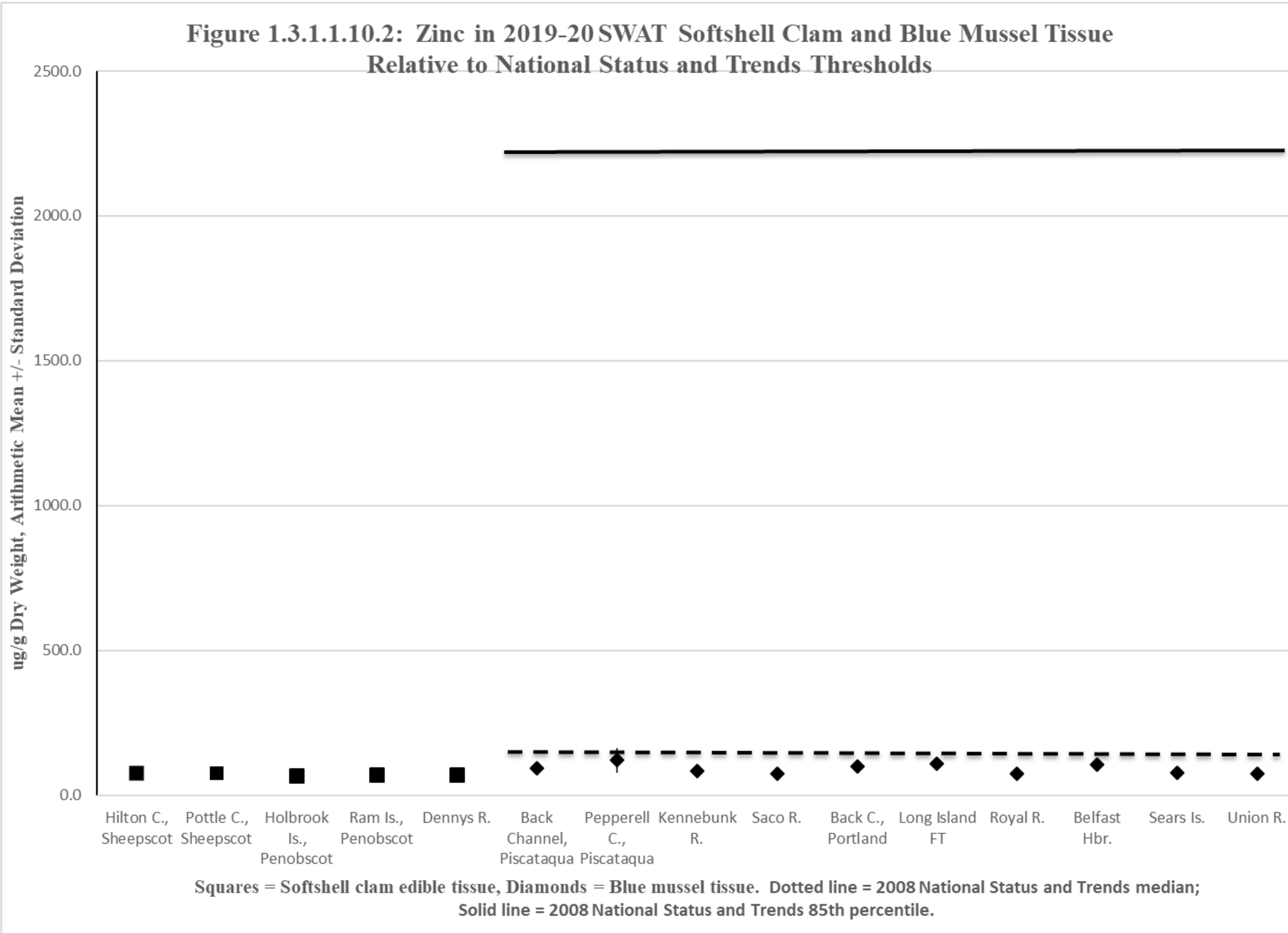


Figure 1.3.1.1.10.2: Zinc in 2019-20 SWAT Softshell Clam and Blue Mussel Tissue Relative to National Status and Trends Thresholds
ug/g Dry Weight, Arithmetic Mean +/- Standard Deviation
2500.0
2000.0
1500.0
1000.0
500.0
0.0
Hilton C., Sheepscot
Pottle C., Sheepscot
Holbrook Is., Penobscot
Ram Is., Penobscot
Dennys R.
Back Channel, Piscataqua
Pepperell C., Piscataqua
Kennebunk R.
Saco R.
Back C., Portland
Long Island FT
Royal R.
Belfast Hbr.
Sears Is.
Union R.
Squares = Softshell clam edible tissue, Diamonds = Blue mussel tissue. Dotted line = 2008 National Status and Trends median;
Solid line = 2008 National Status and Trends 85th percentile.

Zinc is widespread in its distribution but elevated levels primarily originate from a variety of human activities including vehicle tire wear, electroplating and galvanized metals, industrial wastes, and drainage from mining (Kimbrough et al., 2008). Though an essential nutrient at low levels, higher levels in humans can cause anemia or pancreatic and kidney damage. Since humans do not bioaccumulate zinc, health impacts are normally associated with high doses. From a human health perspective, MCDC reports a non-cancer FTAL for zinc of 648 µg/g wet wt., which is higher than any wet wt. concentrations observed in SWAT blue mussel or edible softshell clam tissue. There is no recommended FDA safety level for zinc in fish (Kimbrough et al., 2008).

#### 1.3.1.2 American Eels

##### 1.3.1.2.1 Mercury

Mercury was detected in American eel filet analyzed at all sites sampled in 2019 on the Kennebec and Penobscot rivers. Figure 1.3.1.2.1.1 shows total mercury concentrations in yellow, sub-adult eels, the life stage typically captured in the baited pot fishery commonly used on Maine rivers. There is some variability in the total mercury concentrations between replicate composite samples analyzed, two for each site. In general, Kennebec yellow eel tissue mercury concentrations appear to be somewhat lower than Penobscot concentrations by an approximate factor of two. Means of total mercury of two replicate composite samples ranged from 0.30 µg/g wet wt. in tissue from Waterville to Sidney, Kennebec River, to a high of 0.77 µg/g wet wt. in tissue from Orrington, Penobscot River. Figure 1.3.1.2.1.1 shows mercury concentrations from both replicates at each site to illustrate variation between paired composite samples.

From a human health perspective, the developmental methylmercury FTAL (more protective) used by the MCDC 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 lowest yellow eel filet total mercury concentration measured in 2019 was composite 1 from the Sidney to Augusta segment of the Kennebec River, which had a concentration of 0.141 µg/g wet wt. The concentration for composite 2 from this same location was 0.519 µg/g wet wt., making the mean of the two samples 0.33 µg/g wet wt. The mean at Waterville to Sidney, Kennebec River, was lower at 0.30 µg/g wet wt., the lowest mean total mercury concentration in yellow eel tissue of the six sites tested. This mean concentration, as well as those from the other yellow eel sites sampled, falls above the MCDC methylmercury developmental FTAL of 0.2 µg/g, assuming a similar meal size and frequency.

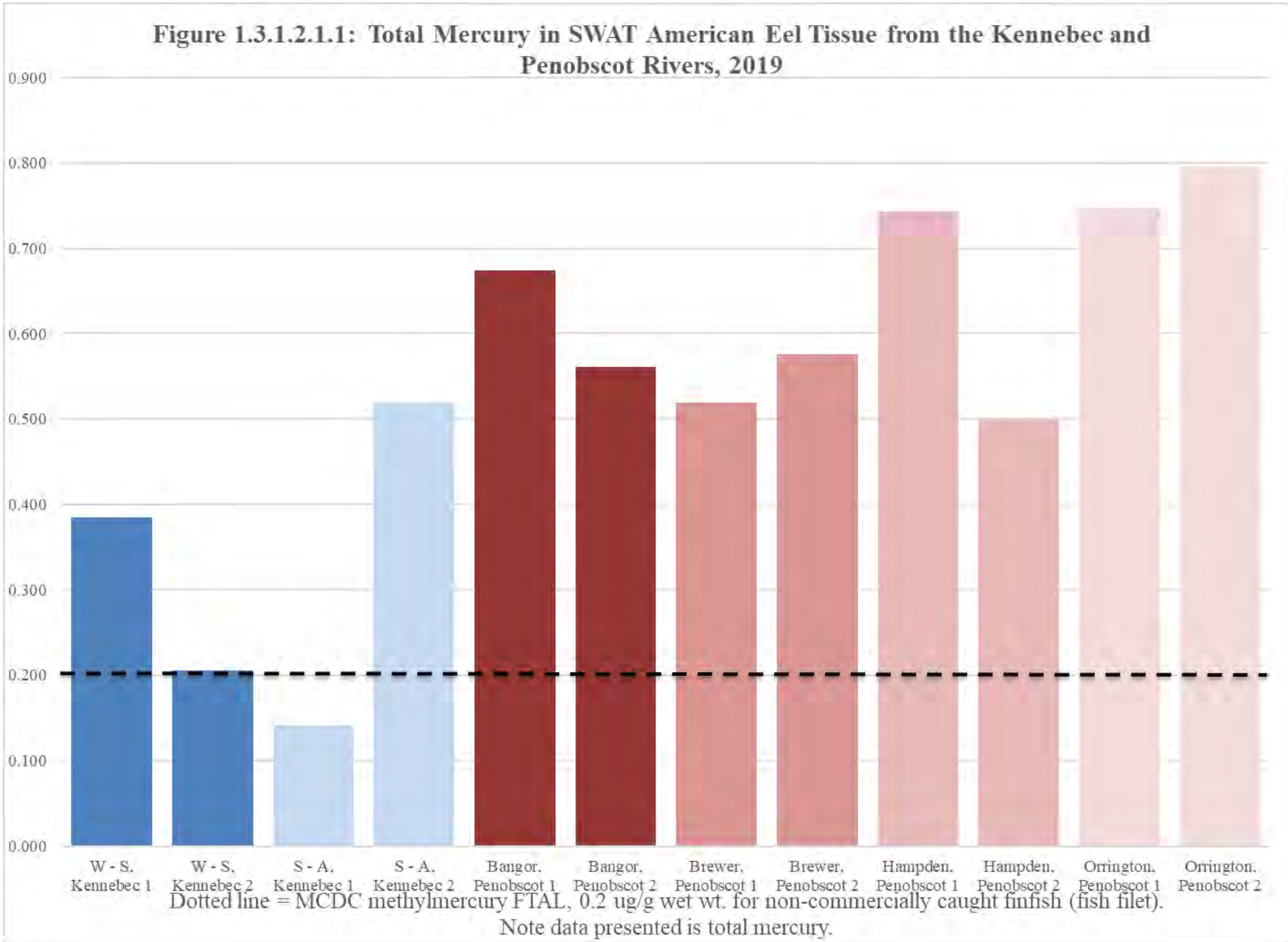


Figure 1.3.1.2.1.1: Total Mercury in SWAT American Eel Tissue from the Kennebec and Penobscot Rivers, 2019
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
W - S, Kennebec 1
W - S, Kennebec 2
S - A, Kennebec 1
S - A, Kennebec 2
Bangor, Penobscot 1
Bangor, Penobscot 2
Brewer, Penobscot 1
Brewer, Penobscot 2
Hampden, Penobscot 1
Hampden, Penobscot 2
Orrington, Penobscot 1
Orrington, Penobscot 2
Dotted line = MCDC methylmercury FTAL, 0.2 ug/g wet wt. for non-commercially caught finfish (fish filet).
Note data presented is total mercury.

### 1.3.2 Perfluorinated Compounds

Perfluorinated compounds or chemicals (PFAS) are organofluorine compounds that have fluorine substituted for all hydrogens where C-H bonds otherwise would occur in organic compounds. PFCs 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.

Analysis for PFAS in blue mussel tissue was initiated in 2013 and additional sites were examined in 2014 and 2016. PFAS testing in 2017 included two softshell clam sites. Prior PFAS laboratory results included 13 PFAS, while 2019-20 results presented in this report provide analyses for 33 PFAS compounds now available from the contracted laboratory. This report utilizes the Maine SWAT blue mussel tissue PFAS data generated by AXYS Analytical, and the list of compounds for which analyses were available are presented in Table 1.3.2.1.1 Table 1.3.2.1.1 also shows the low and high values for the sample-specific detection limits for the PFCs for which analyses were performed.

#### 1.3.2.1 Blue Mussel and Softshell Clam Tissue

In previous PFAS testing in softshell clam tissue, none of the twelve PFAS for which analyses were completed in 2017 were detected in samples from two sites tested. In 2019, Dennys River softshell clams were included in the PFAS analysis since blue mussels were not available at the location at the time of field sampling. Subsequent analysis of edible clam tissue from Dennys River detected no PFAS from the list of 33 now available from the contracted laboratory.

In prior years, PFAS analyses in blue mussel tissue yielded mostly non-detects, with PFOSA detected in several samples but at levels just above the reporting limit. With the lower detection limits available in 2019-20 and a longer list of 33 PFAS compounds now reported, 23 blue mussel sites were sampled (in addition to the Dennys River softshell clam site previously mentioned, with clam tissue substituted for mussel tissue).

Table 1.3.2.1.2. shows detected PFAS compounds by blue mussel site sampled. In total, ten PFAS compounds were detected in blue mussel tissue and the number of intra-site spatial replicates that had detectable concentrations is also shown in Table 1.3.2.1.2. Estimated maximum possible concentration (EMPC) data are also displayed, which describes those compounds which were quantified in the analysis but were below the reporting limit.

## Table 1.3.2.1.1: PFAS Compounds and Reporting Limits for 2019-20 SWAT Shellfish Tissue Analysis

| | REPORTING LIMIT | | | | |
|---|---|---|---|---|---|
| | 2019 | | 2020 | | Unit |
| PFAS COMPOUND | low | high | low | high | wet wt. |
| PERFLUOROBUTANOATE | 0.7339 | 0.8081 | 0.3670 | 0.4000 | NG/G |
| PERFLUOROPENTANOATE | 0.3670 | 0.4040 | 0.1835 | 0.2000 | NG/G |
| PERFLUOROHEXANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PERFLUOROHEPTANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PERFLUOROOCTANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PERFLUORONONANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PERFLUORODECANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PERFLUOROUNDECANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PERFLUORODODECANOATE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| PFTrDA | 0.1869 | 0.5065 | 0.0917 | 0.1034 | NG/G |
| PFTeDA | 0.1861 | 0.2511 | 0.0917 | 0.1949 | NG/G |
| PFBS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| PFPeS | 0.1861 | 0.2010 | 0.0922 | 0.1005 | NG/G |
| PFHxS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| PFHpS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| PFOS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| PFNS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| PFDS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| PFDoS | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| 4:2 FTS | 0.7442 | 0.8040 | 0.3670 | 0.4000 | NG/G |
| 6:2 FTS | 1.3400 | 1.4470 | 0.3307 | 0.3605 | NG/G |
| 8:2 FTS | 0.7442 | 0.8040 | 0.3670 | 0.4000 | NG/G |
| PERFLUOROOCTANE SULFONAMIDE | 0.1835 | 0.2020 | 0.0917 | 0.1000 | NG/G |
| N-MeFOSA | 0.2140 | 0.2312 | 0.0917 | 0.1000 | NG/G |
| N-EtFOSA | 0.4651 | 0.5025 | 0.9174 | 1.0000 | NG/G |
| MeFOSAA | 0.1861 | 0.2010 | 0.0917 | 0.1000 | NG/G |
| EtFOSAA | 0.3721 | 0.4020 | 0.0917 | 0.1000 | NG/G |
| N-MeFOSE | 1.8610 | 2.0100 | 0.9174 | 1.0000 | NG/G |
| N-EtFOSE | 1.3950 | 1.5080 | 0.6862 | 0.7480 | NG/G |
| HFPO-DA | 0.7442 | 0.8040 | 0.3486 | 0.3800 | NG/G |
| ADONA | 0.7442 | 0.8040 | 0.3670 | 0.4000 | NG/G |
| 9Cl-PF3ONS | 0.7442 | 0.8040 | 0.3679 | 0.4010 | NG/G |
| 11Cl-PF3OUdS | 0.7442 | 0.8040 | 0.3674 | 0.4005 | NG/G |

Table 1.3.2.1.2: PFAS Compounds Detected in 2019-20 SWAT Blue Mussel Tissue

| | | | PFAS Compound Detected | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site Name** | **site code** | **year** | **PFOSA** | **PFTrDA** | **PFTeDA** | **EtFOSAA** | **PFDS** | **PFNA** | **PFUnA** | **N-EtFOSE** | **PFOS** | **6:2 FTS** |
| Back Channel, Piscataqua R. | PQBCBC | 2020 | | | | | | 3 | | | | |
| Pepperell C., Piscataqua R. | PQPCPC | 2020 | | | 1-3* | | 1-2* | | | | | |
| Kennebunk R. | SCKBMT | 2020 | | | 1* | | 2* | | | | | |
| Saco R. | SCSAJY | 2020 | | | | | | | | | | |
| Portland Harbor | CBFROR | 2019 | 1-4 | | | | | | | | | |
| Fore R. (middle river) | CBFRMR | 2020 | 1-3 | 1,2 | 2 | 1*, 2-3 | | | | | | |
| Fore R. (inner river) | CBFRIR | 2019 | 1-4 | 3 | | | | | | | 1-4 | |
| East End, Portland | CBEEEE | 2019 | 1-4 | | | 3 | 2* | | | | | |
| Back Cove, Portland | CBBBBB | 2020 | 1-3 | | 2 | | | | | 3 | | |
| Presumpscot R. | CBPRMT | 2019 | 1-4 | 4 | | 2-4 | | | | | | |
| Long Is., Casco Bay | CBLNFT | 2020 | 3 | | | 1-3 | | | | | | |
| Cousins Is. Thorofare | CBTHTH | 2020 | | | | 1-3 | | | | | | 1 |
| Royal R. | CBRYMT | 2020 | | | | 1-2, 3* | | | | | | 1 |
| Maine Yankee, Sheepscot R. | MCSHMY | 2020 | 1-3 | | 1-3 | 1-3 | | | | | | |
| Perkins Is. Kennebec R. | MCKNPI | 2019 | 1-4 | | | | | | | | | |
| Town Cove, Boothbay Harbor | MCBBTC | 2019 | 1-4 | | | | | | | | | |
| Rockland | PBRKCP | 2019 | | 2 | | | | | | | | |
| Belfast | PBBFTD | 2020 | | | | | | | | | | |
| Sears Is., Searsport | PBSIWS | 2020 | | | 1* | | | | | | | |
| Fort Pt., Penobscot R. | PBFPFP | 2020 | | | | | | | | | | |
| Sandy Pt., Penobscot R. | PBSPSP | 2019 | 1 | | | | | 1 | | | | 1 |
| Union R. | BFURMT | 2020 | | | 1* | | | | | | | |
| Cutler | ECMCLM | 2019 | | | | | | | 3 | | | |
| Dennys R. | PMCKDR | 2019 | | | | | | | | | | |

Numbers 1 - 4 represent the number of spatial subsamples at each site with detected concentrations of the PFAS compound

2019 = 4 replicates/site, 2020 = 3 replicates/site

* = EMPC, estimated maximum possible concentration

- Perfluoroctane sulfonate (PFOS) was detected in all four replicates of blue mussel tissue at only one site tested in 2019-20, Fore River (inner river), Portland. The detection of PFOS in inner Fore River mussel tissue is the first time the SWAT program has detected PFOS in blue mussel or softshell clam tissue in the five years sampling has been conducted. PFOS concentrations in blue mussel tissue at inner Fore River ranged from 0.2350 ng/g to 0.4486 ng/g wet wt. (Figure 1.3.2.1.1). Maine CDC uses a Fish Tissue Action Level for PFOS of 34.1 ng/g wet wt. for the general population. Concentrations of PFOS detected in blue mussel tissue in Fore River (inner river) were two orders of magnitude lower than the FTAL of 34.1 ng/g wet wt. (compared to 0.4486 ng/g wet wt. of PFOS in the highest replicate sampled in Fore river (inner river)). Currently, Maine CDC does not have FTALs for any other PFAS compounds.

- Perflourooctane sulfonamide (PFOSA) was the most frequently detected PFAS compound in the 2019-20 blue mussel samples. Nine of the 23 sites had PFOSA present in all replicates, including: Portland Harbor; Fore River (middle river); Fore River (inner river); East End, Portland; Back Cove, Portland; Presumpscot River; Perkins Island, Georgetown Township; Maine Yankee, Wiscasset; and Town Cove, Boothbay Harbor (Figure 1.3.2.1.2). Two locations sampled for blue mussels contained PFOSA at only one replicate: Long Island (Casco Bay) and Sandy Point, Stockton Springs, and these single concentrations are also included in Figure 1.3.2.1.2 with the other nine site mean concentrations.

- Perflourotetradecanoate (PFTeDA) was detected at Maine Yankee, Wiscasset, in all replicates. PFTeDA was detected in one replicate at Fore River (middle river), Portland, and at Back Cove, Portland. Estimated maximum possible concentrations (EMPC - lab code, which indicates the compound was detected but below the established reporting limit) of PFTeDA were reported in all replicates at Pepperell Cove, Kittery, and one replicate had an EMPC reported value at Kennebunk River, Kennebunkport, Back Cove, Portland, Sears Island, Searsport, and Union River, Surry. PFTeDA concentrations ranged from 0.1250 ng/g to 0.2594 ng/g wet wt. for detects and EMPC coded concentrations in blue mussel tissue.

- N-ethyl perfluorooctaine sulfonamidoacetic acid (EtFOSAA) was detected in all replicates at East End and in Back Cove, Portland, Long Island, Casco Bay, Cousins Island Thorofare, Yarmouth, and Maine Yankee, Wiscasset. EtFOSAA was detected in three of four replicates in the Presumpscot River, and in two of three replicates in Fore River (middle river), Portland, and Royal River, Yarmouth. EtFOSAA was detected in one replicate of

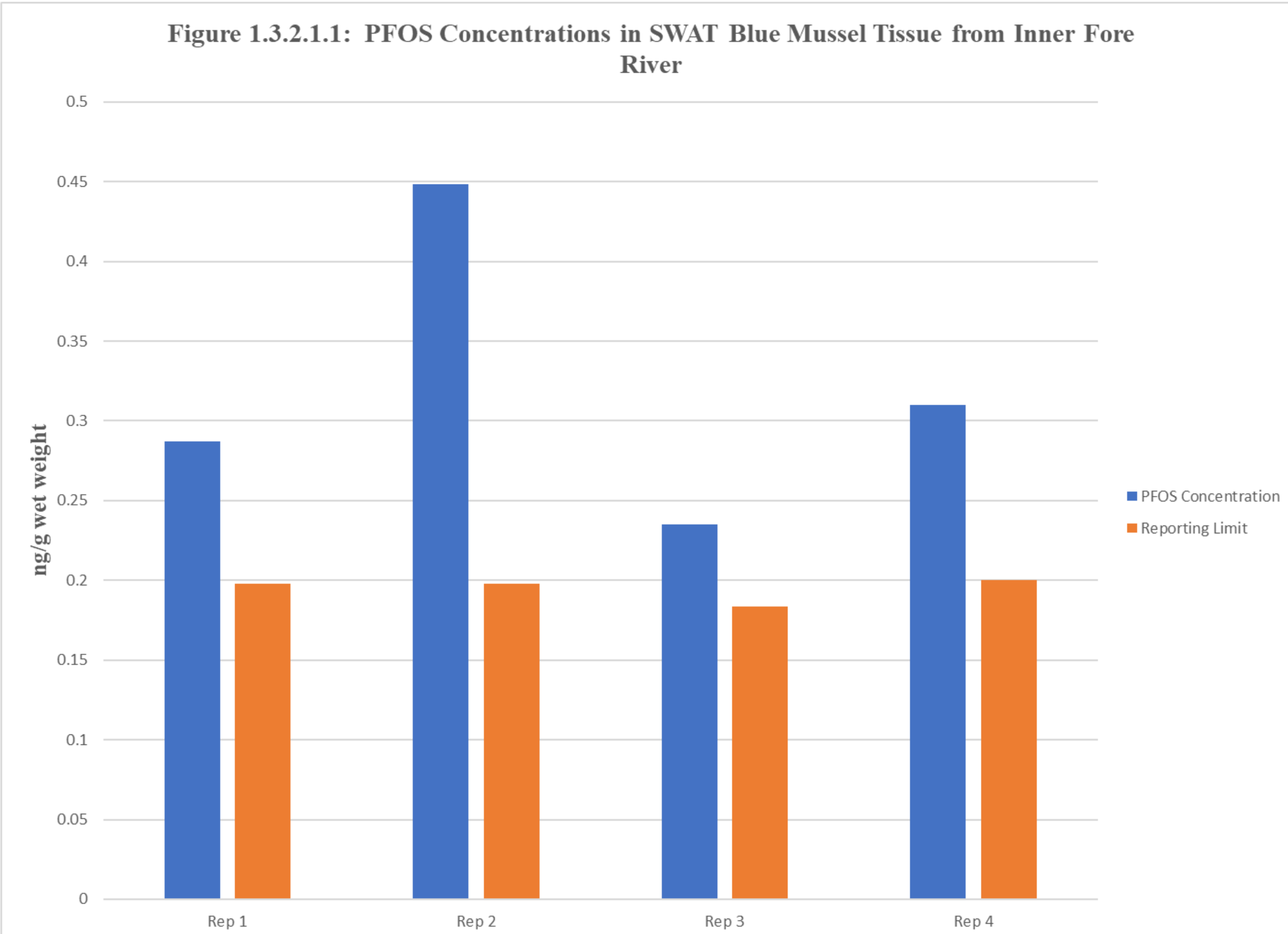
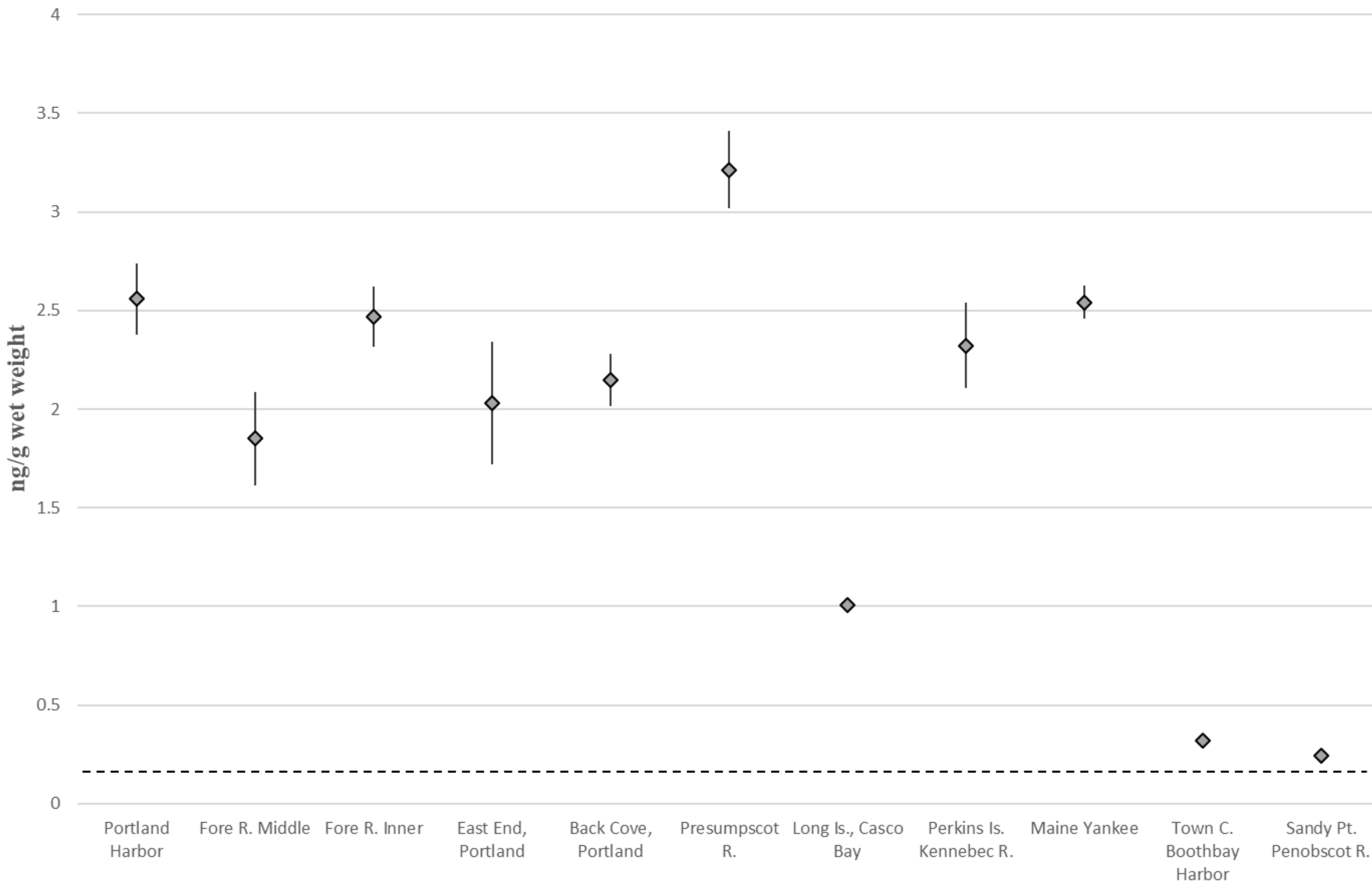


Figure 1.3.2.1.1: PFOS Concentrations in SWAT Blue Mussel Tissue from Inner Fore River
ng/g wet weight
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Rep 1
Rep 2
Rep 3
Rep 4
PFOS Concentration
Reporting Limit

**Figure 1.3.2.1.2: PFOSA Mean Concentrations in SWAT Blue Mussel Tissue**




**Dotted line = Mean Reporting Limit for PFOSA; Long Island and SandyPoint data are from one individual intra-site sample and not site means.**

mussel tissue at East End, Portland. EMPC were found in Fore River (middle river), Portland, and Royal River, Yarmouth, in one replicate at each site. EtFOSAA concentrations ranged from 0.1297 ng/g to 0.5839 ng/g wet wt. for detects in blue mussel tissue.

- Perfluorotridecanoate (PFTrDA) was detected in two of three replicates at Fore River (middle river), Portland. PFTrDA was detected in one replicate at Fore River (inner river), Portland, Presumpscot River, and Rockland. PFTrDA concentrations ranged from 0.1084 ng/g to 0.3009 ng/g wet wt. for detects in blue mussel tissue.

- Fluorotelomer sulfonate (6:2 FTS) was detected in one replicate of mussel tissue at three sites: Cousins Island Thorofare, Yarmouth; Royal River, Yarmouth; and Sandy Point, Stockton Springs. 6:2 FTS concentrations ranged from 1.411 ng/g to 7.955 ng/g wet wt. for detects in blue mussel tissue.

- Perfluorononanoate (PFNA) was detected in one replicate of mussel tissue at Back Channel, Kittery, and Sandy Point, Stockton Springs. PFNA concentrations ranged from 0.2185 ng/g to 0.2566 ng/g wet wt. for detects in blue mussel tissue.

- N-ethyl perfluorooctane sulfonamidoethanol (N-EtFOSE) was detected in one replicate in blue mussel tissue at Back Cove, Portland, at 0.9270 ng/g wet wt.

- Perfluoroundecanoate (PFUnA) was detected in one replicate in blue mussel tissue at Little Machias Bay, Cutler, at 0.3132 ng/g wet wt.

- Perfluorodecane sulfonate (PFDS) was detected in one replicate in blue mussel tissue at Pepperell Cove, Kittery. EMPC were found in one replicate of mussel tissue at: East End, Portland; Pepperell Cove, Kittery; and Kennebunk River, Kennebunkport. PFDS estimated maximum possible concentrations ranged from 0.1157 ng/g to 0.1564 ng/g wet wt. for detects in blue mussel tissue.

PFAS bioaccumulate and biomagnify through the food web. Dodder et al. (2012) tested California *Mytilus spp*. tissue and indicated >25% detection frequency for PFAS in samples and increasing concentrations with urbanization and proximity to stormwater discharge. The same study measured total concentrations of PFAS ranged up to about 10 ppb, with some outliers above that range. Areas with mixed development demonstrated total PFAS concentrations of approximately 2 ng/g dry wt., while urban sites had higher total PFAS concentrations approaching 9-10 ng/g dry wt. Two individual PFAS detected in the California study, PFDoDA and PFUnDA, had mean concentrations of 1.8 and 0.23 ng/g dry wt. respectively (Dodder et al. 2012), which is roughly the same order of magnitude of the PFCs detected in recent SWAT blue mussel sampling in Maine.

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## 2.0 LAKES MODULE

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| 2.1 HARMFUL ALGAL BLOOMS | 55 |

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|---|---|
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# 2.0 LAKES

## 2.1. HARMFUL ALGAE BLOOMS (HABs)

Harmful Algae Blooms (HABs) have been and continue to be a problem in the United States and Maine. HABs can produce hepatotoxic, neurotoxic and acutely dermatotoxic cyanobacterial (blue-green algae) toxins such as microcystins, cylindrospermopsins, anatoxins, and saxitoxins. Although Maine has several lakes and ponds that have experienced algal blooms for decades and there have been only two known toxic events (death of cattle in the 1960s according to Matt Scott, personal communication), there is a growing concern in Maine about the potential for HABs.

In 1998, the World Health Organization (WHO) established the following advisory levels for cyanotoxins: drinking water = 1 µg/L, low-risk recreation = 10 µg/L (low-risk meaning health outcomes not due to toxicity, but irritation or allergic reactions). In early May of 2015, EPA released 10-day drinking water advisory levels for two populations: bottle-fed infants and pre-school children: > 0.3 µg/L, and, school-age children and adults: > 1.6 µg/L. EPA released draft recreation advisory levels in December of 2016. Because children spend more time in the water and ingest more water per body weight while recreating, criteria were derived based on children's recreational exposures. For swimming, the microcystin concentration of 8 µg/L is not to be exceeded on any day; for recreation, 8 µg/L is not to be exceeded more than 10% of days per recreation season up to one calendar year.

In mid-March of 2021, the WHO released their second edition of ***Toxic Cyanobacteria in Water*** (859 pages) which is available for download at this website: https://www.who.int/publications/m/item/toxic-cyanobacteria-in-water---second-edition. This edition presents microcystin-LR ingestion guidelines in terms of long-term (daily and lifetime) and short-term (drinking water and recreation) values. These values, shown in Table 2.1.1, are higher than their previous guidelines as well as current EPA Health Advisory guidelines.

Table 2.1.1. 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 |

Complementary to related water quality measurements, samples for selected cyanotoxin analysis were collected from Maine lakes using a probability-based approach and a targeted approach over the last 7 years. Lakes greater than 150 acres in populated areas of the state were targeted for the probability selection. Lakes with a history of algal blooms were targeted for time-series monitoring. Approximately 22 lakes were randomly selected the first 6 years and in 2020, lakes having the highest concentrations of microcystin were revisited. Microcystin results from 2014 indicated that concentrations were elevated in many Kennebec county probability-draw lakes and in all targeted lakes. Worth noting is that most lakes designated as 'impaired' due to algal blooms are in Kennebec County. Results from 2015 - 2019 indicated that relatively few probability-draw lakes had elevated microcystin, and again, targeted lakes had elevated concentrations. Most lakes that produced algal scums had scum concentrations that greatly exceeded original WHO and EPA levels of concern. In 2020, lakes having elevated microcystin concentrations in 2014 – 2019 were revisited for verification purposes. Samples collected in 2020 will be analyzed in May and June of 2021.

Over the past few years, using SWAT funds, DEP has succeeded in developing the capacity to perform microcystin analysis using the ELISA approach (enzyme-linked immunosorbent assay). Analysis of the backlog of frozen samples (2016-2019) was completed in the Fall of 2020, thus a total of 883 samples were analyzed. Split samples were run at UNH to validate the method Samples collected in 2020 will be analyzed in May and June of 2021.

***Probabilistic Monitoring Results.*** Table 2.1.2 contains descriptive statistics for 382 microcystin results obtained under the probability-based sampling component (2014 – 2019). For purposes of discussion, the two sample types from the deep station and the downwind sample taken from a station that is 2 meters deep, will be referred to as 'open-water' samples.

Table 2.1.2. Descriptive statistics for microcystin (MC) results from probability sampling (2014-2019).

| Sample Location | Deep Station** | | Downwind Station | | |
|---|---|---|---|---|---|
| | Epilimnetic samples (as determined from profile) | Samples from top 3 meters of epilimnion (EPA protocol) | Near-shore** samples (top 1-meter sample from area with 2 meters depth) | Scum Samples | |
| | | | | Per total number of lakes | Per total number of lakes with scums |
| Number of lakes | 125 | 126 | 125 | 126 | 6 |
| Minimum (ppb) | <0.08 | <0.08 | <0.08 | | <0.08 |
| Maximum (ppb) | 5.23 | 17.5 | 13 | | 491 |
| Mean (ppb) | 0.19 | 0.32 | 0.33 | | 83.512 |
| Median (ppb) | 0.1 | 0.1 | 0.1 | | 0.32 |
| Number (%) with [MC] above RL of 0.15* ppb | 14 (11%) | 16 (13%) | 12 (10%) | 3 (2.4%) | 3 (50%) |
| Number (%) with [MC] between 0.3-1.6 ppb | 6 (4.8%) | 5 (4.0%) | 8 (6.4%) | 1 (0.8%) | 1 (17%) |
| Number (%) with [MC] between 1.6-8.0 ppb | 1 (0.8%) | 2 (1.6%) | 2 (1.6%) | 0 | 0 |
| Number (%) with [MC] >8.0 ppb | 0 | 1 (0.8%) | 1 (0.8%) | 2 (1.6%) | 2 (33%) |

[MC] = microcystin concentration
*Analytical batches resulted in three RLs (0.08, 0.1 & 0.15). The highest RL was applied for data summaries, but lower RLs may appear as minimums in table.
**Considered 'open-water' samples.

Open-water results from the probably-based monitoring suggest that approximately 11% of Maine lakes having surface areas greater than 150 acres and located in populated regions of the state, were producing microcystin in open water when visited; 5% had concentrations between 0.3 – 1.6

ppb, 1.3% had concentrations between 1.6 – 8.0 ppb, and 0.5% >8.0 ppb. Scums were present and were sampled in six of the 126 lakes (4.8%). Of the six, only three had detectable concentrations of microcystin, with one falling between 0.3 – 1.6 ppb and two exceeding 8.0 ppb (9.3 ppb and 491 ppb). Higher concentrations derived using ELISA tests may not be as accurate as concentrations closer to the range specified for the kits as the dilution process introduces error into the analysis; nevertheless one can infer that the actual value is in the same order of magnitude.

Table 2.1.3 summarizes the number of samples by station that exceeded EPA Health Advisory guidance for drinking water (2 populations) and recreation.

Table 2.1.3. EPA Microcystin Health Advisory (HA) exceedances for drinking water and recreation (2014-2019).

| Sample Location | Deep Station* | | Downwind Station | |
|---|---|---|---|---|
| | Epilimnetic samples (as determined from profile) | Samples from top 3 meters of epilimnion (EPA protocol) | Near-shore* samples (top 1-meter sample from area with 2 meters depth) | Scum Samples |
| Samples exceeding 0.3 ppb [10-day Drinking Water HA for infants and non-school age children] | 7 (5.6%) | 8 (6.3%) | 11 (8.8%) | 3 (2.4%) |
| Samples exceeding 1.6 ppb [Drinking Water HA for -school age children & adults] | 1 (0.8%) | 3 (2.4%) | 3 ( 2.4%) | 2 (1.6%) |
| Samples exceeding 8.0 ppb [Recreation HA] | 0 | 1 (0.8%) | 1 (0.8%) | 2 (1.6%) |

*Considered ‘open-water’ samples.

Concentrations of microcystin exceeded EPA’s 10-day Drinking Water health advisory value for ‘infants and non-school age children’ in an average of 6.9% of the open water samples and in three of the six scum samples (2.4% of the lakes sampled). The station exceeding these guidelines most often was the downwind near-shore sample with 8.8% exceeding microcystin concentrations of 0.3 ppb. This might present a concern for all shorefront property owners that draw their drinking water from the lake and especially those with young children. Microcystin concentrations exceeded EPA’s 10-day Drinking Water health advisory value for ‘school-age children and adults’ in an average of 1.8% of the open water samples and in two of the six scum samples (1.6% of the lakes sampled), again potentially of concern to shorefront property owners that draw their drinking water from the lake. EPA recreational advisory values were exceeded in an average of 0.5% of the open-water samples and 1.6% of the scum samples.

***Time-series Monitoring Results.***
Time series data was obtained from a total of 487 samples collected from 145 visits to 12 lakes. The sampling regime was identical to that used in the probability study. Lakes known to be chronic severe bloomers were visited frequently to establish ‘worst-case-scenario’ conditions for the state. Lakes that have bloomed for decades, but not as severely, and lakes that have only recently begun

to support blooms were visited less frequently (fewer years). The following three tables present summary statistics for each sample type from each lake.

Table 2.1.4. Microcystin results for lakes considered to be chronic, severe bloomers. [MC] = microcystin concentration (ppb).

| | [MC] Color Key: | <0.3 ppb | 0.3-1.6 ppb | 1.6-8 ppb | >8 ppb |
|---|---|---|---|---|---|
| | | Deep Station* | | Downwind Station | |
| Lake & ID (#visits) | Sample Location / Statistic | Epilimnetic samples (as determined from profile) [MC] ppb | Samples from top 3 meters of epilimnion (EPA protocol) [MC] ppb | Near-shore* samples (top 1-meter sample from area with 2 meters depth) [MC] ppb | Scum Samples [MC] ppb |
| SABATTUS P 3796 (28) | Min | <0.1 | <0.1 | <0.1 | <0.1 |
| | Mean | 1.5 | 2.1 | 1.3 | 764 |
| | Median | 0.32 | 0.34 | 0.31 | 4 |
| | Max | 21 | 38 | 12 | 10605 |
| UNITY P 5172 (19) | Min | <0.1 | <0.1 | <0.1 | 4.1 |
| | Mean | 1.2 | 1.1 | 1.1 | 58 |
| | Median | 0.15 | 0.15 | 0.15 | 17 |
| | Max | 7.89 | 7 | 7.4 | 273 |
| LOVEJOY P 5176 (28) | Min | <0.1 | <0.1 | <0.1 | <0.1 |
| | Mean | 0.56 | 0.45 | 0.47 | 1079 |
| | Median | 0.15 | 0.15 | 0.155 | 15 |
| | Max | 5.7 | 2.94 | 2.81 | 17696 |
| THREEMILE P 5416 (20) | Min | <0.1 | <0.1 | <0.1 | 0.48 |
| | Mean | 0.78 | 0.78 | 1.2 | 155 |
| | Median | 0.28 | 0.29 | 0.28 | 10.5 |
| | Max | 5.12 | 4.14 | 6.61 | 724 |

*Considered ‘open-water’ samples

Table 2.1.4 summarizes microcystin results from four lakes considered to be chronic severe bloomers. Summary statistics from open-water samples are fairly similar within each lake as opposed to scum sample concentrations, which for the most part, greatly exceed both EPA’s drinking water and recreation guidelines. Although open-water samples from all four ponds exceeded drinking water guidelines often, Sabattus Pond samples exceeded guidelines frequently.

Table 2.1.5 summarizes microcystin data from four lakes that have bloomed for three to seven decades, but not as severely as lakes in the previous table. The magnitude and frequency of exceedance of the recreation guidelines is much less and the one open-water exceedance was considerably different than the other two open-water sampled obtained the same day, which suggests that the sample contained some large algal colonies or that the position of the sample on the ELISA plate led to contamination of the result. Because the lab which performed the 2014 analyses has gone out of business, it is not possible to track this down. Algal scums were only observed and sampled during one visit for only two of the lakes (thus the one result is repeated as min, mean, median and max). Despite the overall lower concentrations of microcystin, many samples exceeded the EPA drinking water guidance for *infants and non-school-aged children*.

Table 2.1.5. Microcystin results for lakes that have bloomed for decades, but not severely. [MC] = microcystin concentration (ppb).

| | [MC] Color Key: | <0.3 ppb | 0.3-1.6 ppb | 1.6-8 ppb | >8 ppb |
|---|---|---|---|---|---|
| | | Deep Station* | | Downwind Station | |
| Lake & ID (#visits) | Sample Location / Statistic | Epilimnetic samples (as determined from profile) [MC] ppb | Samples from top 3 meters of epilimnion (EPA protocol) [MC] ppb | Near-shore* samples (top 1-meter sample from area with 2 meters depth) [MC] ppb | Scum Samples [MC] ppb |
| EAST P 5349 (8) | Min | <0.08 | <0.08 | <0.08 | 9.67** |
| | Mean | 1.6 | 0.27 | 0.3 | 9.67** |
| | Median | 0.09 | 0.125 | 0.15 | 9.67** |
| | Max | 12.37 | 1.05 | 0.93 | 9.67** |
| SALMON L (ELLIS P) 5352 (4) | Min | <0.08 | <0.08 | <0.08 | |
| | Mean | 0.35 | 0.56 | 0.38 | |
| | Median | 0.35 | 0.13 | 0.24 | |
| | Max | 0.63 | 1.89 | 0.99 | |
| WEBBER P 5408 (5) | Min | <0.1 | <0.1 | <0.1 | |
| | Mean | 0.12 | 0.2 | 0.23 | |
| | Median | 0.1 | 0.1 | 0.1 | |
| | Max | 0.21 | 0.59 | 0.74 | |
| SEBASTICOOK L 2264 (8) | Min | <0.1 | <0.1 | <0.1 | 1.18** |
| | Mean | 0.24 | 0.36 | 0.41 | 1.18** |
| | Median | 0.14 | 0.19 | 0.21 | 1.18** |
| | Max | 0.89 | 1.57 | 1.21 | 1.18** |

*Considered 'open-water' samples
**Only one scum sample observed and sampled, thus min=mean=median=max

Microcystin results from four lakes that have started blooming in the last 6-8 years were never observed as exceeding EPA's recreation threshold. Again, algal scums were only observed and sampled during one visit for only two of the lakes (thus the one result is repeated as min, mean, median and max). EPA's drinking water standard for *infants and non-school-aged children* was exceeded in open-water samples once; algal scums exceeded the drinking water standards for both sub-populations twice.

Although not illustrated in these tables, microcystin concentrations in open-water tended to peak at the end of August and in early September. Concentrations in scum samples tended to peak in mid to late September. And by November, many samples yielded concentrations below the reporting level.

Table 2.1.6. Microcystin results for lakes that have started blooming in recent years. [MC] = microcystin concentration (ppb).

| [MC] Color Key: | | <0.3 ppb | 0.3-1.6 ppb | 1.6-8 ppb | >8 ppb |
|---|---|---|---|---|---|
| | | Deep Station* | | Downwind Station | |
| Lake & ID (#visits) | Sample Location<br>Statistic | Epilimnetic samples (as determined from profile) [MC] ppb | Samples from top 3 meters of epilimnion (EPA protocol) [MC] ppb | Near-shore* samples (top 1-meter sample from area with 2 meters depth) [MC] ppb | Scum Samples [MC] ppb |
| LONG P (Parsonsfield) 9701 (6) | Min | <0.1 | <0.1 | <0.1 | <0.1 |
| | Mean | <RL | <RL | <RL | 0.13 |
| | Median | <RL | <RL | <RL | <RL |
| | Max | <0.1 | <0.1 | <0.1 | 0.2 |
| TOGUS P 9931 (5) | Min | <0.1 | <0.1 | <0.1 | 2.13** |
| | Mean | <RL | 0.14 | 0.13 | 2.13** |
| | Median | <RL | 0.14 | 0.13 | 2.13** |
| | Max | <0.15 | 0.22 | 0.16 | 2.13** |
| GEORGES P 4406 (6) | Min | <0.1 | <0.1 | <0.1 | 2.78** |
| | Mean | 0.19 | <RL | <RL | 2.78** |
| | Median | <0.1 | <RL | <RL | 2.78** |
| | Max | 0.42 | <0.1 | <0.1 | 2.78** |
| NORTH & LITTLE PONDS (Smithfield) 5344 (8) | Min | <0.08 | <0.08 | <0.08 | <0.08 |
| | Mean | <RL | <RL | <RL | <RL |
| | Median | <RL | <RL | <RL | <RL |
| | Max | <0.1 | <0.1 | <0.1 | <0.08 |
| *Considered 'open-water' samples<br>**Only one scum sample observed and sampled, thus min=mean=median=max | | | | | |

There was considerable variation in microcystin concentrations from year-to-year, likely due to weather-related factors including timing of ice-out, onset of the growing season, and peak population density reached as waters begin to cool as the daylight period decreases.

The time-series results and results from the probabilistic study suggest that relatively few Maine lakes produce microcystin concentrations ~~that~~, but those few that support severe, chronic algal blooms are very likely to exceed EPA guidelines.

**3.0 RIVERS AND STREAMS MODULE**

3.1 AMBIENT BIOLOGICAL MONITORING

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### 3.1.1 Background

As part of the SWAT program, DEP's Biological Monitoring Unit evaluates benthic macroinvertebrate communities of Maine streams and rivers 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 2019, staff evaluated the condition of 42 sample locations, primarily in the Aroostook and St. John basin. In 2020, staff evaluated the condition of 46 sample locations, primarily in the Southern Maine 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. Non-point sources 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 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. For lakes and ponds having an assigned statutory class of GPA, a wetland model result of A is considered to meet GPA aquatic life criteria. Final decisions on aquatic life attainment of a waterbody are made accounting for factors that may allow adjustments to the model outcome. This is called "the final determination."

Tables 3.1.1a and 3.1.1b summarize the results of biological monitoring activities, sorted by waterbody name, for the 2019 and 2020 SWAT sampling years respectively. Column headings of Tables 3.1.1a and 3.1.1b 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 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.

2019 field and water chemistry data for each sampling event (where available) are presented in Table 3.1.2a and 3.1.3a, respectively. 2020 field data for each sampling event is presented in Table 3.1.2b. Due to factors related to the COVID-19 pandemic, water chemistry samples were not collected in 2020. Continuous water temperature data for 2019 and 2020 are shown in Figures 3.1.1a and 3.1.1b., respectively. 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 2019 and

2020, where available, is summarized in Tables 3.1.4a and 3.1.4b.

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.

## 2019 Results

### 3.1.2 2019 Results Summary

The Biological Monitoring Unit concentrated its sampling in 2019 in the Aroostook and St. John basin. Forty-two stations were sampled under the SWAT Program (Table 3.1.1a). Thirty-two of these stations met the aquatic life criteria for their statutory class. One station had an indeterminate result. The following are descriptions of waterbodies not attaining aquatic life criteria for their assigned class in 2019.

Chenery Brook – Falmouth Station 1169

Chenery Brook is a second order stream in Falmouth which flows directly west of and parallel to I-295 before draining to Mill Creek. The watershed contains substantial medium-density residential development. Station 1169 is downstream of Johnson Road. The water quality goal for Chenery Brook is Class B. The macroinvertebrate community did not attain Class B aquatic life criteria and also failed to attain Class C criteria. The dominant taxa were *Dubiraphia* (a riffle beetle) and *Gammarus* (an amphipod), which are both common in low gradient, coastal streams. They also can be tolerant of pollution. The sample contained no stoneflies and a single mayfly, and the Hilsenhoff Biotic index was high (5.32). The sample included many tolerant macroinvertebrates, including various midge larvae, worms, leeches, and isopods. The specific conductance was high (456 uS/cm). The substrate at Station 1169 was 90% clay which is poor habitat for many macroinvertebrates, therefore it may be useful to re-sample at a different location in the future to confirm class attainment.

Concord Gully Brook – Freeport Station 497

Concord Gulley Brook is a second order stream east of I-295 in Freeport which drains to the Harraseeket River, and has a water quality goal of Class B. Station 497 is the middle of three sampling stations maintained by the Biological Monitoring Program. The stream in this location does not attain Class B aquatic life criteria based on benthic macroinvertebrates, and also fails to meet the minimum criteria for Class C. The macroinvertebrate sample contained few stoneflies and no mayflies. The stonefly genera present in the sample, *Leuctra,* is somewhat tolerant and can occur in urban streams with cold water. Over half of the generic richness in the sample was comprised of organisms in the Order Diptera (0.57), with a high relative abundance of Chironomids (midge larvae, 0.46). The Hilsenhoff Biotic Index was also high (5.13). Specific conductance recorded in the field during sampler deployment and retrieval was very high (1,317 uS/cm and 1,625 uS/cm respectively), indicating likely contamination from road salt.

Concord Gully Brook – Freeport Station 498

Station 498 is the most downstream sampling site on Concord Gully Brook. The stream in this location does not attain either Class B aquatic life criteria or the minimum criteria for Class C. The macroinvertebrate sample contained no mayflies or stoneflies, and few caddisflies. The relative abundance of Chironomids was relatively high (0.68). The site receives stormwater inputs from downtown Freeport and shows signs of habitat degradation due to surges of water. Specific conductance was very high during both site visits (1,383 uS/cm and 1,644 uS/cm).

<u>Cowett Brook – Presque Isle</u> Station 1021
Cowett Brook is a cold-water first order stream located in Presque Isle with a water quality goal of Class B. The stream flows west through a very concentrated agricultural landscape before entering the Aroostook River. Cowett Brook does not attain either Class B aquatic life criteria or the minimum criteria for Class C. EPT Generic Richness (mayflies, stoneflies, caddisflies) is only represented by five taxa. The five dominant taxa in the sample were Oligochaetes (worms) and Chironomids (midges), which tend to be tolerant and able to recolonize fairly quickly after disturbances. Diptera relative richness was 0.47. Analysis of water samples revealed elevated nutrient concentrations (40 ug/L total phosphorus and 13 ug/L orthophosphate).

<u>Dickey Pond – Cross Lake Township</u> Station W-329
Dickey Pond is a small (~17 acre), shallow pond within the Dickey Stream watershed in Cross Lake Township assigned the water quality goal of GPA. In 2019, Station W-329 met Class B aquatic life criteria (0.90) based on the macroinvertebrate sample but did not meet criteria for Class GPA/A. The macroinvertebrate community is represented by mostly intermediate-tolerance taxa (17 collected, relative richness 0.55) with 7 sensitive taxa collected (relative richness 0.22) and 8 eurytopic taxa (relative richness of 0.25) which is characteristic of a class B community. Eurytopic taxa are those organisms having a wide range of stressor tolerance and habitat preference. EOT relative richness (mayflies, Odonates and caddisflies) was fairly high (0.24). There is a natural buffer immediately surrounding the pond, but land use in the watershed includes significant amounts of agriculture, and the very deep, loose sediments may indicate historic runoff from upstream agricultural fields. Field observations indicate abundant algae in the water and a manure odor from the sediments. Total phosphorus (41 ug/L) was elevated at the time of sampling.

<u>Mill Creek – Falmouth</u> Station 1167
Mill Creek is a second order, cold-water stream with a rocky substrate and a water quality goal of Class B. There is a substantial amount of medium-density residential development in the watershed. Station 1167 is downstream of Middle Road in Falmouth, west of I-295. The macroinvertebrate community did not attain aquatic life criteria for Class B. The sample contained no stoneflies and few mayflies. The assemblage included several sensitive caddisflies (*Frenesia* and *Psilotreta*) and a sensitive mayfly (*Paraleptophlebia*), however they occurred in low abundance. Most taxa collected were tolerant to pollution, including a diversity of midge larvae. The specific conductance was high (326 uS/cm) during the July site visit.

<u>North Fork McLean Brook – St. Agatha</u> Station 922
North Fork McLean Brook is a second order, cold-water (15$^{o}$ C) stream in St. Agatha that flows through a landscape of dense agriculture (tilled fields). The stream has a water quality goal of Class B. Despite the cold-water habitat, the macroinvertebrate community did not attain either

Class B or Class C aquatic life criteria. The most abundant taxa were midges and worms. There were no stoneflies and only 8 mayfly and caddisfly taxa, which is fairly low. Large amounts of sediment were observed in the stream, and analysis of water samples indicated high concentrations of total phosphorus (70 ug/L) and orthophosphate (17 ug/L). Brook stickleback, which is a species of special concern in Maine, was observed in the stream.

<u>Oliver Brook – Hodgdon</u> Station 1005
Oliver Brook is a second order tributary to the Meduxnekeag River and has a water quality goal of Class B. Land use in the watershed includes relatively concentrated agriculture and recent logging. Station 1005 is located below Bangor Street in Hodgdon. The macroinvertebrate community did not meet aquatic life criteria for Class B. The sample had no stoneflies, and total mean abundance of Chironomids (midge larvae) was high (0.42). Although the Hilsenhoff Biotic Index was fairly high (5.04), 15 different mayfly and caddisfly genera were present which is a positive indicator. Prong-gilled mayflies (Leptophlebiidae and Paraleptophlebia) were abundant in the sample. The dissolved oxygen concentration in August (5.83 mg/L) was below the criterion for Class B streams (7 mg/L). Specific conductance was high in July (366.7 uS/cm) and August (413.4 uS/cm). Field observations indicate siltation was evident at the site.

<u>Robinson Dam Pond</u> – Blaine Station W-198
Robinson Dam Pond is an approximately 30 acre, very shallow impoundment of Prestile Stream in Blaine. Evidence of water level fluctuation can be seen in historic aerial photos and times of low water show a distinct channel, therefore the impoundment is assigned the riverine water quality goal of Class B consistent with the downstream section of Prestile Stream. In 2019, the macroinvertebrate community at Station W-198 did not attain aquatic life criteria for Class B but did attain Class C criteria with a probability of 0.86. The community was dominated by Chironomids (relative abundance of 0.77). There were no caddisflies in the sample, and mayflies and Odonates had low relative abundance (0.02, 0.01) and generic richness (4, 2). Watershed land use consists largely of high-density agriculture, mostly tilled fields. Total phosphorus (66 ug/L) and total Kjeldahl nitrogen (0.6 mg/L) were elevated at the time of sampling. Specific conductance was also high (370.7 us/cm). Field observations indicate that algae were fairly abundant on the water surface, and in clumps near the bottom and among submerged plants.

<u>Unnamed Brook – Presque Isle</u> Station 1027
Unnamed Brook in Presque Isle is a second order stream which flows through an area of densely concentrated agricultural fields to the Aroostook River and has a water quality goal of Class B. Station 1027 is located in northeast Presque Isle, upstream of Parkhurst Siding Road. Total Mean Abundance of the macroinvertebrate sample (24.33) was less than the minimum threshold of 50 required for the Department's predictive model, therefore the class attainment result is Indeterminate. The site attained Class B aquatic life criteria in 2014. Resampling is recommended.

**Table 3.1.1a 2019 SWAT Benthic Macroinvertebrate Biomonitoring Results**

| Waterbody | Town | Station | Log | Potential sources of pollution[1] | Statutory Class/ Final Determination | Attains Class? | Probable Cause |
|---|---|---|---|---|---|---|---|
| Amsden Brook | Fort Fairfield | 1018 | 2754 | Agricultural NPS | B/A | Y | |
| Beaverdam Stream | Wesley | 1149 | 2764 | Salmon Project | AA/A | Y | |
| Big Brook | Madawaska | 728 | 2746 | Agricultural NPS | B/A | Y | |
| Birch Brook | Presque Isle | 1019 | 2729 | Agricultural NPS | B/A | Y | |
| Chenery Brook | Falmouth | 1169 | 2768 | NPS Pollution | B/NA | N | NPS Toxics / Habitat / Resample |
| Coloney Brook | Fort Fairfield | 733 | 2752 | Agricultural NPS | B/A | Y | |
| Concord Gully Brook | Freeport | 497 | 2767 | Urban NPS | B/NA | N | NPS Toxics / Salt |
| Concord Gully Brook | Freeport | 498 | 2766 | Urban NPS | B/NA | N | NPS Toxics / Salt / Habitat Degradation |
| Cowett Brook | Presque Isle | 1021 | 2730 | Agricultural NPS | B/NA | N | Agricultural Runoff |
| Dickey Brook | Cross Lake TWP | 688 | 2744 | Agricultural NPS | B/B | Y | |
| Dickey Pond | Cross Lake Twp | W-329 | 2019-329 | Agricultural NPS | GPA/B | N | Agricultural Runoff |
| East Branch Wesserunsett Stream | Athens | 486 | 2757 | Reference | B/A | Y | |
| Fish Stream | Crystal | W-327 | 2019-327 | Reference | A/A | Y | |

[1] NPS = non-point source pollution.

**Table 3.1.1a 2019 SWAT Benthic Macroinvertebrate Biomonitoring Results (continued)**

| Waterbody | Town | Station | Log | Potential sources of pollution[1] | Statutory Class/ Final Determination | Attains Class? | Probable Cause |
|---|---|---|---|---|---|---|---|
| Frost Brook | Westfield | 1022 | 2736 | Agricultural NPS | B/B | Y | |
| Getchell Brook | Easton | 925 | 2734 | Agricultural NPS | B/A | Y | |
| Gray Brook | Fort Fairfield | 1023 | 2742 | Agricultural NPS | B/B | Y | |
| Hacker Brook | Fort Fairfield | 1024 | 2751 | Agricultural NPS | B/A | Y | |
| Halfmoon Stream | Thorndike | 697 | 2759 | Agricultural NPS | B/A | Y | |
| Hall Brook | Thorndike | 1147 | 2758 | Sand/Salt | A/A | Y | |
| Hockenhull Brook | Fort Fairfield | 1026 | 2732 | Agricultural NPS | B/A | Y | |
| Kennedy Brook | Presque Isle | 646 | 2743 | Urban NPS / Agricultural NPS | B/B | Y | |
| Mill Brook | Ludlow | 1164 | 2750 | Agricultural NPS | B/A | Y | |
| Mill Creek | Falmouth | 1167 | 2769 | NPS Pollution | B/C | N | NPS Toxics |
| Moose Brook | Houlton | 466 | 2749 | Agricultural NPS | B/A | Y | |
| North Branch Meduxnekeag River | TC R2 WELS | 780 | 2748 | Reference | A/A | Y | |
| North Fork McLean Brook | St. Agatha | 922 | 2733 | Agricultural NPS | B/NA | N | Agricultural Runoff |
| Oliver Brook | Hodgdon | 1005 | 2738 | Agricultural NPS | B/C | N | Agricultural Runoff |
| Otter Brook | Caribou | 1035 | 2753 | Agricultural NPS | B/A | Y | |
| Pearce Brook | Houlton | 463 | 2739 | Urban NPS | B/A | Y | |
| Robbinson Dam Pond | Blaine | W-198 | 2019-198 | Agricultural NPS | B/C | N | Agricultural Runoff |
| Rocky Brook | Mars Hill | 375 | 2735 | Agricultural NPS | B/B | Y | |
| Salmon Brook | Washburn | 377 | 2741 | Municipal / NPS | B/A | Y | |
| Salmon Brook | Perham | 376 | 2745 | Reference | B/A | Y | |

[1] NPS = non-point source pollution.

**Table 3.1.1a 2019 SWAT Benthic Macroinvertebrate Biomonitoring Results (continued)**

| Waterbody | Town | Station | Log | Potential sources of pollution[1] | Statutory Class/ Final Determination | Attains Class? | Probable Cause |
|---|---|---|---|---|---|---|---|
| Scarey Brook | Nashville PLT | 1162 | 2728 | NPS / Lumber Yard | A/A | Y | |
| Seboeis River | T6 R7 | 737 | 2765 | Reference | AA/A | Y | |
| Sheepscot River | North Whitefield | 74 | 2756 | Long-term Reference | AA/A | Y | |
| Smith Brook | Houlton | 1007 | 2740 | Agricultural NPS | B/A | Y | |
| Unnamed Brook | Presque Isle | 1027 | 2731 | Urban NPS | B/I | I | Total Mean Abundance < 50 / Resample |
| Unnamed Brook | Madawaska | 1030 | 2747 | Agricultural NPS | B/A | Y | |
| W. Br. Sheepscot River | China | 268 | 2755 | Long Term Reference | AA/A | Y | |
| Williams Brook | Presque Isle | 1031 | 2737 | Agricultural NPS | B/B | Y | |

[1] NPS = non-point source pollution.

## Table 3.1.2a 2019 SWAT Field Data

Measurements were obtained using handheld electronic meters.

| 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 |
| Amsden Brook | 1018 | 2754 | 7/9/2019 | 14.2 | 10.62 | 401.7 | 8.2 | -- | -- | -- | -- | -- |
| Beaverdam Stream | 1149 | 2764 | 7/31/2019 | 27 | 7.73 | 30.2 | 6.63 | 8/29/2019 | 18.39 | 8.96 | 74.6 | 6.54 |
| Big Brook | 728 | 2746 | 7/10/2019 | 18.3 | 9.81 | 167.9 | 7.8 | 8/6/2019 | 17.6 | 10.07 | 147.9 | 7.96 |
| Birch Brook | 1019 | 2729 | 7/10/2019 | 16.4 | 9.95 | 407.9 | 8.29 | 8/6/2019 | 14 | 10.4 | 410.5 | 8.35 |
| Chenery Brook | 1169 | 2768 | 8/6/2019 | 19.4 | 8.97 | 456 | -- | -- | -- | -- | -- | -- |
| Coloney Brook | 733 | 2752 | 7/9/2019 | 15.3 | 10.7 | 408.1 | 8.27 | 8/5/2019 | 17.4 | 13.18 | 400.3 | 8.62 |
| Concord Gully Brook | 498 | 2766 | 8/7/2019 | 17 | 8.42 | 1644 | -- | 9/4/2019 | 15.7 | 8.98 | 1383 | -- |
| Concord Gully Brook | 497 | 2767 | 8/7/2019 | 16.9 | 8.64 | 1625 | -- | 9/4/2019 | 16 | 9.04 | 1317 | -- |
| Cowett Brook | 1021 | 2730 | 7/10/2019 | 9.4 | 11.15 | 461 | 7.94 | 8/6/2019 | 9.7 | 12.11 | 470 | 8.14 |
| Creamer Brook | 1115 | 2763 | 7/31/2019 | 20.53 | 8.46 | 17.29 | 6.06 | 8/29/2019 | 17.02 | 9.18 | 18.1 | 5.9 |
| Dickey Brook | 688 | 2744 | 7/10/2019 | 22.8 | 7.91 | 146.9 | 7.58 | 8/6/2019 | 22.3 | 7.89 | 125.8 | 7.55 |
| Dickey Pond | W-329 | 2019-329 | 6/18/2019 | 20.4 | 10.41 | 139.2 | 7.79 | -- | -- | -- | -- | -- |
| E. Br. Wesserunsett Stream | 486 | 2757 | 7/24/2019 | 20 | 9.9 | 105.7 | 8.25 | 8/22/2019 | 19.9 | 9.45 | 82.8 | 7.87 |
| Fish Stream | W-327 | 2019-327 | 6/17/2019 | 18.9 | 8.6 | 91.1 | 8.49 | -- | -- | -- | -- | -- |
| Frost Brook | 1022 | 2736 | 7/9/2019 | 17.2 | 9.09 | 358.6 | 8.11 | 8/6/2019 | 19.3 | 8.6 | 448.8 | 8.21 |
| Getchell Brook | 925 | 2734 | 7/9/2019 | 17.8 | 10.14 | 474 | 8.18 | 8/6/2019 | 14.1 | 10.24 | 484 | 8.25 |
| Gray Brook | 1023 | 2742 | 7/9/2019 | 16.7 | 11.15 | 399.54 | 8.54 | 8/5/2019 | 16.7 | 10.8 | 114.5 | 8.68 |
| Hacker Brook | 1024 | 2751 | 7/9/2019 | 16.4 | 8.93 | 396.3 | 7.99 | 8/5/2019 | 18.7 | 9.8 | 358.6 | 8.13 |
| Halfmoon Stream | 697 | 2759 | 7/24/2019 | 22.9 | 11.3 | 143.1 | 8.37 | 8/21/2019 | 18.7 | 10.23 | 136.6 | 7.78 |
| Hall Brook | 1147 | 2758 | 7/24/2019 | 18.8 | 9.97 | 148.2 | 7.87 | 8/21/2019 | 17.3 | 10.29 | 144.2 | 7.86 |

## Table 3.1.2a 2019 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 |
| Hockenhull Brook | 1026 | 2732 | 7/10/2019 | 18.4 | 10.05 | 385.1 | 8.29 | 8/6/2019 | 20.8 | 16.23 | 356.1 | 8.78 |
| Kennedy Brook | 646 | 2743 | 7/8/2019 | 19.4 | 9.52 | 552 | 8.28 | 8/6/2019 | 19.7 | 8.71 | 569 | 8.26 |
| Mill Brook | 1164 | 2750 | 7/11/2019 | 17.8 | 9.68 | 63 | 7.76 | 8/7/2019 | 17.5 | 9.79 | 92.4 | 8.02 |
| Mill Creek | 1167 | 2769 | 8/6/2019 | 17.2 | 8.07 | 326 | | 9/3/2019 | 17.4 | 9.93 | 175 | |
| Moose Brook | 466 | 2749 | 7/11/2019 | 19.2 | 10.23 | 156.1 | 8.12 | 8/7/2019 | 18.6 | 10.92 | 261.3 | 8.32 |
| N. Br. Meduxnekeag River | 780 | 2748 | 7/10/2019 | 16.2 | 10.43 | 91.2 | 7.99 | 8/7/2019 | 18.6 | 10.2 | 99.6 | 8.16 |
| N. Fork McLean Brook | 922 | 2733 | 7/10/2019 | 15.3 | 9.82 | 238.6 | 7.54 | 8/6/2019 | 15 | 10.21 | 240.5 | 7.81 |
| Oliver Brook | 1005 | 2738 | 7/11/2019 | 19 | 9.91 | 366.7 | 8.02 | 8/7/2019 | 20.3 | 5.83 | 413.4 | 7.96 |
| Otter Brook | 1035 | 2753 | 7/9/2019 | 20.5 | 9.74 | 337.3 | 8.3 | 8/5/2019 | 20.3 | 9.31 | 380.1 | 8.33 |
| Pearce Brook | 463 | 2739 | 7/11/2019 | 20.4 | 10.6 | 321.5 | 8.35 | 8/7/2019 | 19.4 | 11.61 | 354.7 | 8.47 |
| Robinson Dam Pond | W-198 | -- | 6/20/2019 | 17.3 | 7.64 | 370.7 | 8.48 | -- | -- | -- | -- | -- |
| Rocky Brook | 375 | 2735 | 7/9/2019 | 16.6 | 9.63 | 368.2 | 8.15 | 8/6/2019 | 22.4 | 10.54 | 379.7 | 8.29 |
| Salmon Brook | 377 | 2741 | 7/8/2019 | 22.5 | 9.03 | 195.9 | 8.08 | 8/6/2019 | 22.9 | 9.63 | 270 | 8.27 |
| Salmon Brook | 376 | 2745 | 7/8/2019 | 23.9 | 8.26 | 95.6 | 7.54 | 8/6/2019 | 23.8 | 9.1 | 130.1 | 7.91 |
| Scarey Brook | 1162 | 2728 | 7/8/2019 | 18.4 | 8.5 | 105.1 | 7.36 | 8/5/2019 | 16.7 | 8.93 | 144.2 | 7.66 |
| Seboeis River | 737 | 2765 | 7/22/2019 | 21.9 | 8.89 | 46 | 7.65 | 8/19/2019 | 20.29 | 8.72 | 59.1 | 7.47 |
| Sheepscot River | 74 | 2756 | 7/22/2019 | 22.2 | 7.1 | 74.2 | 7.22 | 8/20/2019 | 22.5 | 7.32 | 98.1 | 7.35 |
| Smith Brook | 1007 | 2740 | 7/11/2019 | 17.2 | 9.21 | 383.1 | 8.04 | 8/7/2019 | 18 | 8.16 | 222.8 | 8.04 |
| Unnamed Brook | 1027 | 2731 | 7/10/2019 | 13.2 | 10.6 | 390.1 | 8.27 | 8/6/2019 | 12.8 | 11.01 | 406.2 | 8.44 |
| Unnamed Brook | 1030 | 2747 | 7/10/2019 | 14.4 | 9.39 | 290 | 7.92 | 8/6/2019 | 15.7 | 9.25 | 329 | 8.09 |
| W. Br. Sheepscot River | 268 | 2755 | 7/22/2019 | 22.6 | 9.08 | 102.2 | 7.61 | 8/20/2019 | 20.8 | 9.02 | 99.6 | 7.56 |
| Williams Brook | 1031 | 2737 | 7/9/2019 | 18.9 | 9.2 | 390.3 | 8.08 | 8/6/2019 | 19.9 | 9 | 427.4 | 8.2 |

**Table 3.1.3 2019 SWAT Water Chemistry Data**

Samples were analyzed by the Health & Environmental Testing Laboratory, Augusta, ME.

| **Waterbody** | **Station** | **Log** | **Sampling Date** | **TKN** *(MG/L)* | **NO2-NO3-N** *(MG/L)* | **Total P** *(MG/L)* | **SRP** *(MG/L)* |
|---|---|---|---|---|---|---|---|
| Amsden Brook | 1018 | 2754 | 7/9/2019 | <0.2 | 2.3 | 0.015 | 0.008 |
| Big Brook | 728 | 2746 | 7/10/2019 | 0.4 | 0.53 | 0.019 | 0.003 |
| Birch Brook | 1019 | 2729 | 7/10/2019 | <0.2 | 2.6 | 0.017 | 0.01 |
| Coloney Brook | 733 | 2752 | 7/9/2019 | 0.4 | 2.3 | 0.052 | 0.035 |
| Cowett Brook | 1021 | 2730 | 7/10/2019 | 0.2 | 4 | 0.04 | 0.013 |
| Dickey Brook | 688 | 2744 | 7/10/2019 | 0.6 | 0.12 | 0.12 | 0.005 |
| Dickey Pond | W-329 | 2019-329 | 6/18/2019 | 0.6 | 0.34 | 0.041 | -- |
| Fish Stream | W-327 | 2019-327 | 6/17/2019 | 0.3 | 0.01 | 0.023 | -- |
| Frost Brook | 1022 | 2736 | 7/9/2019 | 0.3 | 0.18 | 0.019 | 0.005 |
| Getchell Brook | 925 | 2734 | 7/9/2019 | 0.3 | 1.2 | 0.008 | 0.004 |
| Gray Brook | 1023 | 2742 | 7/9/2019 | 0.4 | 1.8 | 0.023 | 0.016 |
| Hacker Brook | 1024 | 2751 | 7/9/2019 | 0.4 | 0.77 | 0.042 | 0.027 |
| Halfmoon Stream | 697 | 2759 | 7/24/2019 | 0.3 | 0.31 | 0.021 | 0.002 |
| Hall Brook | 1147 | 2758 | 7/24/2019 | 0.3 | 0.04 | 0.023 | 0.006 |
| Hockenhull Brook | 1026 | 2732 | 7/10/2019 | 0.3 | 1.1 | 0.015 | 0.007 |
| Mill Brook | 1164 | 2750 | 7/11/2019 | 0.7 | 0.02 | 0.008 | 0.001 |
| Moose Brook | 466 | 2749 | 7/11/2019 | 0.4 | 0.31 | 0.011 | 0.002 |

TKN = Total Kjeldahl-Nitrogen, $NO_2$-$NO_3$-N = Nitrite-Nitrate-Nitrogen, Total P = Total Phosphorus, SRP = Soluble Reactive Phosphorus (ortho-phosphate), “<” = constituent not detected at the reporting limit.

**Table 3.1.3a 2019 SWAT Water Chemistry Data (continued)**

| Waterbody | Station | Log | Sampling Date | TKN *(MG/L)* | NO2-NO3-N *(MG/L)* | Total P *(MG/L)* | SRP *(MG/L)* |
|---|---|---|---|---|---|---|---|
| North Branch Meduxnekeag River | 780 | 2748 | 7/10/2019 | 0.2 | 0.03 | 0.006 | 0.001 |
| North Fork McLean Brook | 922 | 2733 | 7/10/2019 | <0.2 | 5.42 | 0.07 | 0.017 |
| Oliver Brook | 1005 | 2738 | 7/11/2019 | 0.4 | 0.43 | 0.019 | 0.008 |
| Otter Brook | 1035 | 2753 | 7/9/2019 | 0.4 | 0.98 | 0.007 | 0.001 |
| Pearce Brook | 463 | 2739 | 7/11/2019 | 0.3 | 0.13 | 0.016 | 0.002 |
| Robinson Dam Pond | W-198 | -- | 6/20/2019 | 0.6 | 0.57 | 0.066 | -- |
| Rocky Brook | 375 | 2735 | 7/9/2019 | 0.3 | 0.39 | 0.01 | 0.002 |
| Sheepscot River | 74 | 2756 | 7/22/2019 | 0.5 | 0.02 | 0.017 | 0.002 |
| Smith Brook | 1007 | 2740 | 7/11/2019 | 0.3 | 0.27 | 0.016 | 0.001 |
| Unnamed Brook (Madawaska) | 1030 | 2747 | 7/10/2019 | 0.6 | 1.8 | 0.061 | 0.013 |
| Unnamed Brook (Presque Isle) | 1027 | 2731 | 7/10/2019 | <0.2 | 2 | 0.025 | 0.014 |
| West Branch Sheepscot River | 268 | 2755 | 7/22/2019 | 0.5 | 0.07 | 0.02 | 0.001 |
| Williams Brook | 1031 | 2737 | 7/9/2019 | 0.4 | 0.53 | 0.021 | 0.011 |

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

**Figure 3.1.1a 2019 In-Stream Continuous Temperature Data**

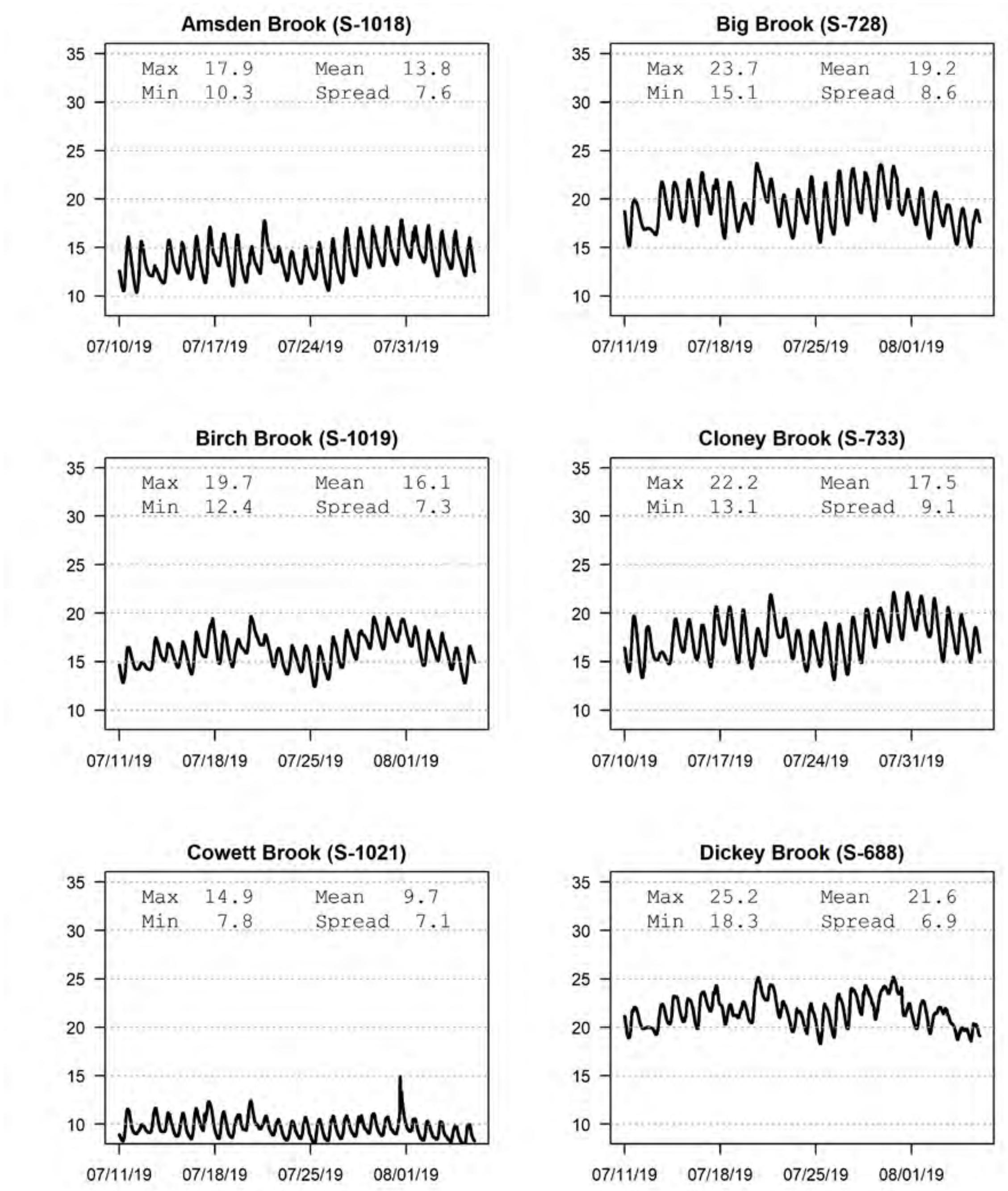


**Figure 3.1.1a 2019 In-Stream Continuous Temperature Data (continued)**

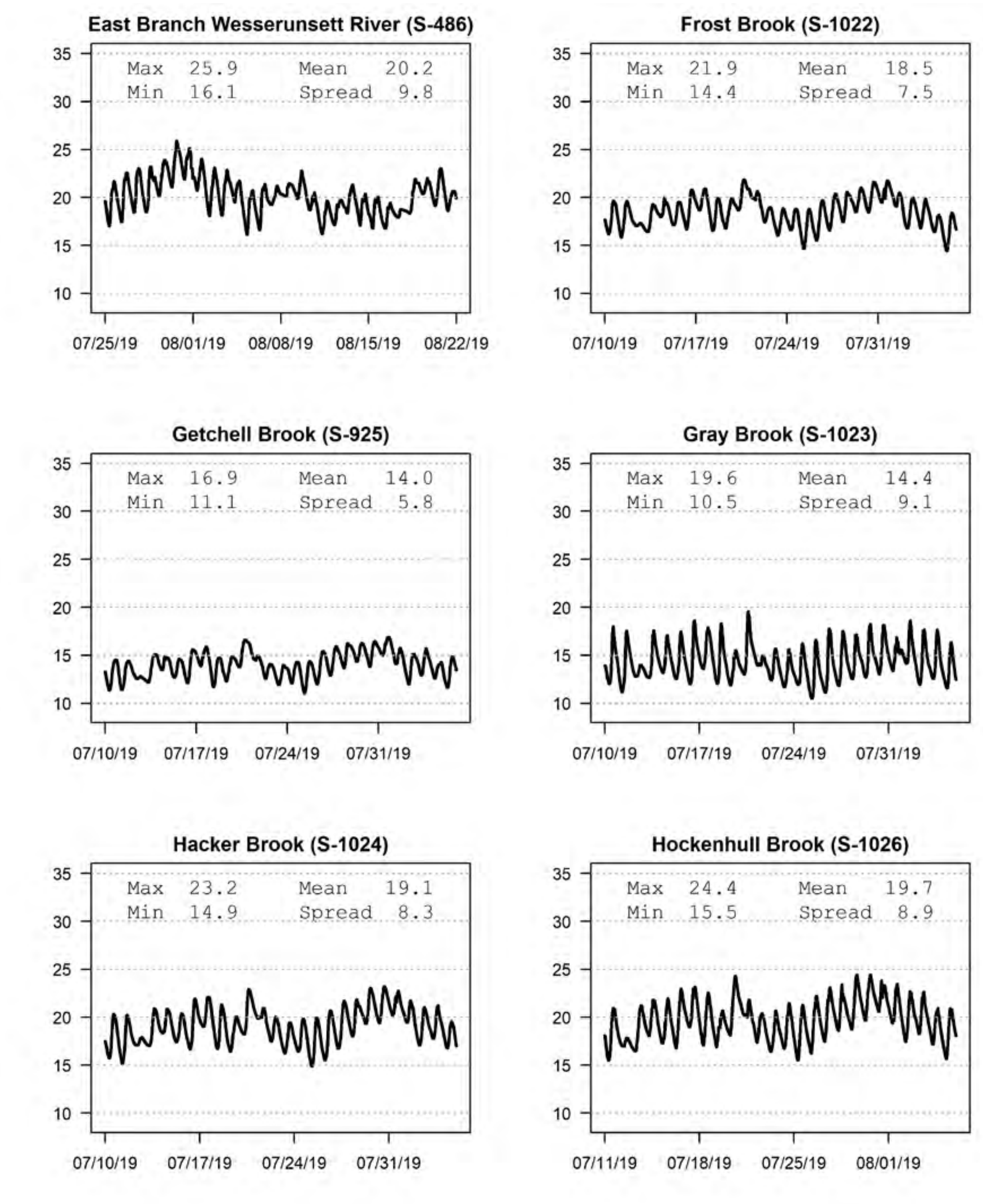


**Figure 3.1.1a 2019 In-Stream Continuous Temperature Data (continued)**

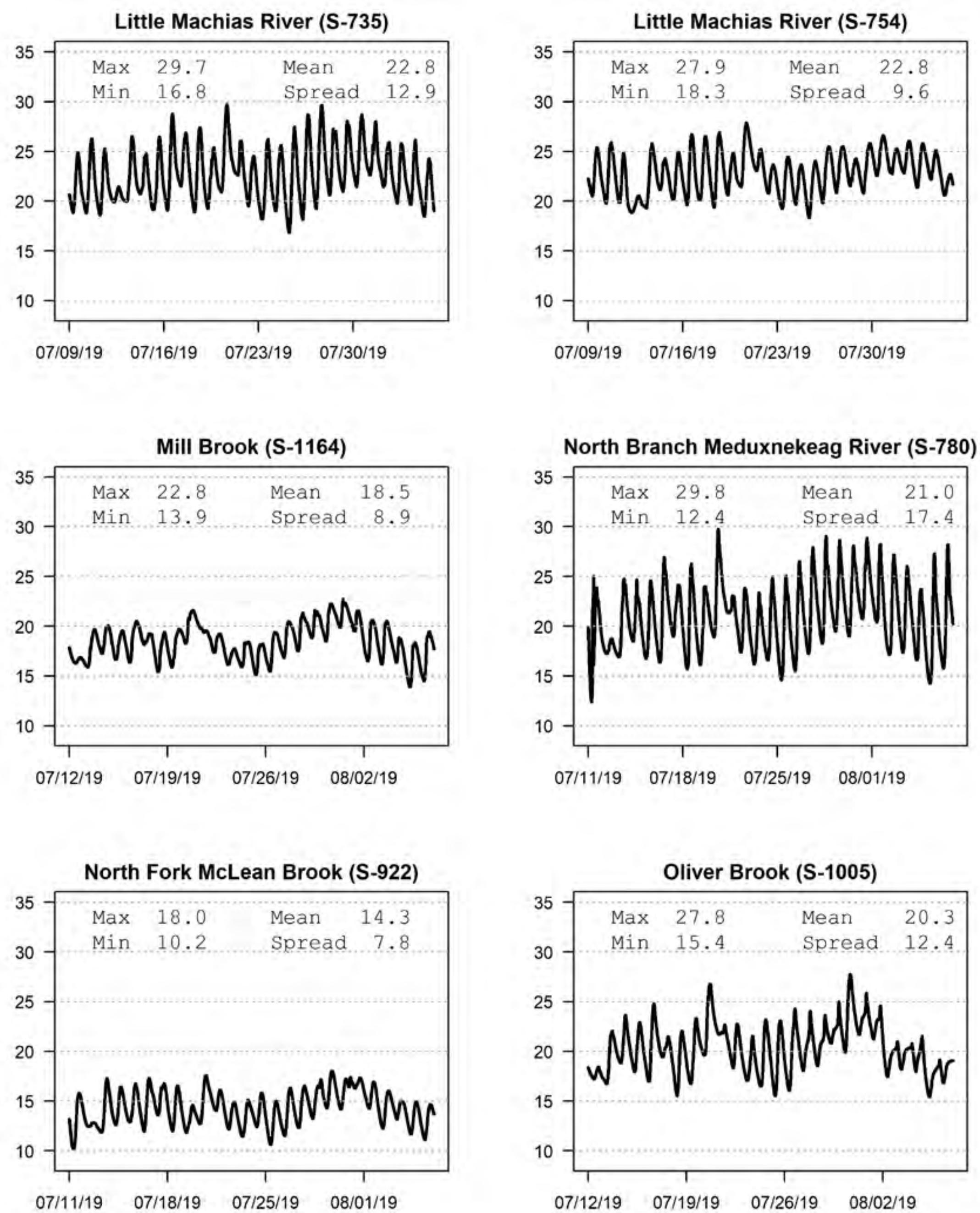


**Figure 3.1.1a 2019 In-Stream Continuous Temperature Data (continued)**

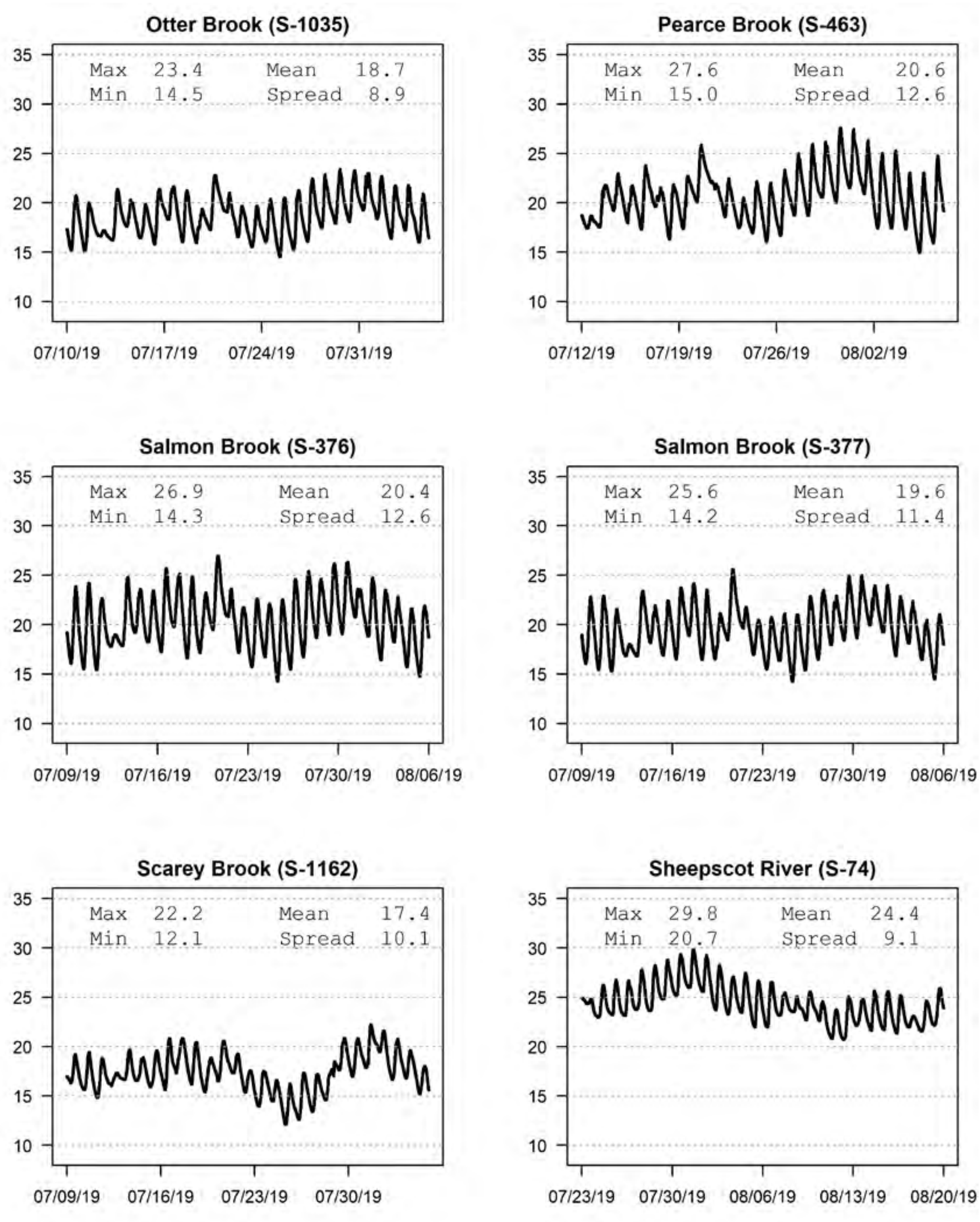
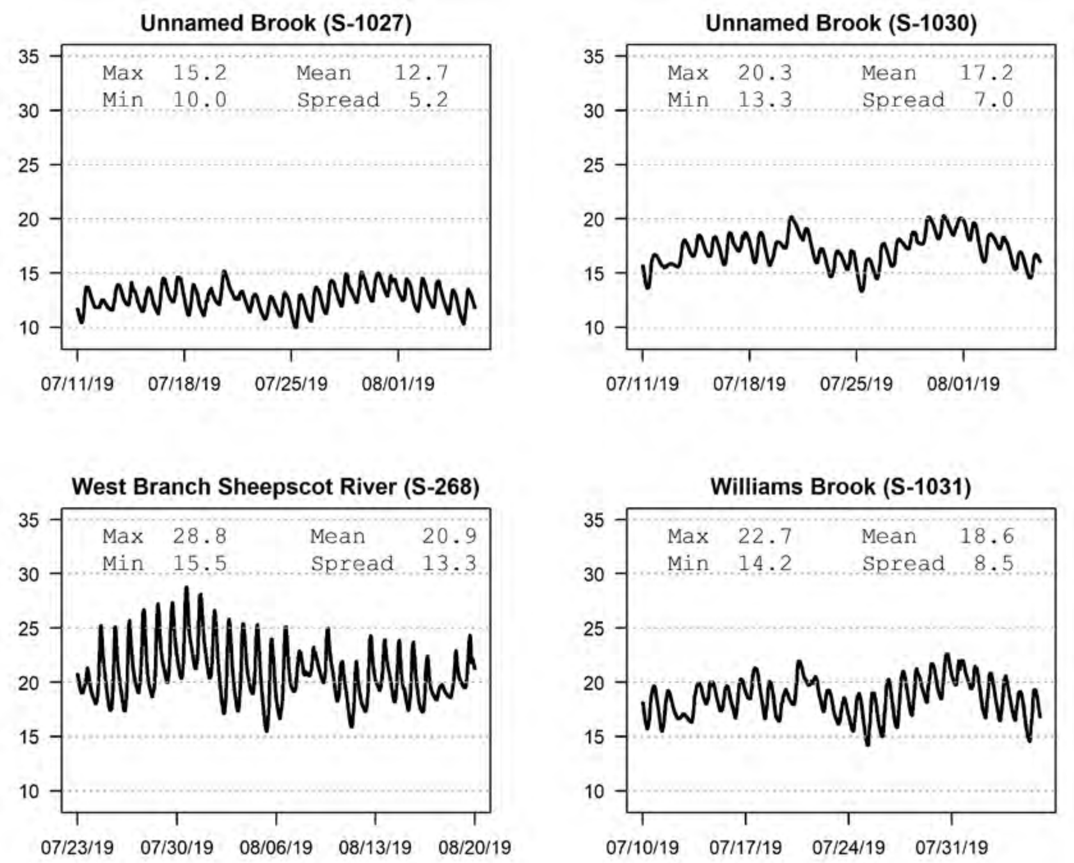


**Figure 3.1.1a 2019 In-Stream Continuous Temperature Data (continued)**



### Table 3.1.4a Past Attainment History of 2019 Sampling Stations

The table below provides the attainment history for 2019 sampling stations that have been sampled in the past.

| Waterbody | Station | Attained Class | Did not Attain Class | Indeterminate Result |
|---|---|---|---|---|
| Amsden Brook | 1018 | 2019 | 2014 | -- |
| Beaverdam Stream | 1149 | 2019 | 2018 | -- |
| Big Brook | 728 | 2004, 2014, 2019 | -- | -- |
| Birch Brook | 1019 | 2014, 2019 | -- | -- |
| Coloney Brook | 733 | 2004, 2019 | 2009 | -- |
| Concord Gully Brook | 498 | 2018 | 2019 | 2001, 2010, 2012 |
| Concord Gully Brook | 497 | -- | 2018, 2019 | 2001, 2012 |
| Cowett Brook | 1021 | -- | 2014, 2019 | -- |
| Creamer Brook | 1115 | 2017, 2018, 2019 | -- | -- |
| Dickey Brook | 688 | 2003, 2009, 2019 | -- | -- |
| E. Br. Wesserunsett Stream | 486 | 2001, 2007, 2012-2019 | -- | -- |
| Frost Brook | 1022 | 2014, 2019 | -- | -- |
| Getchell Brook | 925 | 2009, 2014, 2019 | -- | -- |
| Gray Brook | 1023 | 2014, 2019 | -- | -- |
| Hacker Brook | 1024 | 2019 | 2014 | -- |
| Halfmoon Stream | 697 | 2003, 2007, 2019 | 2012-2018 | -- |
| Hall Brook | 1147 | 2019 | 2018 | -- |
| Hockenhull Brook | 1026 | 2014, 2019 | -- | -- |
| Kennedy Brook | 646 | 2002, 2004, 2009, 2019 | -- | -- |
| Moose Brook | 466 | 1999, 2000, 2019 | -- | -- |
| N. Br. Meduxnekeag River | 780 | 2004, 2019 | -- | -- |
| N. Fork McLean Brook | 922 | 2014 | 2009, 2019 | -- |
| Oliver Brook | 1005 | 2014 | 2019 | -- |
| Otter Brook | 1035 | 2014, 2019 | -- | -- |
| Pearce Brook | 463 | 1999, 2000, 2004, 2014, 2019 | -- | -- |
| Robinson Dam Pond | W-198 | -- | 2009, 2014, 2019 | -- |
| Rocky Brook | 375 | 1999, 2004, 2019 | -- | -- |
| Salmon Brook | 377 | 1999, 2009, 2019 | -- | -- |
| Salmon Brook | 376 | 1999, 2009, 2019 | -- | -- |

**Table 3.1.4a Past Attainment History of 2019 Sampling Stations (continued)**

| Waterbody | Station | Attained Class | Did not Attain Class | Indeterminate Result |
|---|---|---|---|---|
| Seboeis River | 737 | 2006, 2011, 2019 | -- | -- |
| Sheepscot River | 74 | 1985, 1987, 1988-1990, 1992, 1995, 1996, 1998-2017, 2019 | 1984-1986, 1988, 1991, 1993, 1994, 1997 | -- |
| Smith Brook | 1007 | 2014, 2019 | -- | -- |
| Unnamed Brook | 1027 | 2014 | -- | 2019 |
| Unnamed Brook | 1030 | 2014, 2019 | -- | -- |
| W. Br. Sheepscot River | 268 | 1996-1999, 2001, 2002, 2005, 2007, 2009-2017, 2019 | 2000, 2003, 2004, 2006, 2008, 2018 | 1995 |
| Williams Brook | 1031 | 2014, 2019 | -- | -- |

# 2020 Results

### 3.1.2b 2020 Results Summary

The Biological Monitoring Unit concentrated its sampling in 2020 in the Southern Maine basin. Forty-six stations were sampled under the SWAT Program (Table 3.1.1b). Samplers at two stations were disturbed and no macroinvertebrate data were obtained, however field data are included in this report. Due to circumstances related to the COVID-19 pandemic, water samples were not collected in 2020. Macroinvertebrate sample processing and taxonomic analysis were delayed due to COVID-related issues affecting contractors and their staff, therefore some results were not available for this initial report. Remaining results will be added to the on-line SWAT report as data are received. The following are summaries for waterbodies not attaining aquatic life criteria for their assigned class.

<u>Black Brook – Windham</u> Station 1181

Black Brook is a second order stream with a water quality goal of Class B. Land use in the watershed consists of moderately high concentrations of residential and commercial development, along with some agriculture. Station 1181 is located upstream of River Road in Windham. The macroinvertebrate community did not meet aquatic life criteria for either Class B or Class C. Total Mean Abundance was low (64), as were the abundance of mayflies and caddisflies. No stoneflies were present in the sample. The dominant taxon was Gammarus, which is an amphipod that feeds on detritus and is generally tolerant to pollution. The second most abundant genera was Dubiraphia, a riffle beetle that is sometimes common in low gradient streams. Despite the low mean abundance of mayflies (6.67), there were eight different types representing five families present in the sample. Dissolved oxygen was low in August (6.62 mg/L), and specific conductance was high in July (328.9 uS/cm). The low-gradient, silty habitat at Station 1181 may have contributed to impairment of the macroinvertebrate community, therefore resampling at a different location to is recommended to verify attainment status.

Capisic Brook – Portland Station 1039
Capisic Brook is a second order stream in an urbanized watershed with a water quality goal of Class C. Station 1039 is located approximately 200 m downstream of the Springfield Terminal railroad tracks in Portland. The stream did not meet the minimum aquatic life criteria for Class C. Ninety-three percent of the macroinvertebrate community was comprised of the tolerant amphipod Gammarus, which feeds on detritus. Total Generic Richness in the sample was very low (16), with no stoneflies, mayflies or other sensitive taxa present, indicating potential toxic impacts. Specific conductance was high during July (660 uS/cm) and August (932 uS/cm).

Goosefare Brook – Saco Station 48
Goosefare Brook Station 48 is a well-established site which has been periodically sampled since 1984. The station is located below the Jenkins Road crossing in Saco in the upper part of the watershed and is used as a reference site. Goosefare Brook is a first order stream in this location with a water quality goal of Class B, however it did not meet Class B aquatic life criteria in 2020. The upper part of the watershed is unique as it consists of a large raised bog called the Great Heath, which is the southernmost raised bog in North America. The upper part of the watershed can become highly acidic when the sphagnum moss dies off in the fall, and the stream is highly colored with tannic water. The site had few stoneflies and mayflies, which affected the class attainment result. Dissolved oxygen, pH, and specific conductance were within normal range, however low water levels may have impacted the composition of the macroinvertebrate assemblage.

Phillips Brook – Scarborough Station 953
Phillips Brook is a first order stream with a water quality goal of Class C. Watershed land use includes substantial residential and commercial development. Station 953 is the lowest station in the watershed and is located off Payne Road. The stream did not meet the minimum aquatic life criteria for Class C. EPT Generic Richness was low (7), with no stoneflies present in the sample, and mayfly mean abundance was also quite low (3.3). The dominant taxon in the sample was Dubiraphia, which is a small riffle beetle common to low gradient streams. The remaining dominant taxa were midges and a snail. Specific conductance was higher than normal with readings of 328.6 and 288.9 uS/cm. Water levels and flow velocity were low.

Red Brook – South Portland Station 412
Red Brook is a second order stream with a water quality goal of Class C. The brook originates in Scarborough in an area of small farms and mixed residential and commercial development, including a golf course. It then flows through an area of dense commercial development in the vicinity of the Maine Mall, where it crosses I-95 and I-295 several times before draining to Long Creek. Station 412 is located 100 meters below the I-295 highway culvert. The macroinvertebrate community did not meet aquatic life criteria for Class C. The macroinvertebrate sample contained no stoneflies and one mayfly. The dominant taxon was Gammarus (48.4%), an amphipod that is tolerant of pollution and can be common in coastal streams. Although some more sensitive organisms were found in the sample including a dobsonfly, a dragonfly, a damselfly, and 7 genera of caddisflies, their abundance was very low. Specific conductance was high in both July (628

uS/cm) and August (1,086 uS/cm), indicating groundwater that feeds the stream is contaminated by road salt.

Thacher Brook – Biddeford Station 451

Thacher Brook is a third order stream that has a water quality goal of Class B. Station 451 is located below I-95, above South Street in a small residential area. Downstream, the brook flows northeast into the Saco River. Watershed land use is comprised of residential and commercial development. The macroinvertebrate community at Station 451 did not meet aquatic life criteria for either Class B or Class C. The sample had no stoneflies and only a single mayfly, with few macroinvertebrates that are sensitive to pollution. The Hilsenhoff Biotic Index was high (6.46), indicating a relatively high proportion of organisms that are tolerant of organic pollution. The dominant taxon was Caecidotea (29.2%), an isopod that is tolerant of pollution and can be common in coastal streams. The second most abundant taxon was a midge larva, Microtendipes (28.1%). The stream is contaminated by road salt, and specific conductance was elevated in both July (793 uS/cm) and August (688 uS/cm).

Trout Brook – South Portland Station 675

Trout Brook is a cold-water, second order stream which flows through an urbanized watershed, and has a water quality goal of Class C. Station 675 is located approximately 125 meters upstream of Boothby Avenue in South Portland. In 2020, the stream did not meet the minimum aquatic life criteria for Class C. The dominant organisms in the macroinvertebrate community were amphipods (Gammarus) and isopods (Caecidotea), both of which are tolerant to pollution. There were no stonefly or mayfly taxa present. Specific Conductance during the sampling period was very high, with a reading at sampler retrieval of 744 uS/cm. This station was last sampled in 2015 and did not meet the minimum Class C aquatic life criteria at that time.

Trout Brook – South Portland Station 1040

Trout Brook Station 1040 is located approximately 80 meters upstream of Ocean House Road in South Portland. The upstream watershed is characterized by urban development and farm fields. The stream did not meet the minimum Class C aquatic life criteria in 2020. Generic Richness of the macroinvertebrate sample was low (12) and did not meet the minimum provision of 15 for DEP's predictive model, however class attainment was determined by DEP biologists using Best Professional Judgement. The dominant organism representing 80% of the macroinvertebrate assemblage was the tolerant amphipod Gammarus, which feeds on detritus and can recolonize quickly after disturbance. There were no stonefly or mayfly taxa present in the sample, and only 2 caddisfly taxa. Water levels were low and remaining pools had little flow. The dissolved oxygen concentration in August was very low (2.92 mg/L) and below the criterion for Class C streams (5 ug/L). Specific Conductance was elevated during sampler deployment and retrieval (344 uS/cm and 423 uS/cm).

West Branch Pleasant River - Katahdin Iron Works TWP    Station 686

The West Branch Pleasant River is a third order stream with a water quality goal of Class AA. The watershed is almost entirely forested, with some recent logging in the vicinity of Station 686. The macroinvertebrate community did not meet aquatic life criteria for Class AA/A, however the stream supports many sensitive taxa. Twenty-one different genera of mayflies, stoneflies and caddisflies were present in the sample, out of a total generic richness of 40. There were 6 different kinds of stoneflies, which is exceptional. Dissolved oxygen, pH and specific conductance measurements for July and August did not indicate any signs of degraded water quality, and in fact specific conductance was quite low during both field visits (28.3 and 29.7 uS/cm). The mean abundance of the midge Rheotanytarsus was extremely high however (1442.67), representing 77% of total abundance in the sample. Rheotanytarsus is a filter-feeding midge that is common in small rivers that are oligotrophic to mesotrophic, however the excessive dominance of this organism in a largely undisturbed watershed is unusual and caused the model to shift from A to B. Resampling is therefore recommended.

**Table 3.1.1b  2020 SWAT Benthic Macroinvertebrate Biomonitoring Results**

****** = Data not yet available from taxonomists (results pending).

| Waterbody | Town | Station | Log | Potential sources of pollution[1] | Statutory Class / Final Determination | Attains Class? | Probable Cause |
|---|---|---|---|---|---|---|---|
| Black Brook | Windham | 1181 | 2841 | NPS | B/NA | N | NPS Toxics / Habitat |
| Blood Brook | Katahdin Iron Works TWP | 666 | 2828 | Iron mine | A/A | Y | |
| Bull Branch Sunday River | Riley TWP | 659 | 2837 | Reference | / | ** | |
| Capisic Brook | Portland | 257 | 2808 | Urban NPS | / | ** | |
| Capisic Brook | Portland | 1039 | 2809 | Urban NPS | C/NA | N | NPS Toxics |
| Card Brook | Ellsworth | 815 | 2839 | Urban NPS | B/A | Y | |
| E. Br. Wesserunsett Stream | Athens | 486 | 2850 | Reference | A/A | Y | |
| Goosefare Brook | Saco | 48 | 2801 | Reference | B/C | N | Low water levels |
| Goosefare Brook | Saco | 271 | 2803 | In Place Contamination | / | ** | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Goosefare Brook | Saco | 338 | -- | NPS | -- | No data | Samplers disturbed |
| Great Works River | N. Berwick | 439 | 2802 | NPS | / | ** | |
| Kennebunk River | Kennebunk | 270 | 2846 | Urban NPS | B/B | Y | |

**Table 3.1.1b 2020 SWAT Benthic Macroinvertebrate Biomonitoring Results (continued)**

| Waterbody | Town | Station | Log | Potential sources of pollution[1] | Statutory Class/ Final Determination | Attains Class? | Probable Cause |
|---|---|---|---|---|---|---|---|
| Little River | Lebanon | 440 | -- | NPS | -- | No data | Samplers disturbed |
| Mare Brook | Brunswick | 457 | 2811 | Former BNAS | B/A/ | Y | |
| Mare Brook | Brunswick | 1064 | 2812 | Former BNAS | / | ** | |
| Mare Brook | Brunswick | 330 | 2813 | Former BNAS | / | ** | |
| Merriland River | Wells | 437 | 2826 | NPS / Turnpike | / | ** | |
| Mile Brook | Casco | 998 | 2821 | Hatchery | / | ** | |
| Mount Blue Stream | Avon | 1182 | 2814 | NPS | B/A | Y | |
| Mousam River | Sanford | 391 | 2805 | Downstream of POTW | / | ** | |
| Mousam River | Sanford | 390 | 2806 | Upstream of POTW | / | ** | |
| Mousam River | Sanford | 259 | 2831 | Urban NPS / Landfill | / | ** | |
| Mousam River | Sanford | 388 | 2832 | Upstream of Landfill | / | ** | |
| Narramissic River | Orland | 1094 | 2840 | Lake Outlet Reference | / | ** | |
| Nason's Brook | Portland | 638 | 2827 | Urban NPS | / | ** | |
| Phillips Brook | Scarborough | 953 | 2820 | NPS | C/NA | N | NPS Toxics / Low water levels |
| Piscataqua River | Cumberland | 758 | 2815 | Urban NPS | / | ** | |
| Piscataqua River | Falmouth | 759 | 2817 | Urban NPS | B/B | Y | |
| Pleasant River | Gray | 394 | 2822 | Reference - upper station | B/B | Y | |
| Pleasant River | Windham | 155 | 2842 | NPS - downstream station | B/A | Y | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pleasant River | Windham | 548 | 2843 | NPS - middle station | B/B | Y | |
| Red Brook | Scarborough | 219 | 2804 | NPS / Landfill | / | ** | |
| Red Brook | S. Portland | 412 | 2807 | Urban NPS | C/NA | N | |

**Table 3.1.1b 2020 SWAT Benthic Macroinvertebrate Biomonitoring Results (continued)**

| Waterbody | Town | Station | Log | Potential sources of pollution[1] | Statutory Class/ Final Determination | Attains Class? | Probable Cause |
|---|---|---|---|---|---|---|---|
| Salmon Falls River | Berwick | 52 | 2849 | Municipal | / | ** | |
| Sheepscot River | N. Whitefield | 74 | 2823 | Long-term reference | AA/A | Y | |
| South Branch Sandy River | Phillips | 600 | 2825 | Reference | A/A | Y | |
| Tannery Brook | Gorham | 474 | 2847 | NPS | / | ** | |
| Temple Stream | Farmington | 1183 | 2816 | Salmon project | B/A | Y | |
| Thacher Brook | Biddeford | 451 | 2844 | Urban NPS | B/NA | N | |
| Trout Brook | S. Portland | 675 | 2818 | Urban NPS | C/NA | N | NPS / Urban Runoff |
| Trout Brook | Cape Elizabeth | 1040 | 2819 | Urban NPS | C/NA | N | NPS / Urban Runoff / Low water levels |
| W. Branch Sheepscot River | China | 268 | 2824 | Long-term reference | AA/A | Y | |
| West Branch Pleasant River | Katahdin Iron Works TWP | 286 | 2829 | Iron mine | AA/A | Y | |
| West Branch Pleasant River | Katahdin Iron Works TWP | 686 | 2830 | Upstream of iron mine | AA/B | N | |
| West Brook | Biddeford | 797 | 2845 | Urban NPS | / | ** | |
| Wild River | Batchelder Grant TWP | 674 | 2838 | Long-term reference | / | ** | |

## Table 3.1.2b 2020 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 |
| Black Brook | 1181 | 2841 | 7/31/2020 | 20.2 | 7.98 | 328.9 | 7.62 | 8/25/2020 | 20.6 | 6.62 | 186.3 | 7.28 |
| Blood Brook | 666 | 2828 | 7/20/2020 | 23 | 8.06 | 131.1 | 6.86 | 8/17/2020 | 20.7 | 9.61 | 272.1 | 7.07 |
| Bull Branch Sunday River | 659 | 2837 | 7/24/2020 | 20.4 | 9.48 | 16.8 | 6.45 | 8/21/2020 | 17.9 | 9.93 | 20.4 | 6.53 |
| Capisic Brook | 257 | 2808 | 7/6/2020 | 18.1 | 7.97 | 439.5 | 7.4 | 8/3/2020 | 23.3 | 7.08 | 1043 | 7.38 |
| Capisic Brook | 1039 | 2809 | 7/6/2020 | 20.8 | 9.39 | 660 | 7.58 | 8/3/2020 | 32.2 | 9.55 | 932 | 7.77 |
| Card Brook | 815 | 2839 | 7/27/2020 | 24 | 8.82 | 469 | 7.64 | 8/24/2020 | 19.8 | -- | 692 | 7.73 |
| E. Br. Wesserunsett | 486 | 2850 | 9/2/2020 | 15.2 | 10.93 | 100.1 | 7.77 | 9/28/2020 | 17.3 | 9.95 | 142.5 | 7.72 |
| Goosefare Brook | 48 | 2801 | 7/13/2020 | 18.2 | 8.91 | 146.2 | 7.15 | 8/12/2020 | 19.5 | 8.38 | 105.3 | 7.2 |
| Goosefare Brook | 271 | 2803 | 7/13/2020 | 20.7 | 8.36 | 1046 | 7.1 | 8/12/2020 | 20.7 | 7.32 | 1046 | 7.31 |
| Goosefare Brook | 338 | -- | 7/13/2020 | 20.7 | 9.76 | 822 | 7.81 | -- | -- | -- | -- | -- |
| Great Works River | 439 | 2802 | 7/15/2020 | 21.7 | 9.6 | 169.6 | 7.29 | 8/11/2020 | 23.6 | 9.16 | 163.2 | 7.33 |
| Kennebunk River | 270 | 2846 | 7/29/2020 | 25.6 | 10.26 | 113.7 | 7.75 | 8/27/2020 | 17.7 | 11.14 | 132.1 | 7.75 |
| Little River | 440 | -- | 7/15/2020 | 21 | 9.75 | 76.7 | 7.3 | -- | -- | -- | -- | -- |
| Mare Brook | 457 | 2811 | 7/17/2020 | 15.3 | 10.07 | 252.7 | 6.99 | 8/10/2020 | 19.6 | 9.3 | 267.8 | 6.99 |
| Mare Brook | 1064 | 2812 | 7/17/2020 | 13.9 | 9.87 | 317.5 | 6.79 | 8/10/2020 | 16.8 | 9.15 | 279.7 | 6.73 |
| Mare Brook | 330 | 2813 | 7/17/2020 | 19.2 | 8.42 | 381.6 | 6.82 | 8/10/2020 | 22.3 | 7.93 | 457 | 9.61 |
| Merriland River | 437 | 2826 | 7/16/2020 | 20.8 | 9.39 | 110.8 | 7.35 | 8/17/2020 | 19.1 | 9.53 | 129.2 | 7.43 |
| Mile Brook | 998 | 2821 | 7/8/2020 | 19 | 9.13 | 74.8 | 6.88 | 8/3/2020 | 23.8 | 8.33 | 59.5 | 6.65 |
| Mount Blue Stream | 1182 | 2814 | 7/10/2020 | 19.9 | 9.39 | 30.7 | 7.19 | 8/6/2020 | 18.6 | 9.74 | 32.4 | 7.15 |
| Mousam River | 391 | 2805 | 7/9/2020 | 24.1 | 8.42 | 137.2 | 7.16 | 8/6/2020 | 22.9 | 8.51 | 159.3 | 7.26 |
| Mousam River | 390 | 2806 | 7/9/2020 | 26.4 | 8.96 | 134.2 | 7.26 | 8/6/2020 | 24.2 | 10.22 | 150.6 | 7.59 |
| Mousam River | 259 | 2831 | 7/30/2020 | 26.5 | 8.6 | 144.5 | 7.38 | 8/18/2020 | 24.5 | 9.75 | 134 | 7.43 |

## Table 3.1.2b 2020 SWAT Field Data (continued)

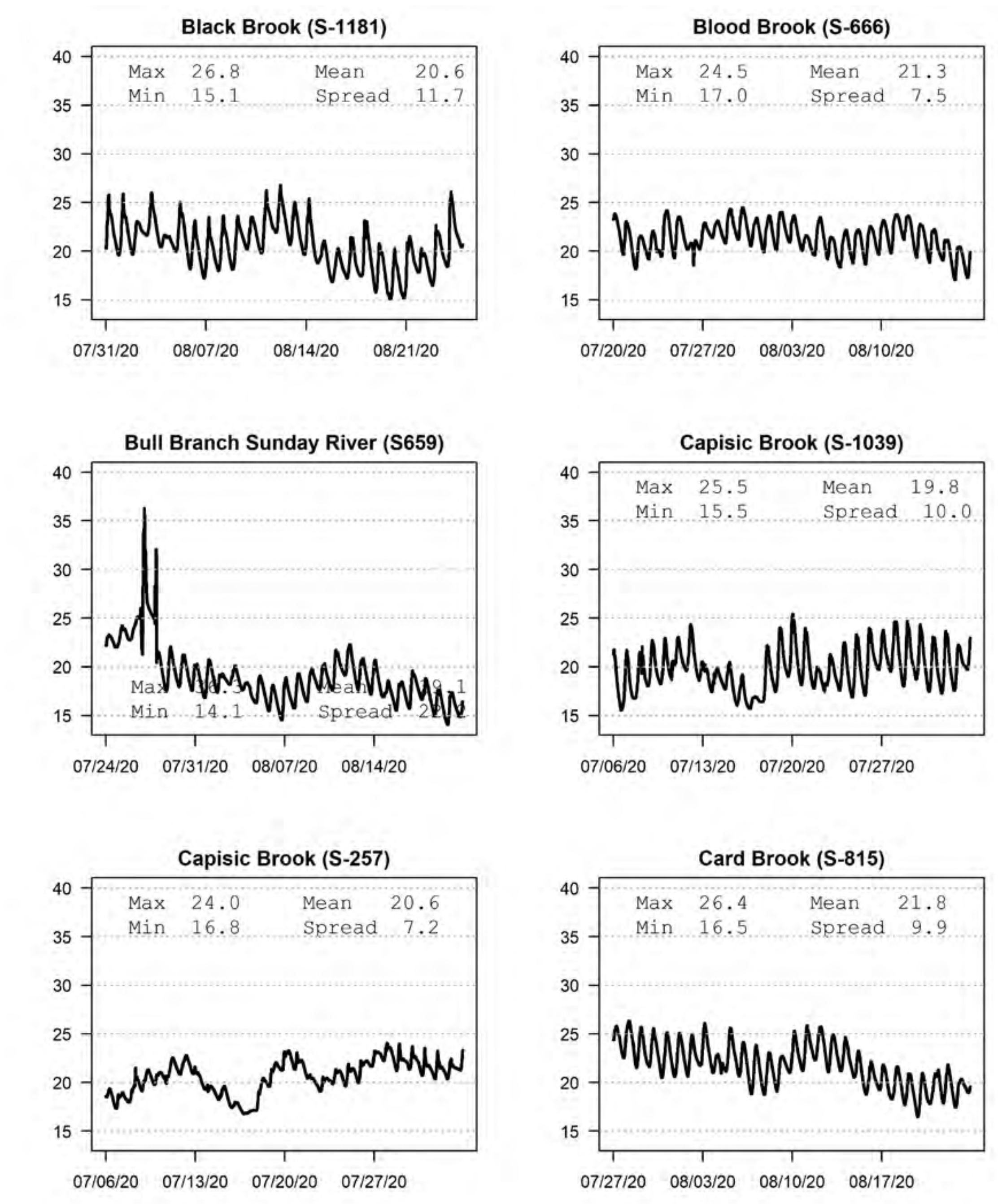
| Site | Station | Log | Sample Deployment | | | | | Sample Retrieval | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Date | Temperature Deg C | Dissolved Oxygen MG/L | Specific Conductance US/CM | pH STU | Date | Temperature Deg C | Dissolved Oxygen MG/L | Specific Conductance US/CM | pH STU |
| Mousam River | 388 | 2832 | 7/22/2020 | 24.8 | 8.27 | 96.3 | 7.25 | 8/18/2020 | 23.4 | 8.8 | 94 | 7.26 |
| Narramissic River | 1094 | 2840 | 7/27/2020 | 26.7 | 8.53 | 60.5 | 6.99 | 8/24/2020 | 24.9 | 9.36 | 61.6 | 7.23 |
| Nason's Brook | 638 | 2827 | 7/16/2020 | 18.7 | 8.41 | 957 | 7.51 | 8/17/2020 | 18.5 | 6.27 | 1595 | 7.61 |
| Phillips Brook | 953 | 2820 | 7/7/2020 | 18.4 | 8.85 | 328.6 | 7.38 | 8/5/2020 | 19.1 | 7.23 | 288.9 | 7.28 |
| Piscataqua River | 758 | 2815 | 7/6/2020 | 21.8 | 8.96 | 246 | 7.08 | 8/5/2020 | 22.8 | 8.45 | 305.8 | 7.02 |
| Piscataqua River | 759 | 2817 | 7/6/2020 | 18.5 | 9.76 | 309.5 | 7.32 | 8/5/2020 | 22.1 | 10.22 | 447.4 | 7.61 |
| Pleasant River | 394 | 2822 | 7/8/2020 | 19.6 | 7.9 | 226 | 6.85 | 8/3/2020 | 23.5 | 6.12 | 240.9 | 6.87 |
| Pleasant River | 155 | 2842 | 7/31/2020 | 22.4 | 9.62 | 224.5 | 7.67 | 8/25/2020 | 20.6 | 9.2 | 272.6 | 7.47 |
| Pleasant River | 548 | 2843 | 7/31/2020 | 23.8 | 9.45 | 201.5 | 7.66 | 8/25/2020 | 21.4 | 8.26 | 282.3 | 7.35 |
| Red Brook | 219 | 2804 | 7/8/2020 | 18 | 9.64 | 157.7 | 7.35 | 8/10/2020 | 19.5 | 9.44 | 101.2 | 7.21 |
| Red Brook | 412 | 2807 | 7/8/2020 | 17.7 | 10.3 | 628 | 7.38 | 8/10/2020 | 20.8 | 9.86 | 1086 | 7.42 |
| Salmon Falls River | 52 | 2849 | 8/11/2020 | 25.9 | 8.66 | 243.4 | 7.26 | 9/10/2020 | 22.3 | 9.77 | 321.5 | 7.21 |
| Sheepscot River | 74 | 2823 | 7/2/2020 | 22.7 | 8.81 | 132.1 | | 7/30/2020 | 27.8 | 8.14 | 85.4 | 7.09 |
| South Branch Sandy River | 600 | 2825 | 7/10/2020 | 20.7 | 9.4 | 24 | 6.9 | 8/6/2020 | 18.1 | 9.81 | 24.4 | 6.62 |
| Tannery Brook | 474 | 2847 | 7/29/2020 | 20.1 | 9.3 | 570 | 7.69 | 8/27/2020 | 14.8 | 10.48 | 540 | 7.78 |
| Temple Stream | 1183 | 2816 | 7/10/2020 | 24.1 | 9 | 61 | 7.19 | 8/6/2020 | 21.5 | 8.85 | 61.1 | 6.95 |
| Thacher Brook | 451 | 2844 | 7/28/2020 | 24.6 | 8.43 | 793 | 7.7 | 8/26/2020 | 19.6 | 9.01 | 688 | 7.42 |
| Trout Brook | 675 | 2818 | 7/7/2020 | 15.2 | 8.46 | 435.5 | 6.94 | 8/5/2020 | 15.2 | 6.04 | 744 | 6.63 |
| Trout Brook | 1040 | 2819 | 7/7/2020 | 18.1 | 8.37 | 344.4 | 7.23 | 8/5/2020 | 20.1 | 2.92 | 432.3 | 6.95 |

## Table 3.1.2b 2020 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** |
| W. Branch Sheepscot River | 268 | 2824 | 7/2/2020 | 24.6 | 9.06 | 80.3 | | 7/30/2020 | 24.6 | 9.06 | 92.7 | 7.21 |
| West Branch Pleasant River | 286 | 2829 | 7/20/2020 | 25.7 | 8.77 | 26.7 | 7.16 | 8/17/2020 | 23.7 | 8.78 | 28.5 | 6.93 |
| West Branch Pleasant River | 686 | 2830 | 7/20/2020 | 23.3 | 8.59 | 28.3 | 6.73 | 8/17/2020 | 21.1 | 9.03 | 29.7 | 6.59 |
| West Brook | 797 | 2845 | 7/28/2020 | 20.7 | 8.34 | 173.4 | 7.25 | 8/26/2020 | 20.7 | 8.34 | 221.1 | 7.25 |
| Wild River | 674 | 2838 | 7/24/2020 | 19.7 | 9.59 | 14.2 | 6.57 | 8/21/2020 | 18.7 | 9.85 | 17.3 | 6.74 |

### Figure 3.1.1b 2020 In-Stream Continuous Temperature Data

Note that samplers and temperature loggers at Goosefare Brook Station S-338 and Little River Station S-440 were disturbed



# Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)

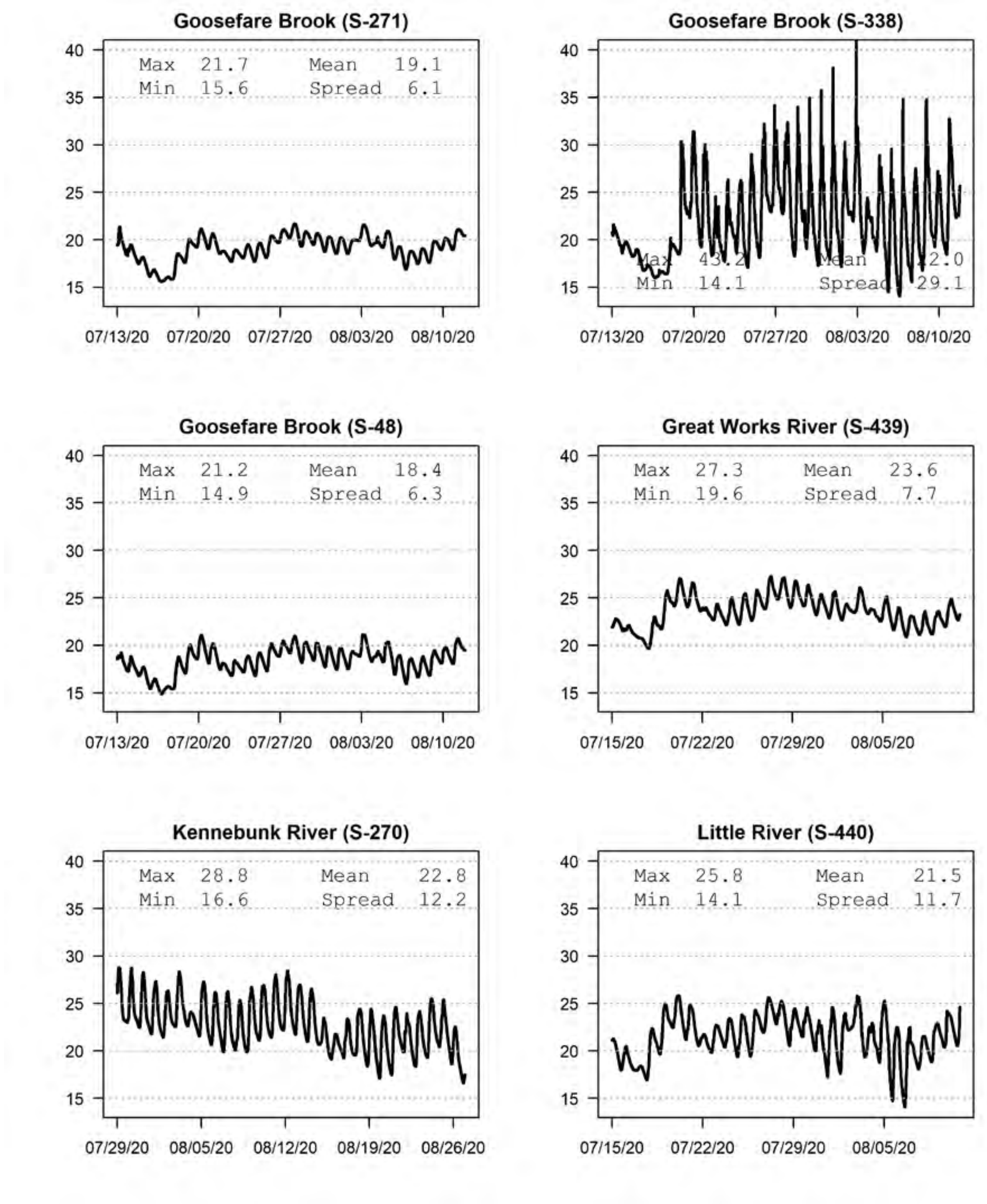


**Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)**

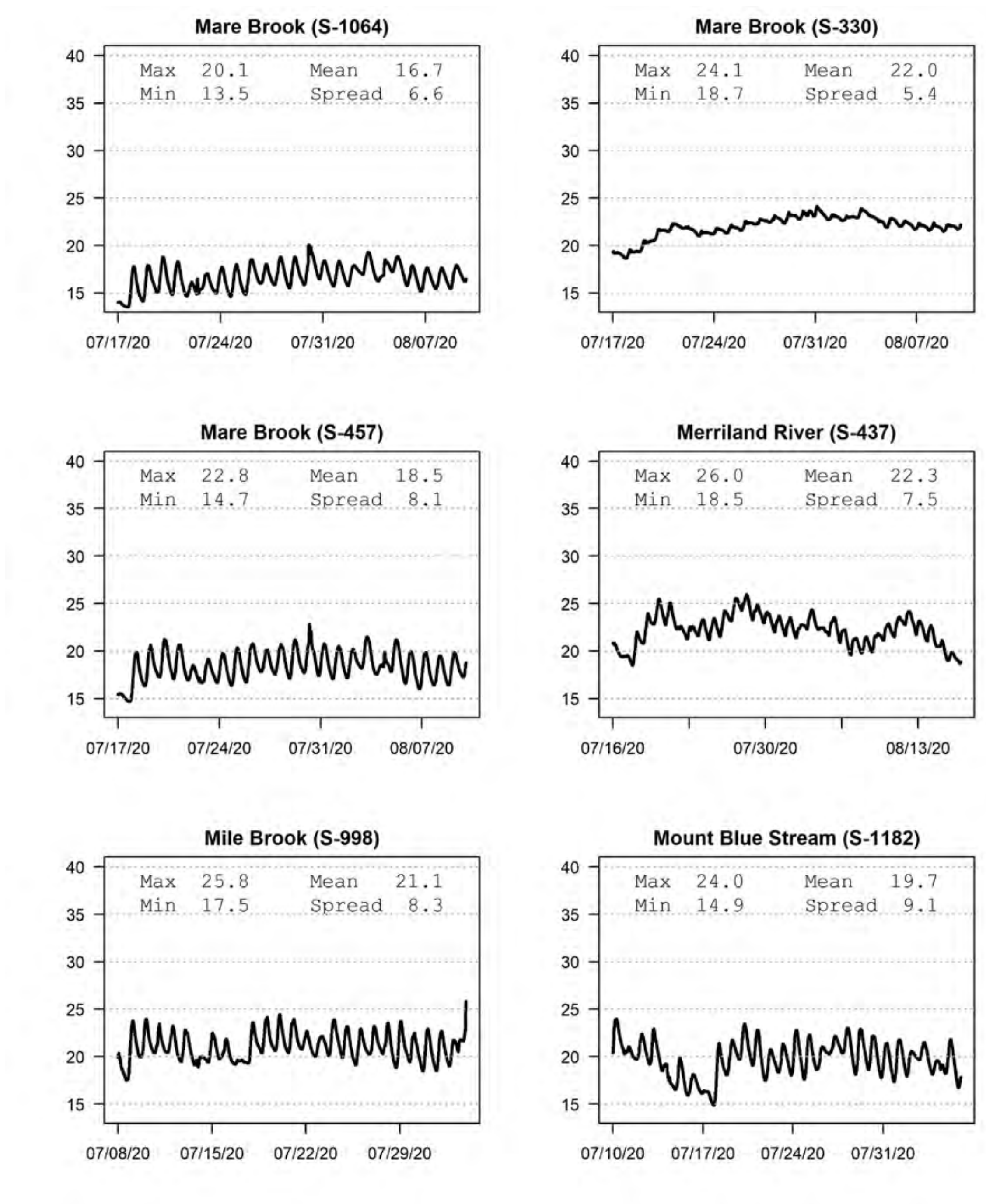
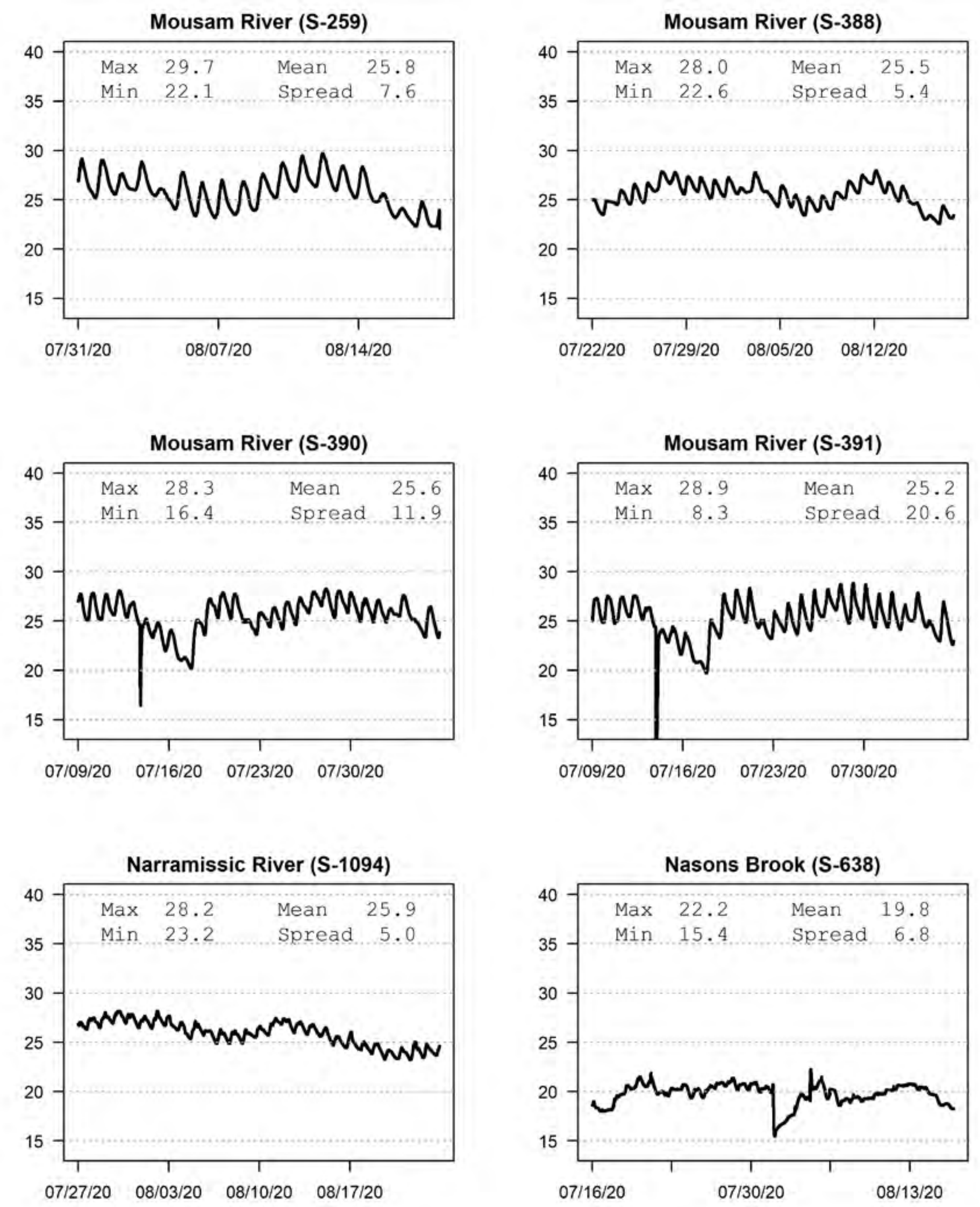


**Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)**



## Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)

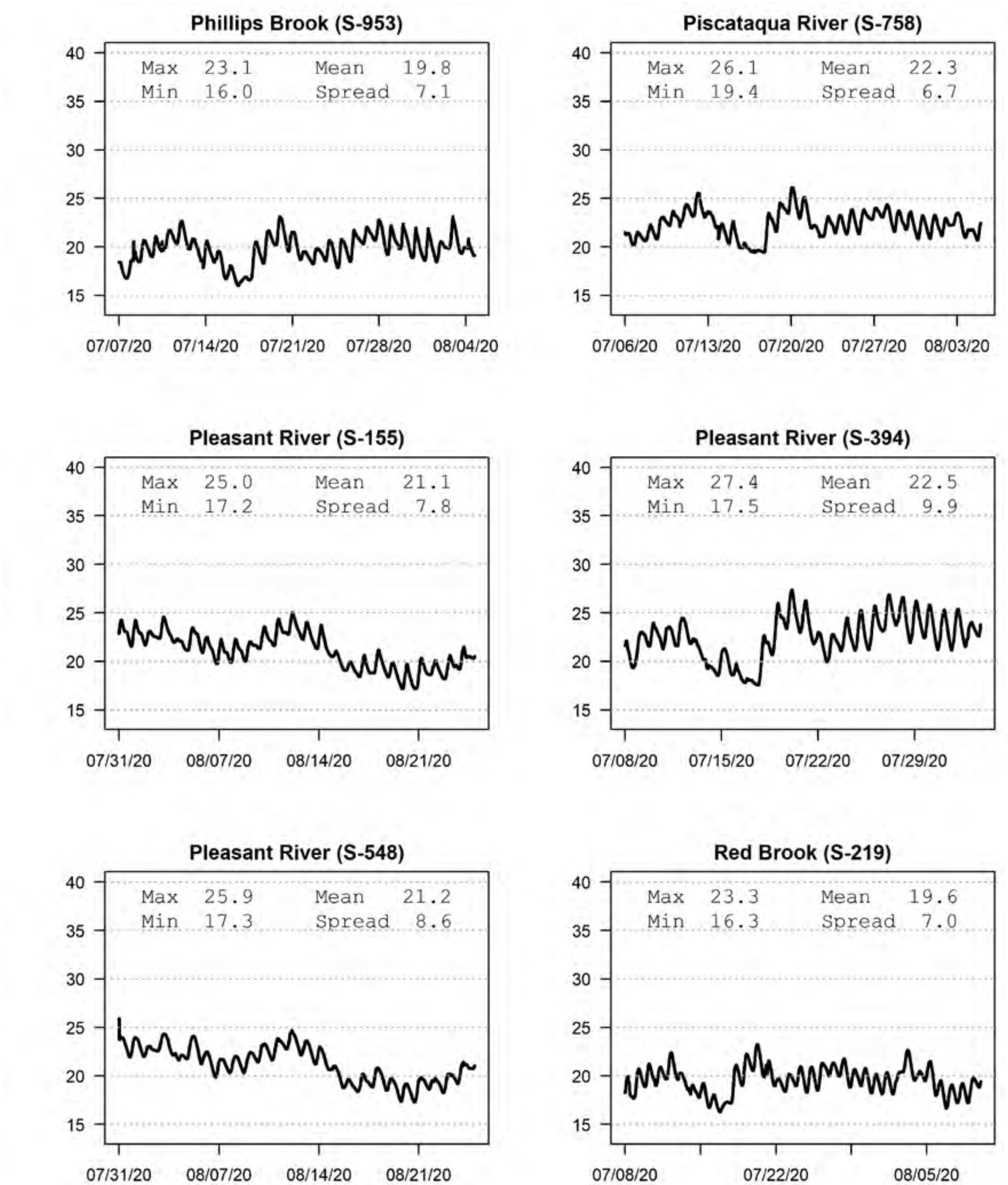


**Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)**

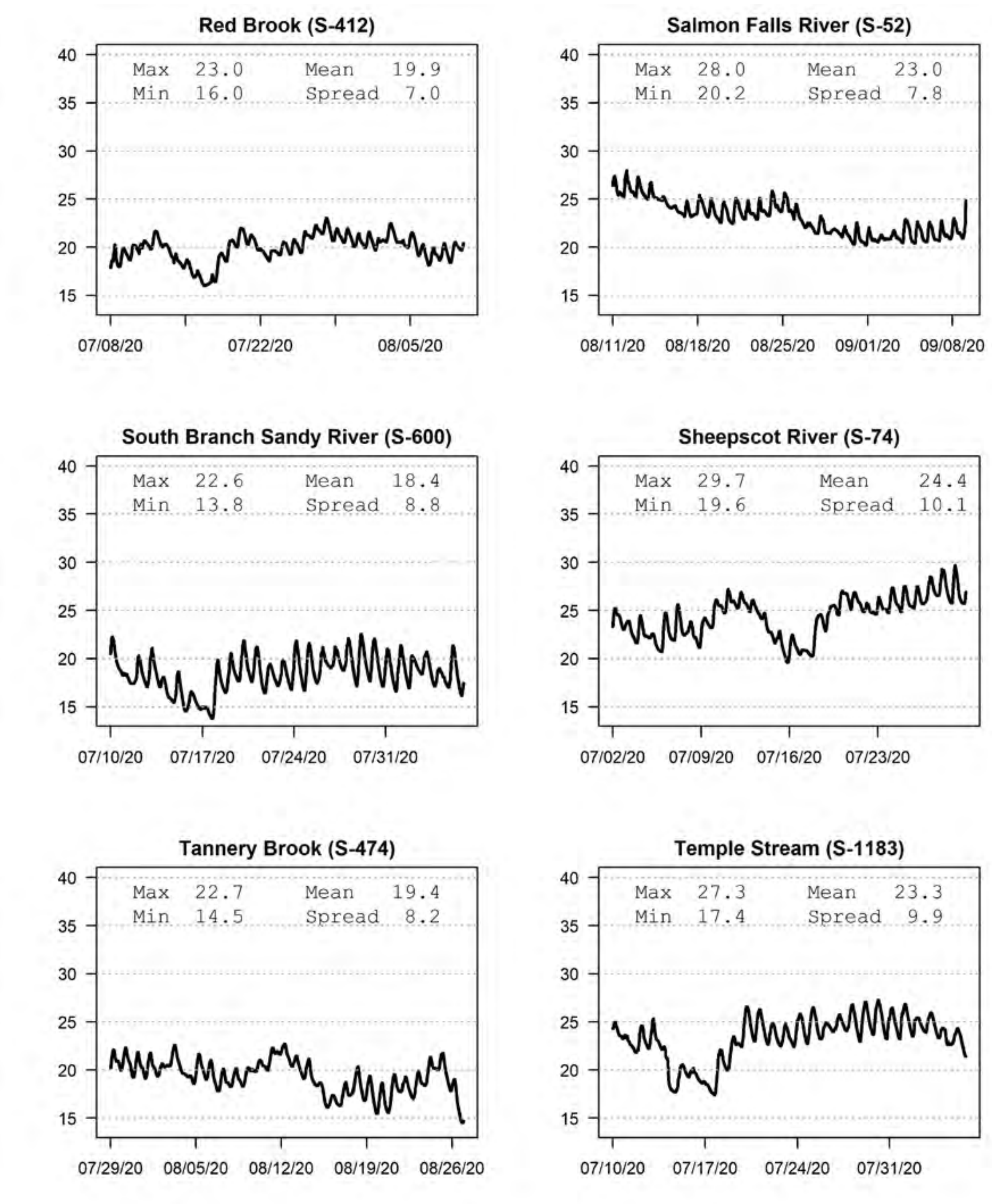


**Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)**

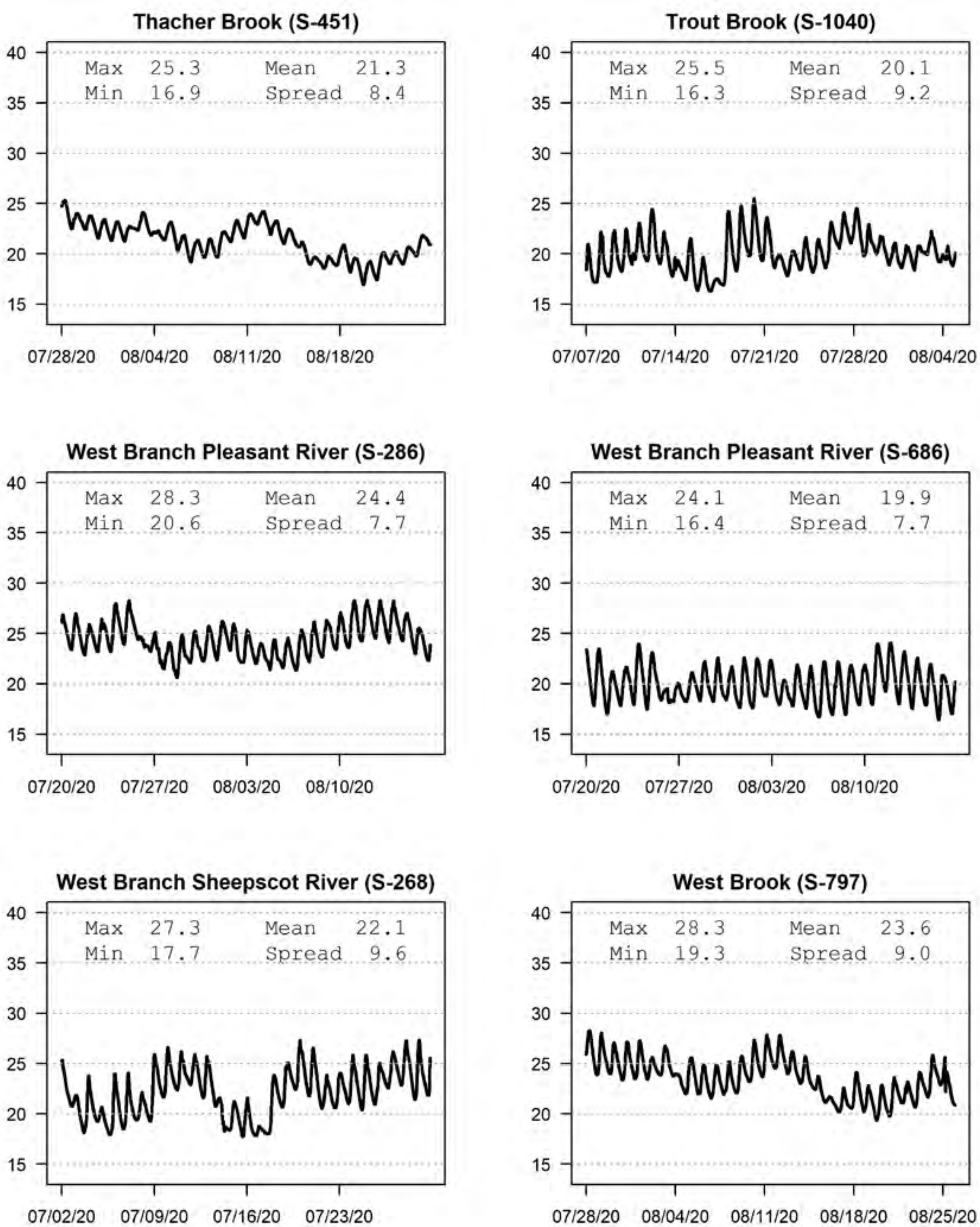
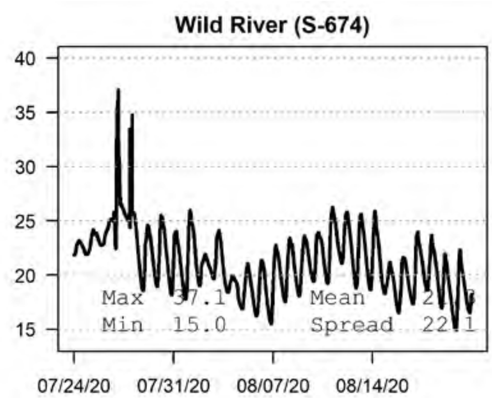


**Figure 3.1.1b 2020 In-Stream Continuous Temperature Data (continued)**



**Attainment History**
The table below provides the attainment history for 2020 sampling stations that have been sampled in the past.

| Waterbody | Station | Attained Class | Did not Attain Class | Indeterminate Result |
|---|---|---|---|---|
| Capisic Brook | 257 | 1995 | 1996, 1999, 2003, 2009, 2015 | -- |
| Capisic Brook | 1039 | -- | 2014 | -- |
| Card Brook | 815 | -- | 2006, 2011 | 2016 |
| E. Branch Wesserunsett Stream | 486 | 2001, 2007, 2012-2019 | -- | -- |
| Goosefare Brook | 48 | 1984, 1986, 1994, 1998, 2000, 2015 | 1995, 2005, 2010 | -- |
| Goosefare Brook | 271 | 2005 | 1995, 1998, 2000, 2015 | 2010 |
| Goosefare Brook | 338 | -- | 1998, 2015 | -- |
| Great Works River | 439 | 2000, 2005, 2010, 2015 | -- | -- |
| Kennebunk River | 270 | 1995, 2000, 2010 | 2005, 2015 | -- |
| Little River | 440 | 2000, 2005, 2010, 2015 | -- | -- |
| Mare Brook | 457 | -- | 1998-2003, 2015 | -- |
| Mare Brook | 1064 | -- | 2015 | -- |
| Mare Brook | 330 | -- | 1997-2003, 2015 | -- |
| Merriland River | 437 | 2000, 2005, 2010 | 2015 | -- |
| Mile Brook | 998 | 2013, 2015 | -- | -- |
| Mousam River | 391 | 1999, 2010, 2015 | -- | -- |
| Mousam River | 390 | 1999, 2010, 2015 | -- | -- |
| Mousam River | 259 | 1995, 1999, 2005, 2010, 2015 | -- | -- |
| Mousam River | 388 | 1999, 2005 | -- | -- |
| Nason's Brook | 638 | -- | 2002, 2003 | -- |

## Table 3.1.4b Past Attainment History (continued)

| Waterbody | Station | Attained Class | Did not Attain Class | Indeterminate Result |
|---|---|---|---|---|
| Phillips Brook | 953 | 2015 | -- | 2010, 2016 |
| Piscataqua River | 758 | 2004, 2015 | -- | -- |
| Piscataqua River | 759 | 2004, 2015 | -- | -- |
| Pleasant River | 394 | 1999, 2005, 2010 | -- | -- |
| Pleasant River | 155 | 1991, 1992, 1999, 2005, 2010 | -- | -- |
| Red Brook | 219 | 2005, 1994 | 1999, 2015 | 2010 |
| Red Brook | 412 | 1999, 2010 | 2015 | -- |
| Salmon Falls River | 52 | 2005, 2010, 2015 | 1984, 1991, 1992, 1995 | -- |
| Sheepscot River | 74 | 1985, 1987, 1988-1990, 1992, 1995, 1996, 1998-2017, 2019 | 1984-1986, 1988, 1991, 1993, 1994, 1997 | -- |
| Tannery Brook | 474 | 2000, 2005 | 2010, 2015 | -- |
| Thacher Brook | 451 | 2000, 2005, 2010 | 2015 | -- |
| Trout Brook | 675 | -- | 2003-2005, 2010, 2015 | -- |
| Trout Brook | 1040 | -- | 2014 | -- |
| W. Branch Sheepscot River | 268 | 1996-1999, 2001, 2002, 2005, 2007, 2009-2017, 2019 | 2000, 2003, 2004, 2006, 2008, 2018 | 1995 |
| West Branch Pleasant River | 286 | 2001 | 1996 | -- |
| West Brook | 797 | 2015 | 2005, 2010 | -- |

## 3.2 FISH CONTAMINANTS

| | |
|---|---|
| PRINCIPAL INVESTIGATOR | Barry Mower |
| TECHNICAL ASSISTANTS | Joseph Glowa<br>Josh Noll |
| SPECIAL THANKS | Jim Stahlnecker |

3.2.1 PFAS in Fish Tissue (requested by Maine Center for Disease Control and Prevention)

*Background*

PerFluoroAlkyl Substances (PFAS) are a large (>5000) class of highly persistent and mobile chemicals composed of fully fluorinated straight or branched carbon chains with different functional groups at one end. Consequently, they may be hydrophilic, hydrophobic, and/or lipophilic. They have many specialized industrial and commercial uses for products that resist heat, stains, water, oil and grease, including hair conditioners, non-stick coatings, wetting agents, insulation, dust repellants, cleaners, anti-static agents, antifogging agents, and fire-fighting foams among others (Qi et al., 2011; Yingling, 2013).

PFAS are continuously emitted into the environment from point and nonpoint sources such as industrial or municipal wastewater treatment plants (WWTPs) and atmospheric deposition, respectively (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. The most commonly detected PFAS are perfluorooctane sulfonate (PFOS) and to a lesser extent perfluorooctanoic acid (PFOA). Beginning in 2002, PFOS has been phased out in the US, Canada, and Europe, but its use has been increasing in China (Yingling, 2013).

PFAS have been found in humans and wildlife all over the world including the artic and deep seas (Yingling, 2013), which suggests atmospheric sources (Houde et al., 2011). They have been correlated with increased cancers, thyroid disease, interference with normal growth and development, and endocrine disruption in humans (Yingling, 2013). There are also reports in the literature of high concentrations in invertebrates, fish, reptiles, and marine mammals worldwide (Houde et al. 2011). Laboratory animal studies on the toxic effects of PFAS (primarily PFOS and PFOA) show various effects on development, reproduction, and immune function of birds, fish, and mammals (Murphy et al., 2012 as cited by Stahl et al. 2014).

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). Bioaccumulation of PFOS is considered similar to that of a moderately lipophilic substance (Houde et al., 2011). Bioaccumulation is higher in some tissues than others (liver>kidneys>whole blood>gill>carcass) but bioaccumulation factors in the carcass range up to ~2400 (Sharpe et al., 2010). PFC concentrations have been reported as high as 1900 ng/g wet wt. (Houde et al., 2011). Adverse effects in fish are not well known, but mortality, decreased fecundity, and histopathological alterations have been reported (Ahrens and Bundschuh, 2014; Sharpe et al. 2010).

MeCDC derived human health risk-based screening levels for PFOS and PFOA in 2014, updated them in 2016 following new toxicological data published by EPA, and modified them again in 2018 for development of Remedial Action Guidelines (RAGs) for cleanup of hazardous waste sites in Maine. RAGS were developed for exposures to soil, sediment, groundwater, surface water, and for the ingestion of fish. In 2019 MECDC updated its fish tissue action levels (FTAL =34.1 ug/kg for protection of sensitive populations, 79.0 ug/kg for protection of the general population) using some different factors for use in evaluating the need for Fish Consumption Advisories.

In a Maine study of streams near Loring Air Force Base (LAFB), where fire-fighting foams have been used, DEP found brook trout to have concentrations of PFOS ranging from 41-1080 ng/g wet wt. in exposed sites, all of which exceed MECDC’s FTAL for sensitive populations. Concentrations of PFOS in some brook trout (0-43 ng/g) exceeded the FTAL at a reference site (Akladiss, 2014).

In 2014, to gather data from more reference sites and from other species, DEP collected six to ten brook trout, smallmouth bass, and brown bullhead from each of three lakes or ponds, which receive no direct discharges of pollutants. Fish were combined into two composites of three to five fish each and analyzed for a suite of PFAS. Results showed that concentrations of most PFAS were undetected. PFOS and perfluoroundecanoate were the most commonly detected, at four and five of nine sites respectively. Both compounds were detected at one or two of the three sites for all three species. PFOS concentrations (1-4.7 ng/g) were well below MECDC’s FTAL and the concentrations found near LAFB. The magnitude of detected concentrations was no greater in the benthic omnivorous species brown bullhead (BBH) than in the pelagic predators brook trout (BKT) and smallmouth bass (SMB).

High levels of PFAS have been found in surface waters near wastewater treatment plants and urban centers (Zushi et al. 2012 as cited in Stahl et al. 2014). In U.S. Environmental Protection Agency's (EPA's) 2008–2009 National Rivers and Streams Assessment (NRSA) and the Great Lakes Human Health Fish Tissue Study component of the 2010 EPA National Coastal Condition Assessment, analyses of PFAS in fish from randomly selected locations in the US (164 urban river sites and 157 nearshore Great Lake sites) showed that PFOS dominated in frequency of occurrence, followed by three other longer-chain PFAS (perfluorodecanoic acid, perfluoroundecanoic acid, and perfluorododecanoic acid) (Stahl et al. 2014). Maximum PFOS concentrations were 127 and 80 ng/g in urban river samples and Great Lakes samples, respectively.

As part of the Maine study, single composite samples of up to 5 fish each from three urban rivers in Maine were analyzed. No PFAS were detected in chain pickerel from the Saco River above Saco, but concentrations of PFOS in smallmouth bass were 16 ng/g in the Androscoggin River at Lisbon and 28 ng/g in the Kennebec River at Waterville. There were a few other PFAS detected at lower concentrations at both sites.

In 2015, in order to more fully assess the occurrence of PFAS in Maine, DEP targeted ten samples of both predator and omnivore fish for collection from five rivers below major municipal wastewater treatment plants (WWTPs). The results show that concentrations of PFAS were low (1 ng/g or less) similar to levels found in fish from lakes and ponds with no discharges in 2014 except for perflourooctane sulfonate (PFOS). PFOS was well below MECDC's FTAL for all samples except for white perch in the Mousam River below Sanford where the mean concentration exceeded the FTAL. The ratio of the WWTP discharge to size of the river is much larger for Sanford than any of the other rivers in this study, which may explain these results.

In 2016, to confirm the elevated level in the Mousam River fish with respect to consumption by anglers, ten white perch and ten bass from Estes Lake were collected and analyzed as two composites of five fish each for PFAS. In addition, given recent detection of PFAS in groundwater nearby, the same species of fish were also to be sampled from stations upstream at Number One Pond in downtown Sanford, a popular fishing spot above the WWTP and at Mousam Lake, the headwater of the Mousam River upstream of Sanford. Results showed that concentrations of PFAS in white perch from Estes Lake were similar to those from 2015 Concentrations of most congeners were undetected. PFOS was the only congener detected at significant levels. Concentrations of PFOS in white perch in the Mousam River below Sanford were similar to those from 2015 exceeding MECDC's FTAL. Concentrations in largemouth bass from the same site were similar to those of the white perch. Concentrations of PFOS were much lower in largemouth bass from Number One Pond in downtown Sanford, and even lower above Sanford at Mousam lake in Acton, well below MECDC's FTAL. The variance between the two composites at each site was small and there was no relationship between fish PFC concentrations and fish size

In 2017, elevated levels of PFAS were found in a Maine municipal water supply well and were traced to biosolids (sludge) from industrial and municipal WWTPs that had been spread on farm field in the watershed. Subsequently, PFAS have been found in biosolids from other WWTPs and in receiving farm fields in Maine.

*Methods*

In 2019 and 2020, following SWAT standard operating procedure for collection and handling to prevent contamination of samples, fish were captured by angling or gill nets from several rivers and streams at popular fishing sites, historic sampling stations above and below industrial and municipal WWTPs, and above and below farms where elevated levels of PFAS have been found in soils treated with biosolids from industrial and or municipal WWTPs (Table 3.2.1). Some sites were resampled from previous years as noted.

The target was 10 fish to be combined into 2 composites of 5 fish each. Upon capture, fish were rinsed in site water and stored in a clean garbage bag on ice until transfer to the DEP. At the lab the fish were immediately measured and weighed for length and weight, rinsed in tap water, wrapped in new aluminum foil (shiny side out), labelled with site and species codes and date, aggregated by site and species in new garbage bags, and frozen. After all fish were collected, they were shipped overnight to the lab, SGS AXYS in British Columbia, Canada, for analyses.

Immediately after capture, fish were euthanized and stored in a clean plastic garbage bag on ice until transported back to the lab where they were weighed and measured, rinsed in tap water, wrapped in aluminum foil (shiny side out), labeled and placed in a clean garbage bag in the freezer. After all fish were collected, they were shipped frozen overnight to SGS AXYS in British Columbian, Canada for analysis. All fish were analyzed as skinless filets for several PFAS compounds.

| Table 3.2.1. 2019-2020 PFAS fish samples | | | | |
|---|---|---|---|---|
| | | | | |
| YEAR/WATER | Location | CODE | SPECIES | COMMENT |
| **2019** | | | | |
| Androscoggin R | Rumford Point | ARP | SMB, RBT | below NH paper mill, WWTPS, and farms, SMB =smallmouth bass, RBT= rainbow trout |
| | Rumford | ARF | SMB | below Rumford pulp/paper mill and Rumford-Mexico WWTP |
| | Jay | ARY | SMB | above Riley Dam, below farms |
| | Livermore | ALV | SMB | below Jay pulp/paper mill |
| | Auburn | AGI | SMB | Gulf Island Pond, below farms |
| | Lisbon | ALS | SMB | below Lewiston-Auburn WWTP |
| | | | | |
| Halfmoon Str | Knox | HMK | BKT | above farm, BKT= brook trout |
| | Thorndike | HMT | BKT | below farm |
| | | | | |
| Kennebec R | Madison | KMD | SMB, WHS | above Madison, WHS= white sucker |
| | Norridgewock | KNW | SMB | below Anson Madison WWTP |
| | Skowhegan | KSK | SMB | below Weston dam near Skowhegan WWTP |
| | Fairfield | KFF | SMB, WHS | below Shawmut Dam and Hinkley pulp/paper mill |
| | Sidney | KSD | SMB, WCF | below Waterville WWTP at Sidney boat ramp, WCF= white catfish |
| | Gardiner | KGD | SMB, WCF | below Augusta WWTP |
| | | | | |
| Kennebunk R | Days Mill, Arundel | KND | BKT, EEL | above farm, EEL= American eel |
| | Rt 1 Arundel | KNA | BNT, EEL | below farm |
| | | | | |
| **2020** | | | | |
| China L | China | China L | SMB, WHP | public water supply, history of PFAS |
| | | | | |
| Mousam R | Mousam L - Acton | Mousam L | LMB | Mousam River headwaters, this site and next two repeat sampling from 2016 |
| | Number One Pond- Sanford | No. 1 P | LMB | Mousam River in downtown Sanford, below historical mills |
| | Estes L- Sanford | Estes L | LMB, WHP | Mousam River impounded lake, below Sanford WWTP |
| | | | | |
| Halfmoon Str | Knox | HMK | BKT | above farm, repeat from 2019 |
| | Thorndike | HMT | BKT | below farm, repeat from 2019 |
| | | | | |
| Kenduskeag Str | Kenduskeag | KRK | SMB | below farms |
| | | | | |
| Penobscot R | E Br Grindstone | PBG | SMB | East Branch, background |
| | Medway | PBW | SMB | Mattaseunk Impoundment, below former pulp/paper mills and current WWTP |
| | Lincoln | PBL | SMB | below former Lincoln pulp/paper mill and Lincoln WWTP at boat ramp |
| | Veazie | PBV | SMB | below Old Town pulp/paper mill and mumicipal WWTPs |
| | | | | |
| Preumpscot R | Windham | PWD | SMB | above Westbrook |
| | Westbrook | PWB | SMB | below Westbrook paper mill and Westbrook WWTP |
| | | | | |
| St Croix R | Woodland | SCW | SMB | Woodland impoundment above pulp/paper mill |
| | Baring | SCB | SMB | River below pulp/paper mill and Baileyville WWTP |
| | | | | |
| Salmon Falls R | Great East Lake | Great East L | LMB | Salmon Falls River headwaters |
| | South Berwick | SFS | LMB | Salmon Falls River below municipal WWTPs |
| | | | | |

*Results and Discussion*
In 2019, the target of 10 fish at each site was achieved for most of the sites; exceptions were 1 large rainbow trout (hatchery brood fish) from the Androscoggin River at Rumford Point (ARP), 2 composites from 8 smallmouth bass at Androscoggin River below Rumford (ARF), 2 composites from 9 smallmouth bass from the Kennebec River above Madison, (KMD), 1 large stocked and one composite of 2 wild brook trout, and 1 large eel from the Kennebunk River at Days Mill above the farm (KND), and composites of 2 brown trout and 9 small eel from the Kennebunk River below the farm at Rt 1 (KNA).

Results show that PFOS was the compound detected most often and at the highest level, with lower amounts of PFOSA, PFDoDA, and PFUnA (Appendix 1). Concentrations of PFOS were well below MeCDC's FTAL (34.1 ng/g) for all samples but were elevated below industrial sources on the Androscoggin River (at Livermore (ALV), downstream in Gulf Island Pond in Auburn (AGI), and Lisbon (ALS) and Kennebec River at Fairfield (KFF), downstream in Sidney (KSD), and Gardiner (KGD) (Figures 3.2.1 and 3.2.2). PFOS levels were relatively low but elevated below the farm in Knox on Halfmoon Stream in Thorndike (HMT) (Figure 3.2.3). Both brook trout and brown trout are stocked by the Department of Inland Fisheries and Wildlife into the Kennebunk River in April and May. Both the brown trout at KNA and the largest brook trout at KND are believed to be stocked fish but had been in the river until caught in September and October, and therefore were exposed to any PFAS in the river for several months. Nevertheless, concentrations cannot be compared across species and therefore between these 2 sites based on trout. American eel were caught at both sites, but were a composite of small eels at KNA and 1 large eel at KND, making any comparison weak (Figure 3.2.4). The Kennebunk River will be resampled to try to collect the same species and size at both sites to facilitate comparison.

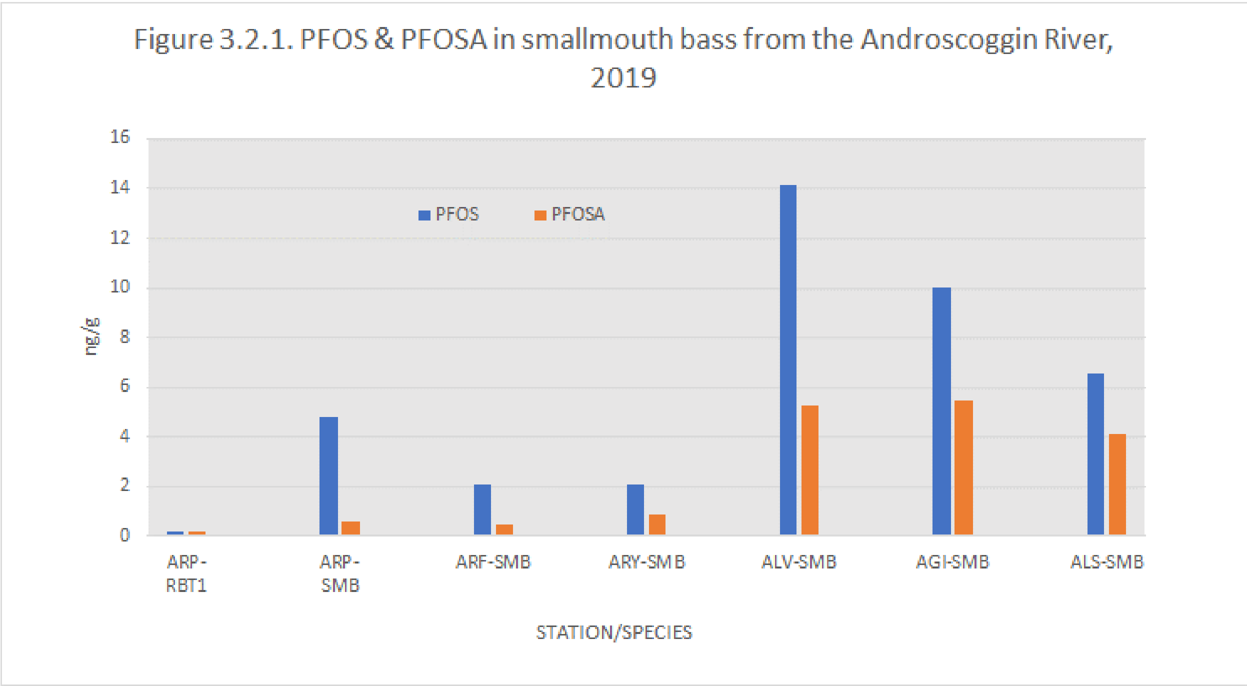


Figure 3.2.1. PFOS & PFOSA in smallmouth bass from the Androscoggin River, 2019
16
14
12
10
8
6
4
2
0
ng/g
PFOS
PFOSA
ARP-RBT1
ARP-SMB
ARF-SMB
ARY-SMB
ALV-SMB
AGI-SMB
ALS-SMB
STATION/SPECIES

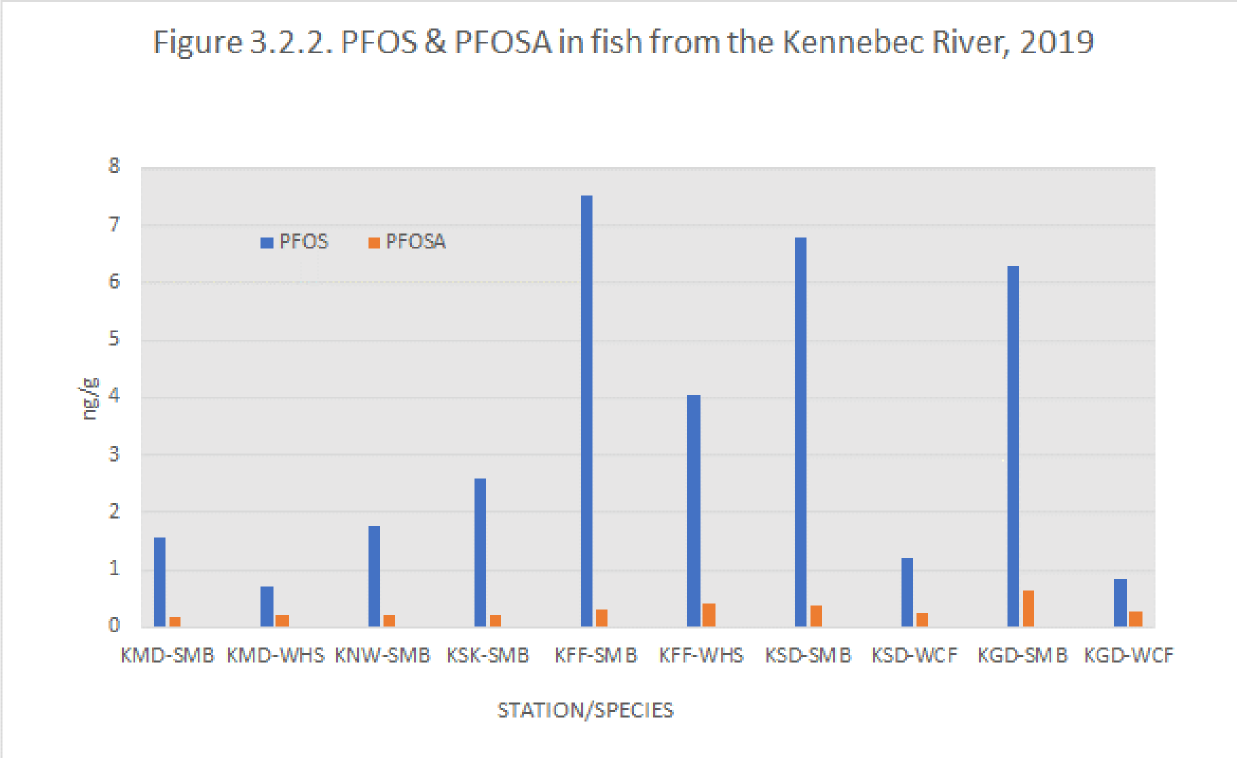


Figure 3.2.2. PFOS & PFOSA in fish from the Kennebec River, 2019
PFOS
PFOSA
ng/g
8
7
6
5
4
3
2
1
0
KMD-SMB
KMD-WHS
KNW-SMB
KSK-SMB
KFF-SMB
KFF-WHS
KSD-SMB
KSD-WCF
KGD-SMB
KGD-WCF
STATION/SPECIES

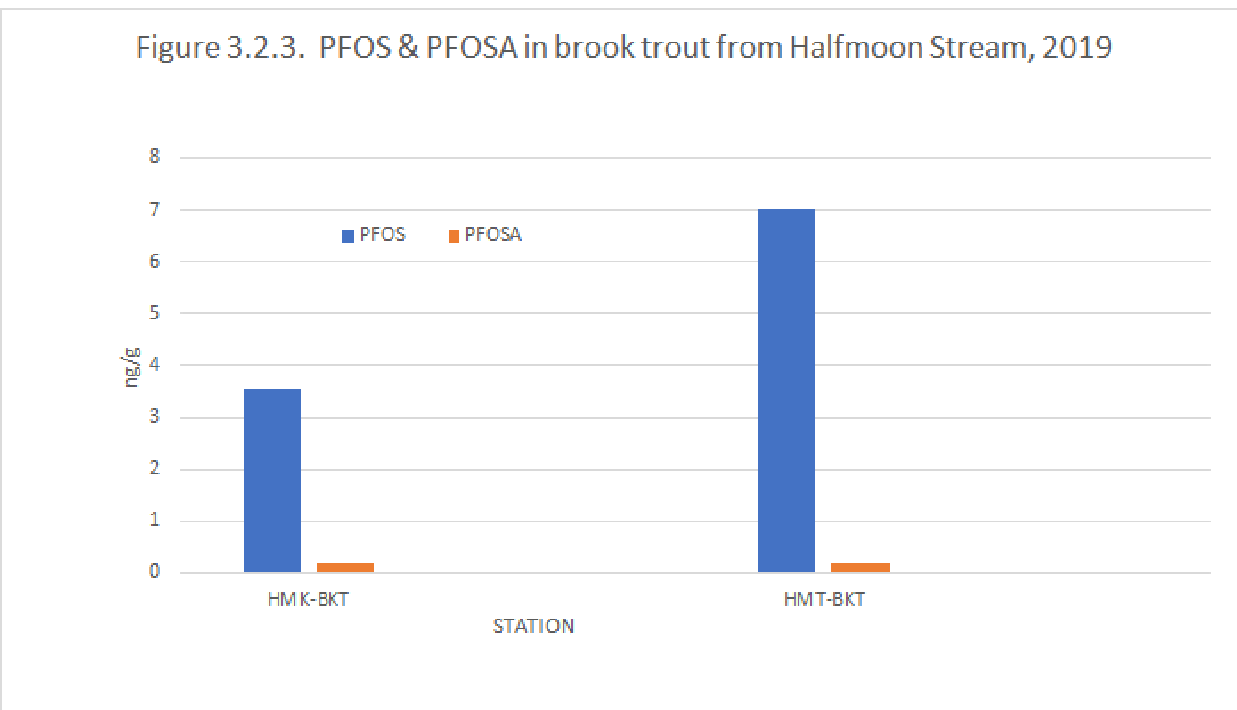
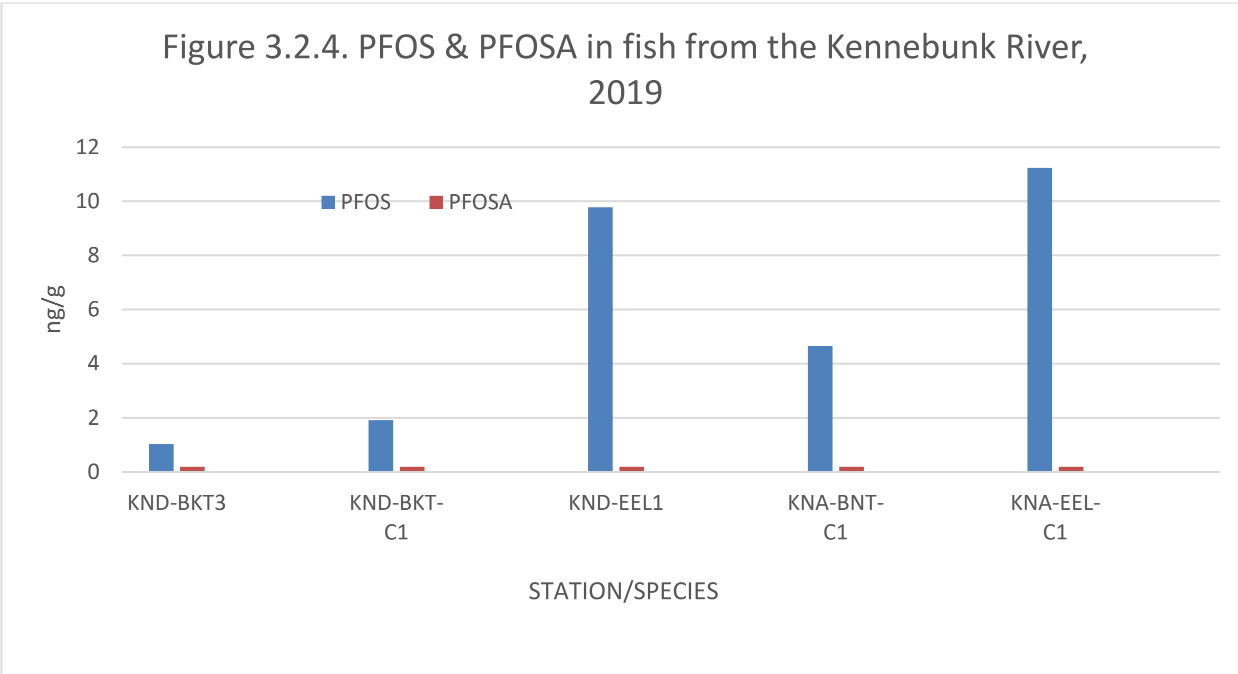


Figure 3.2.3. PFOS & PFOSA in brook trout from Halfmoon Stream, 2019
PFOS
PFOSA
ng/g
8
7
6
5
4
3
2
1
0
HMK-BKT
HMT-BKT
STATION




In 2020, the target of 10 fish from each site was achieved except for Great East Lake and the Salmon Falls River where only 9 largemouth bass were sent to the lab, and the Kennebunk River where no fish were captured due to sampling restrictions because of Covid-19. As in previous years, the results showed that PFOS was the most commonly measured compound, with insignificant amounts of PFUnA and others (Appendix 1). Concentrations were elevated below some farms and industrial and municipal discharges but remained below MeCDC's FTAL (34.1 ng/g), while exceeding the FTAL below other industrial and municipal discharges as noted below.

As in 2016, PFOS increased from a barely detectable amount in largemouth bass from the headwaters of the Mousam River at Mousam Lake, to elevated levels still below the FTAL in largemouth bass at Number One Pond in Downtown Sanford, and elevated levels above the FTAL in both largemouth bass and white perch from the Mousam River at Estes Lake below the Sanford WWTP (Figure 3.2.5). Concentrations were also elevated in both smallmouth bass and white perch from China Lake, although well below the FTAL. PFAS compounds have been found in China Lake, which is the source of drinking water for several towns, but sources are unknown.

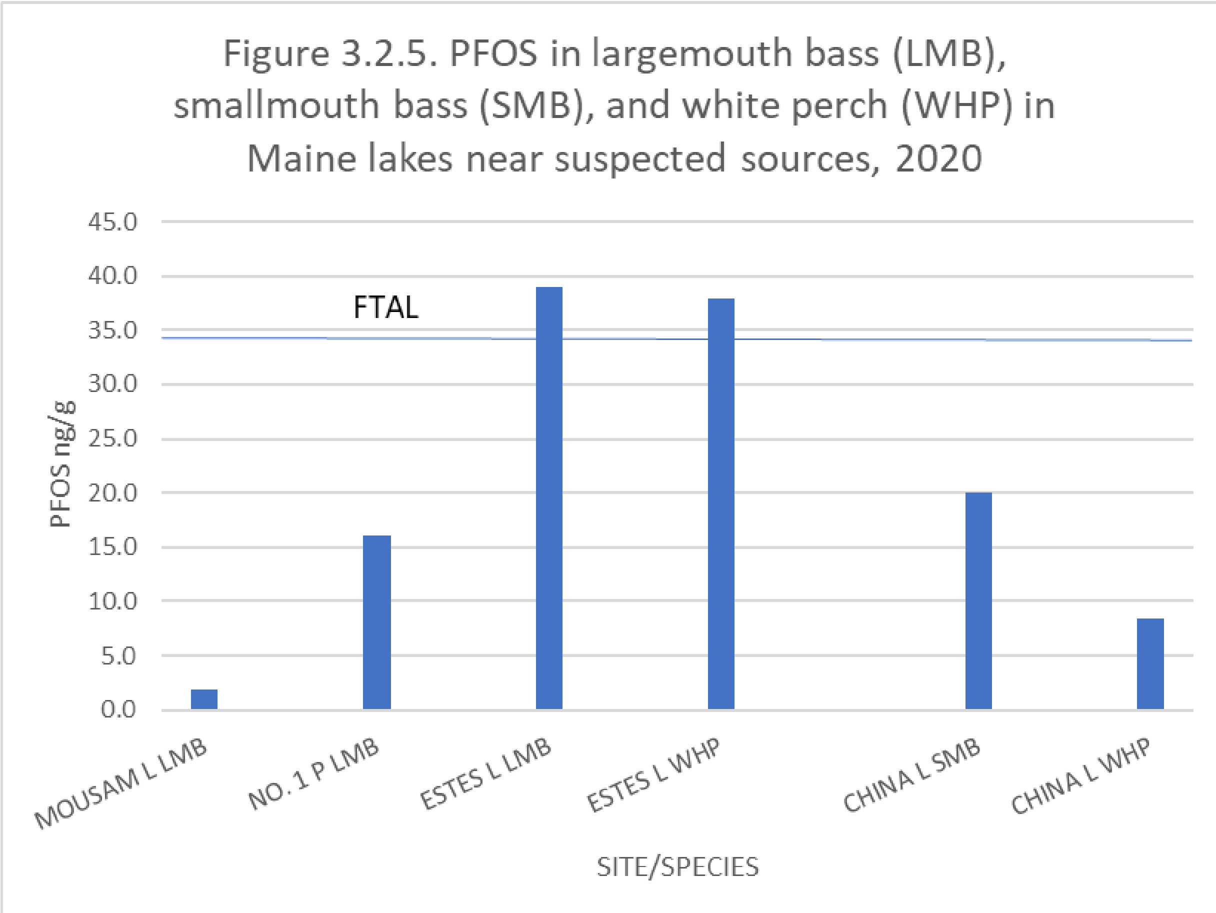
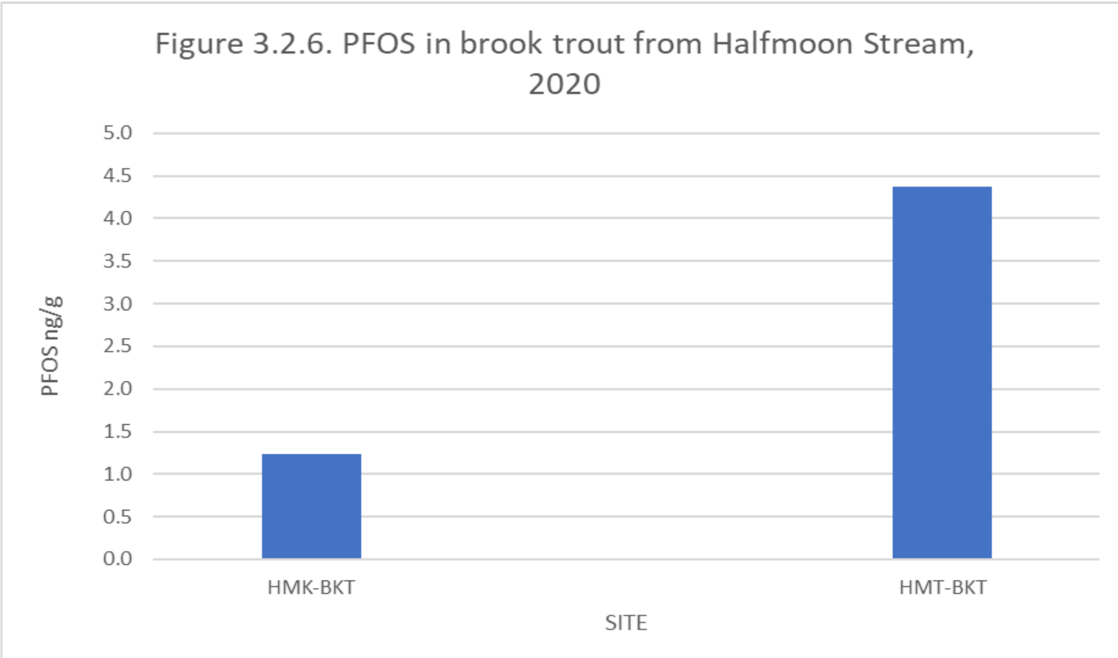
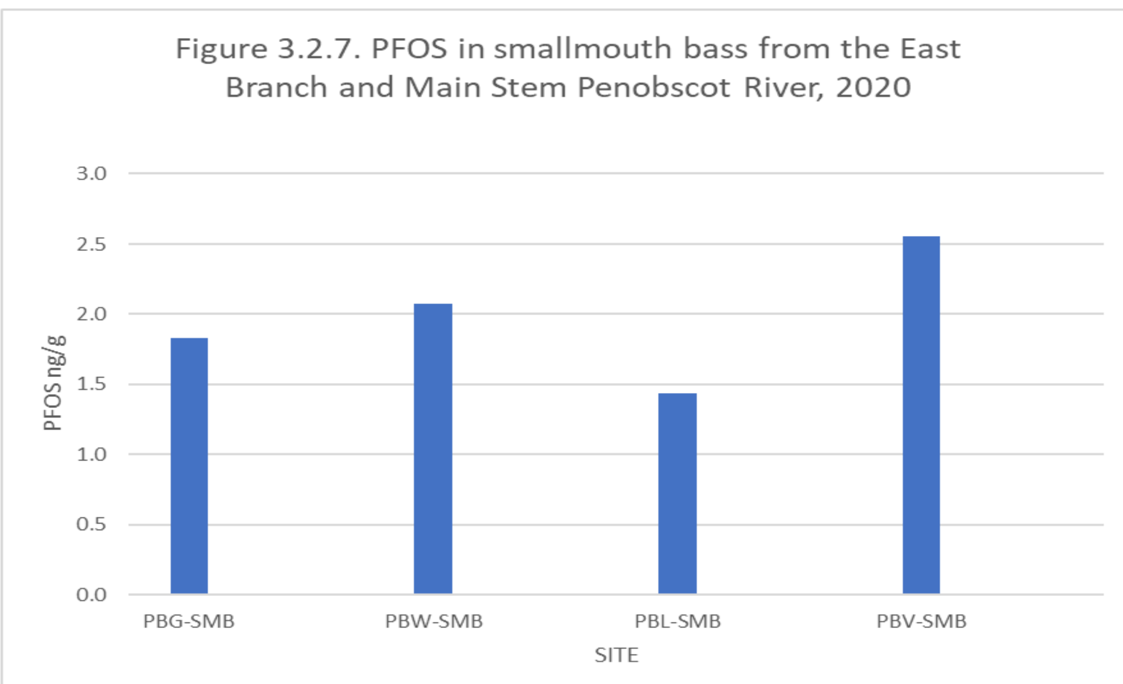


Figure 3.2.5. PFOS in largemouth bass (LMB), smallmouth bass (SMB), and white perch (WHP) in Maine lakes near suspected sources, 2020
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
PFOS ng/g
FTAL
MOUSAM L LMB
NO. 1 P LMB
ESTES L LMB
ESTES L WHP
CHINA L SMB
CHINA L WHP
SITE/SPECIES

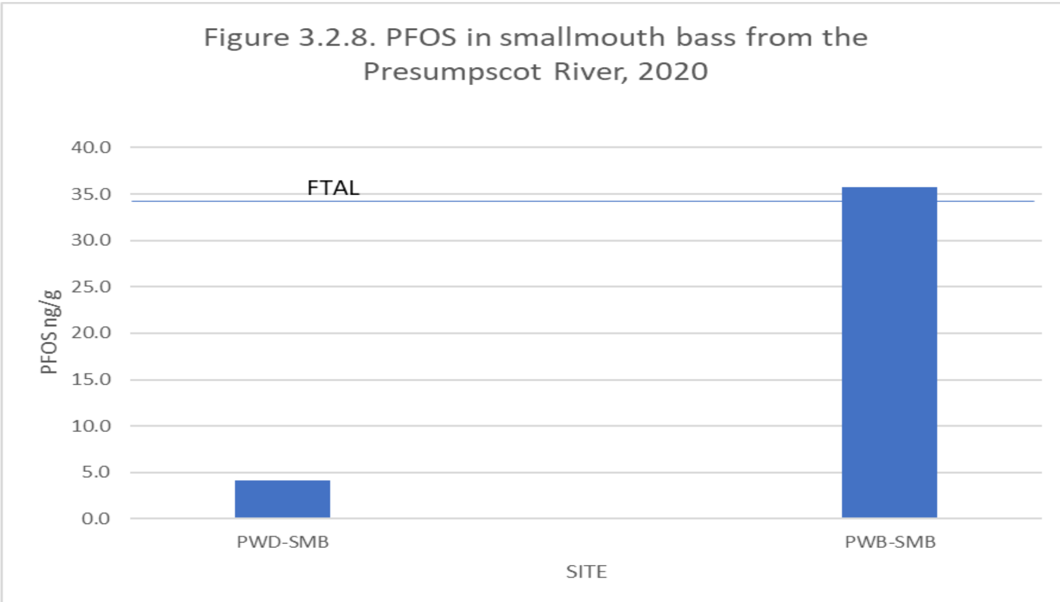
Levels of PFOS in brook trout from Halfmoon Stream were very low above the farm in Knox but elevated below the farm in Thorndike at levels slightly lower those in 2019, and well below the FTAL (Figure 3.2.6).



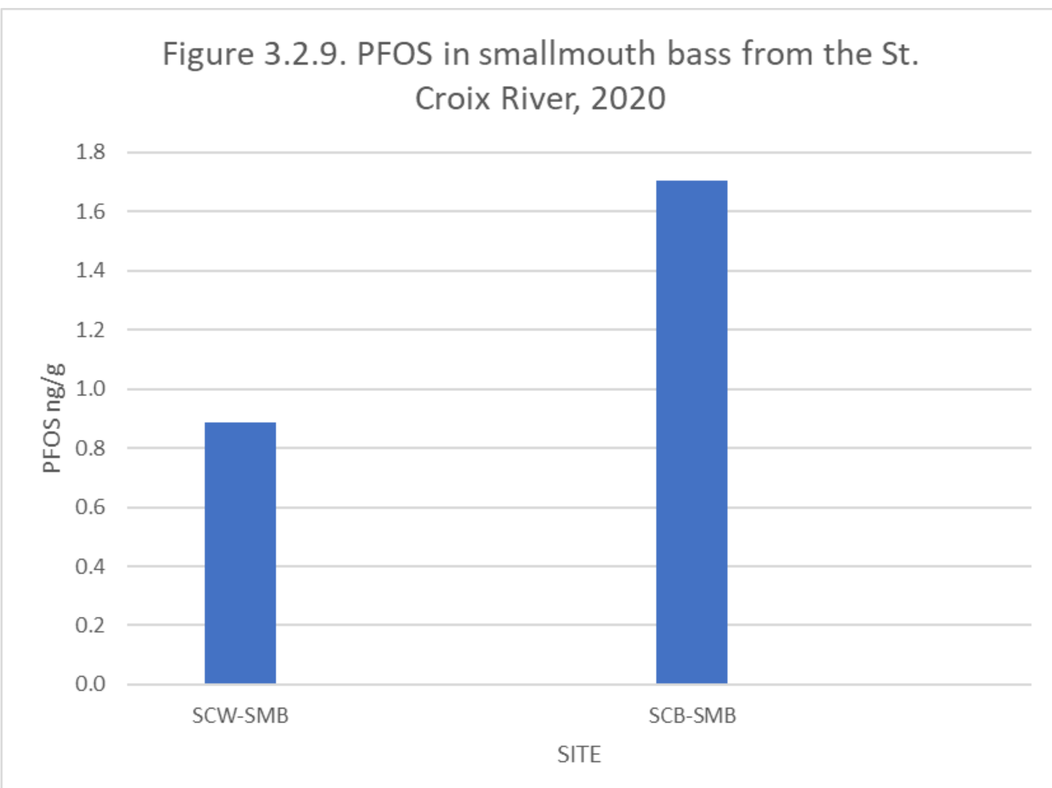

Levels of PFOS in smallmouth bass from the Penobscot River were all near background levels as shown by the East Branch levels (PBG) where there are no known sources (Figure 3.2.7).



Levels of PFOS in smallmouth bass were insignificant at Windham but elevated above the FTAL below the mill and WWTP in Westbrook (Figure 3.2.8).




Levels of PFOS in smallmouth bass at both sites on the St. Croix River were near background levels (Figure 3.2.9).



Levels of PFOS were near background levels  in largemouth bass in the headwaters of the Salmon Falls River at Great East Lake, but elevated in the river below at South Berwick below several WWTPs, although still below the FTAL (Figure 3.2.10).   Levels of PFOS were also elevated in smallmouth bass from the Kenduskeag River in Kenduskeag below several farms, but well below the FTAL.

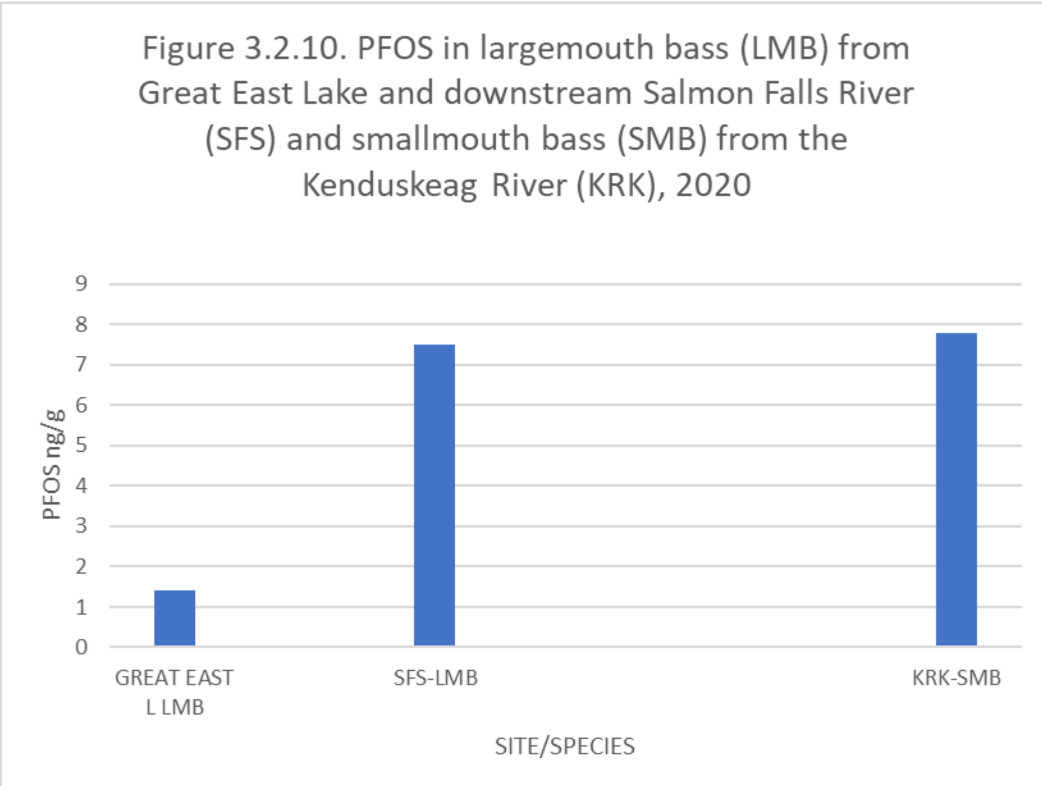
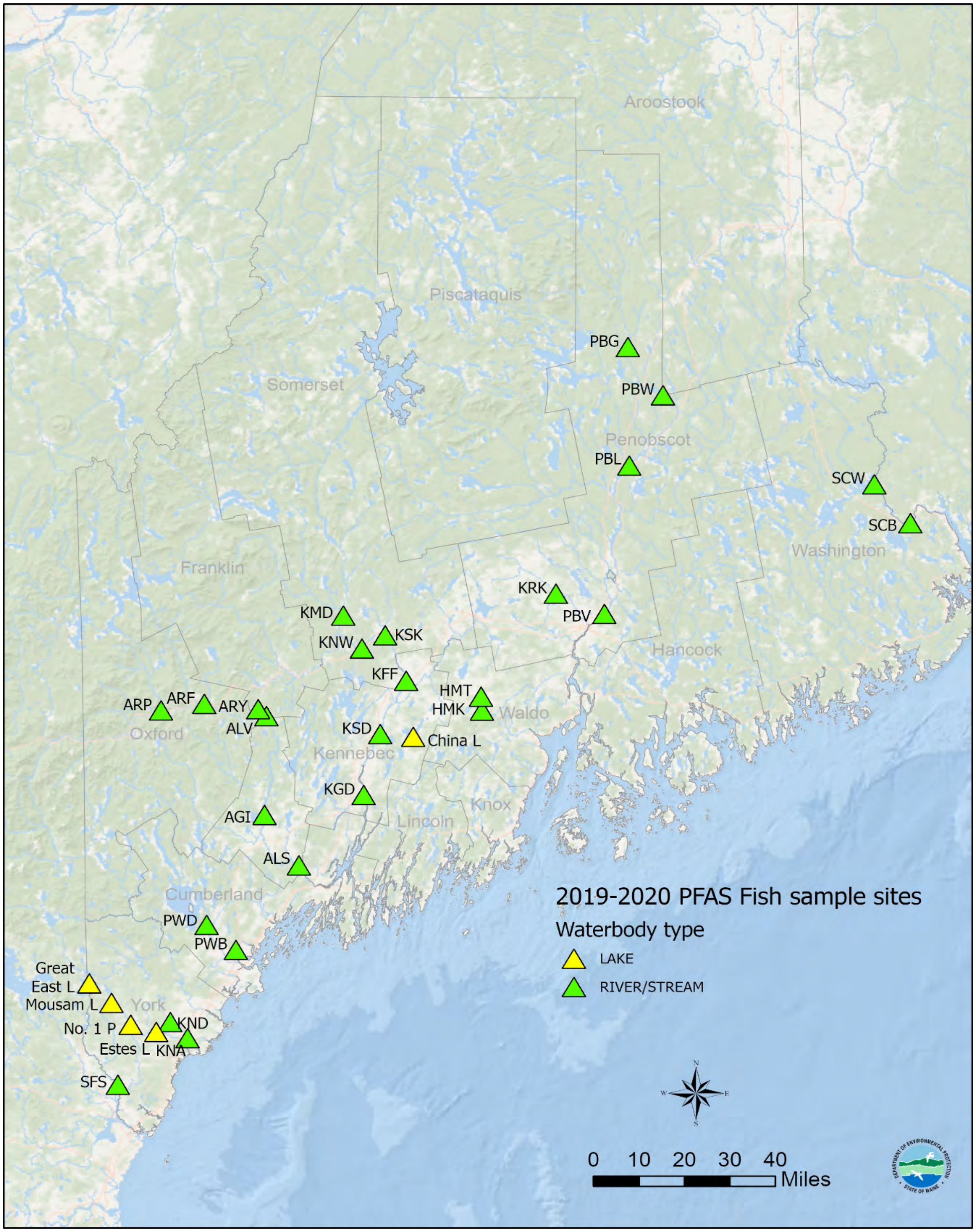


Figure 3.2.11. PFAS Fish Sample Sites



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| Appendix 1. PFAS in fish from Maine rivers and streams, 2019 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| DEP Sample ID | | ARP-RBT1 | | ARP-SMB | | ARF-SMB | | ARY-SMB | | ALV-SMB | | AGI-SMB | | ALS-SMB | |
| PERFLUOROBUTANE SULFONATE | NG/G | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | 0.19 | U |
| PERFLUOROBUTANOATE | NG/G | 0.78 | U | 0.76 | U | 0.74 | U | 0.74 | U | 0.79 | U | 0.78 | U | 0.76 | U |
| PERFLUORODECANOATE | NG/G | 0.20 | U | 0.19 | U | 0.15 | | 0.19 | U | 0.66 | | 0.41 | | 0.39 | |
| PERFLUORODODECANOATE | NG/G | 0.20 | U | 0.20 | | 0.34 | | 0.32 | | 1.86 | | 1.27 | | 1.04 | |
| PERFLUOROHEPTANOATE | NG/G | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | 0.19 | U |
| PERFLUOROHEXANE SULFONATE | NG/G | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | 0.19 | U |
| PERFLUOROHEXANOATE | NG/G | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | 0.19 | U |
| PERFLUORONONANOATE | NG/G | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | 0.19 | U |
| PERFLUOROOCTANE SULFONATE | NG/G | 0.20 | U | 4.77 | | 2.10 | | 2.11 | | 14.16 | | 9.98 | | 6.55 | |
| PERFLUOROOCTANE SULFONAMIDE | NG/G | 0.20 | U | 0.63 | | 0.45 | | 0.88 | | 5.28 | | 5.50 | | 4.10 | |
| PERFLUOROOCTANOATE | NG/G | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | 0.19 | U |
| PERFLUOROPENTANOATE | NG/G | 0.39 | U | 0.38 | U | 0.37 | U | 0.37 | U | 0.39 | U | 0.39 | U | 0.38 | U |
| PERFLUOROUNDECANOATE | NG/G | 0.20 | U | 0.58 | | 0.78 | | 0.64 | | 1.48 | | 0.86 | | 0.81 | |
| | | | | | | | | | | | | | | | |
| DEP Sample ID | | KMD-SMB | | KMD-WHS | | KNW-SMB | | KSK-SMB | | KFF-SMB | | KFF-WHS | | | |
| PERFLUOROBUTANE SULFONATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | | |
| PERFLUOROBUTANOATE | NG/G | 0.76 | U | 0.77 | U | 0.79 | U | 0.78 | U | 0.74 | U | 0.76 | U | | |
| PERFLUORODECANOATE | NG/G | 0.20 | U | 0.17 | | 0.26 | | 0.44 | | 0.66 | | 0.60 | | | |
| PERFLUORODODECANOATE | NG/G | 0.35 | | 0.19 | U | 0.25 | U | 0.38 | | 0.62 | | 0.33 | | | |
| PERFLUOROHEPTANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | | |
| PERFLUOROHEXANE SULFONATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | | |
| PERFLUOROHEXANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.19 | U | 0.19 | U | | |
| PERFLUORONONANOATE | NG/G | 0.19 | U | 0.22 | U | 0.20 | U | 0.19 | U | 0.19 | U | 0.40 | | | |
| PERFLUOROOCTANE SULFONATE | NG/G | 1.56 | | 0.70 | | 1.77 | | 2.58 | | 7.53 | | 4.06 | | | |
| PERFLUOROOCTANE SULFONAMIDE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.22 | | 0.31 | | 0.40 | | | |
| PERFLUOROOCTANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.19 | U | 0.17 | | | |
| PERFLUOROPENTANOATE | NG/G | 0.38 | U | 0.39 | U | 0.40 | U | 0.39 | U | 0.37 | U | 0.38 | U | | |
| PERFLUOROUNDECANOATE | NG/G | 0.91 | | 0.50 | | 0.70 | | 1.04 | | 1.15 | | 0.61 | | | |

| Appendix 1. PFAS in fish from Maine rivers and streams, 2019 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| DEP Sample ID | | KSD-SMB | | KSD-WCF | | KGD-SMB | | KGD-WCF | | | | HMK-BKT | | HMT-BKT | |
| PERFLUOROBUTANE SULFONATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | | | 0.19 | U | 0.20 | U |
| PERFLUOROBUTANOATE | NG/G | 0.78 | U | 0.76 | U | 0.79 | U | 0.78 | U | | | 0.78 | U | 0.78 | U |
| PERFLUORODECANOATE | NG/G | 0.71 | | 0.19 | U | 0.74 | | 0.20 | U | | | 0.19 | | 1.01 | |
| PERFLUORODODECANOATE | NG/G | 0.46 | | 0.21 | | 0.57 | J | 0.15 | J | | | 0.19 | U | 0.40 | |
| PERFLUOROHEPTANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | | | 0.30 | | 1.65 | |
| PERFLUOROHEXANE SULFONATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | | | 0.30 | | 0.49 | |
| PERFLUOROHEXANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | | | 0.19 | U | 0.54 | EMPC |
| PERFLUORONONANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | | | 0.53 | | 1.85 | |
| PERFLUOROOCTANE SULFONATE | NG/G | 6.79 | | 1.19 | | 6.30 | | 0.84 | | | | 3.54 | | 7.01 | |
| PERFLUOROOCTANE SULFONAMIDE | NG/G | 0.36 | | 0.25 | U | 0.63 | | 0.26 | | | | 0.19 | U | 0.20 | U |
| PERFLUOROOCTANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.20 | U | | | 0.85 | | 3.64 | |
| PERFLUOROPENTANOATE | NG/G | 0.39 | U | 0.38 | U | 0.39 | U | 0.39 | U | | | 0.39 | U | 0.39 | U |
| PERFLUOROUNDECANOATE | NG/G | 1.03 | | 0.33 | | 1.17 | | 0.28 | | | | 0.41 | | 0.53 | J |
| | | | | | | | | | | | | | | | |
| DEP Sample ID | | KND-BKT3 | | KND-BKT-C1( | | KND-EEL1 | | KNA-BNT-C1 | | KNA-EEL-C1(1,2,3,4,5,6,7,8,9) | | | | | |
| PERFLUOROBUTANE SULFONATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.20 | U | | | | |
| PERFLUOROBUTANOATE | NG/G | 0.76 | U | 0.77 | U | 0.79 | U | 0.77 | U | 0.78 | U | | | | |
| PERFLUORODECANOATE | NG/G | 0.19 | U | 0.19 | U | 0.72 | | 0.19 | U | 0.67 | | | | | |
| PERFLUORODODECANOATE | NG/G | 0.19 | U | 0.19 | U | 0.62 | | 0.19 | U | 0.56 | | | | | |
| PERFLUOROHEPTANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.20 | U | | | | |
| PERFLUOROHEXANE SULFONATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.20 | U | | | | |
| PERFLUOROHEXANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.20 | U | | | | |
| PERFLUORONONANOATE | NG/G | 0.19 | U | 0.19 | U | 0.25 | | 0.19 | U | 0.38 | | | | | |
| PERFLUOROOCTANE SULFONATE | NG/G | 1.03 | | 1.91 | | 9.78 | | 4.66 | | 11.23 | | | | | |
| PERFLUOROOCTANE SULFONAMIDE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.20 | U | | | | |
| PERFLUOROOCTANOATE | NG/G | 0.19 | U | 0.19 | U | 0.20 | U | 0.19 | U | 0.20 | U | | | | |
| PERFLUOROPENTANOATE | NG/G | 0.38 | U | 0.39 | U | 0.39 | U | 0.39 | U | 0.39 | U | | | | |
| PERFLUOROUNDECANOATE | NG/G | 0.19 | U | 0.40 | | 1.90 | | 0.19 | U | 1.23 | | | | | |
| | | | | | | | | | | | | | | | |

Appendix 1. PFAS in fish from Maine rivers, streams, lakes, & ponds, 2020

| SITE | MOUSAM L | | NO 1 P | | ESTES L | | ESTES L | |
|---|---|---|---|---|---|---|---|---|
| DEP Sample ID | LK3838-LMB | | LK3848-LMB | | LK0007-LMB | | LK0007-WHP | |
| Weight Basis: WET ng/g | MEAN | | MEAN | | MEAN | | MEAN | |
| PERFLUOROBUTANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROBUTANOATE | 0.4 | U | 0.4 | U | 0.4 | U | 0.4 | U |
| PERFLUORODECANOATE | 0.4 | | 0.4 | | 0.6 | | 0.6 | |
| PERFLUORODODECANOATE | 1.3 | | 0.8 | | 0.6 | | 0.7 | |
| PERFLUOROHEPTANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANE SULFONATE | 0.1 | U | 0.1 | | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUORONONANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | |
| PERFLUOROOCTANE SULFONATE | 1.8 | | 16.0 | | 38.9 | | 38.0 | |
| PERFLUOROOCTANE SULFONAMIDE | 0.1 | U | 0.1 | U | 0.1 | B | 0.2 | B |
| PERFLUOROOCTANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROPENTANOATE | 0.2 | U | 0.2 | U | 0.2 | U | 0.2 | U |
| PERFLUOROUNDECANOATE | 1.1 | | 0.8 | | 0.8 | | 0.8 | |
| SITE | CHINA L | | CHINA L | | HALFMOON ST | | HALFMOON ST | |
| DEP Sample ID | LK5448-SMB | | LK5448-WHP | | HMK-BKT | | HMT-BKT | |
| Weight Basis: WET ng/g | MEAN | | MEAN | | MEAN | | MEAN | |
| PERFLUOROBUTANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROBUTANOATE | 0.4 | U | 0.4 | U | 0.4 | U | 0.5 | |
| PERFLUORODECANOATE | 2.8 | | 1.1 | | 0.1 | | 0.6 | |
| PERFLUORODODECANOATE | 1.1 | | 0.5 | | 0.1 | U | 0.3 | |
| PERFLUOROHEPTANOATE | 0.1 | U | 0.1 | U | 0.3 | | 1.0 | |
| PERFLUOROHEXANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.2 | |
| PERFLUOROHEXANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.2 | |
| PERFLUORONONANOATE | 0.1 | U | 0.3 | | 0.5 | | 1.1 | |
| PERFLUOROOCTANE SULFONATE | 20.0 | | 8.4 | | 1.2 | | 4.4 | |
| PERFLUOROOCTANE SULFONAMIDE | 0.3 | B | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROOCTANOATE | 0.1 | U | 0.1 | U | 0.4 | | 2.4 | |
| PERFLUOROPENTANOATE | 0.2 | U | 0.2 | U | 0.2 | U | 0.2 | U |
| PERFLUOROUNDECANOATE | 4.6 | | 1.7 | | 0.2 | | 0.3 | |

| SITE<br>DEP Sample ID<br>Weight Basis: WET ng/g | E BR PENOBSCOT R<br>PBG-SMB<br>MEAN | | PENOBSCOT R<br>PBW-SMB<br>MEAN | | PENOBSCOT R<br>PBL-SMB<br>MEAN | | PENOBSCOT R<br>PBV-SMB<br>MEAN | |
|---|---|---|---|---|---|---|---|---|
| PERFLUOROBUTANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROBUTANOATE | 0.4 | U | 0.4 | U | 0.4 | U | 0.4 | U |
| PERFLUORODECANOATE | 0.3 | | 0.4 | | 0.2 | | 0.3 | |
| PERFLUORODODECANOATE | 0.3 | | 0.3 | | 0.3 | | 0.3 | |
| PERFLUOROHEPTANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUORONONANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROOCTANE SULFONATE | 1.8 | | 2.1 | B | 1.4 | B | 2.6 | B |
| PERFLUOROOCTANE SULFONAMIDE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | B |
| PERFLUOROOCTANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROPENTANOATE | 0.2 | U | 0.2 | U | 0.2 | U | 0.2 | U |
| PERFLUOROUNDECANOATE | 0.9 | | 0.8 | B | 0.7 | B | 0.7 | B |

| SITE<br>DEP Sample ID<br>Weight Basis: WET ng/g | KENDUSKEAG R<br>KRK-SMB<br>MEAN | | ST CROIX R<br>SCW-SMB<br>MEAN | | ST CROIX R<br>SCB-SMB<br>MEAN | |
|---|---|---|---|---|---|---|
| PERFLUOROBUTANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROBUTANOATE | 0.4 | U | 0.4 | U | 0.4 | U |
| PERFLUORODECANOATE | 0.9 | | 0.2 | | 0.2 | |
| PERFLUORODODECANOATE | 0.8 | | 0.3 | | 0.2 | |
| PERFLUOROHEPTANOATE | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANOATE | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUORONONANOATE | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROOCTANE SULFONATE | 7.8 | | 0.9 | B | 1.7 | B |
| PERFLUOROOCTANE SULFONAMIDE | 0.2 | B | 0.1 | U | 0.1 | B |
| PERFLUOROOCTANOATE | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROPENTANOATE | 0.2 | U | 0.2 | U | 0.2 | U |
| PERFLUOROUNDECANOATE | 1.1 | | 0.7 | B | 0.7 | B |

| SITE<br>DEP Sample ID<br>Weight Basis: WET ng/g | PRESUMPSCOT R<br>PWD-SMB<br>MEAN | | PRESUMPSCOT R<br>PWB-SMB<br>MEAN | | GREAT EAST L<br>LK3922-LMB<br>MEAN | | SALMON FALLS R<br>SFS-LMB<br>MEAN | |
|---|---|---|---|---|---|---|---|---|
| PERFLUOROBUTANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROBUTANOATE | 0.4 | U | 0.4 | U | 0.4 | U | 0.4 | U |
| PERFLUORODECANOATE | 0.5 | | 1.0 | | 0.5 | | 0.5 | |
| PERFLUORODODECANOATE | 1.1 | | 1.6 | | 1.1 | | 0.6 | |
| PERFLUOROHEPTANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANE SULFONATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROHEXANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUORONONANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROOCTANE SULFONATE | 4.2 | B | 35.7 | B | 1.4 | B | 7.5 | B |
| PERFLUOROOCTANE SULFONAMIDE | 0.1 | B | 1.4 | B | 0.1 | U | 0.1 | U |
| PERFLUOROOCTANOATE | 0.1 | U | 0.1 | U | 0.1 | U | 0.1 | U |
| PERFLUOROPENTANOATE | 0.2 | U | 0.2 | U | 0.2 | U | 0.2 | U |
| PERFLUOROUNDECANOATE | 1.4 | B | 1.5 | B | 1.2 | B | 0.6 | B |

| Appendix 2. SWAT fish sample date, lengths and weights 2019 | DATE | L | W | N |
|---|---|---|---|---|
| FIELD ID | SAMPLED | mm | g | |
| | | | | |
| **ANDROSCOGGIN RIVER** | | | | |
| **RUMFORD POINT** | | | | |
| ARP-SMB1 | 7/16/2019 | 416 | 929 | 2C5 |
| ARP-SMB2 | 7/16/2019 | 346 | 566 | |
| ARP-SMB3 | 7/16/2019 | 320 | 464 | |
| ARP-SMB4 | 7/16/2019 | 290 | 347 | |
| ARP-SMB5 | 7/16/2019 | 316 | 476 | |
| ARP-SMB6 | 8/16/2019 | 350 | 556 | |
| ARP-SMB7 | 8/16/2019 | 354 | 571 | |
| ARP-SMB8 | 8/16/2019 | 334 | 489 | |
| ARP-SMB9 | 8/16/2019 | 326 | 458 | |
| ARP-SMB10 | 8/16/2019 | 305 | 347 | |
| | | | | |
| ARP-RBT1 | 7/16/2019 | 528 | 1794 | 1 |
| | | | | |
| **RUMFORD (Dixfield)** | | | | |
| ARF-SMB1 | 7/15/2019 | 468 | 1425 | 2C4 |
| ARF-SMB2 | 7/15/2019 | 400 | 963 | |
| ARF-SMB3 | 7/15/2019 | 400 | 1380 | |
| ARF-SMB4 | 7/15/2019 | 352 | 594 | |
| ARF-SMB5 | 7/15/2019 | 282 | 341 | |
| ARF-SMB6 | 7/15/2019 | 394 | 898 | |
| ARF-SMB7 | 7/15/2019 | 316 | 452 | |
| ARF-SMB8 | 7/15/2019 | 386 | 800 | |
| | | | | |
| **RILEY** | | | | |
| ARY-SMB1 | 8/24/2019 | 420 | 966 | 2C5 |
| ARY-SMB2 | 8/24/2019 | 434 | 1247 | |
| ARY-SMB3 | 8/24/2019 | 320 | 369 | |
| ARY-SMB4 | 8/25/2019 | 346 | 582 | |
| ARY-SMB5 | 8/25/2019 | 396 | 721 | |
| ARY-SMB6 | 8/25/2019 | 416 | 990 | |
| ARY-SMB7 | 8/25/2019 | 462 | 1430 | |
| ARY-SMB8 | 8/25/2019 | 320 | 466 | |
| ARY-SMB9 | 8/25/2019 | 474 | 1305 | |
| ARY-SMB10 | 8/25/2019 | 494 | 1619 | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **LIVERMORE** | | | | |
| ALV-SMB1 | 8/26/2019 | 466 | 1207 | 2C5 |
| ALV-SMB2 | 8/26/2019 | 420 | 904 | |
| ALV-SMB3 | 8/26/2019 | 410 | 1004 | |
| ALV-SMB4 | 8/26/2019 | 384 | 664 | |
| ALV-SMB5 | 8/26/2019 | 420 | 767 | |
| ALV-SMB6 | 8/26/2019 | 404 | 695 | |
| ALV-SMB7 | 8/26/2019 | 362 | 483 | |
| ALV-SMB8 | 8/26/2019 | 326 | 464 | |
| ALV-SMB9 | 8/26/2019 | 306 | 371 | |
| ALV-SMB10 | 8/26/2019 | 314 | 349 | |
| | | | | |
| **AUBURN GULF ISLAND POND** | | | | |
| AGI-SMB1 | 7/31/2019 | 334 | 483 | 2CX |
| AGI-SMB2 | 7/31/2019 | 397 | 362 | |
| AGI-SMB3 | 7/31/2019 | 292 | 340 | |
| AGI-SMB4 | 7/31/2019 | 294 | 308 | |
| AGI-SMB5 | 8/4/2019 | 282 | 323 | |
| AGI-SMB6 | 8/4/2019 | 364 | 662 | |
| AGI-SMB7 | 8/20/2019 | 290 | 307 | |
| AGI-SMB8 | 8/20/2019 | 394 | 857 | |
| AGI-SMB9 | 8/20/2019 | 430 | 1216 | |
| AGI-SMB10 | 8/20/2019 | | | |
| | | | | |
| **LISBON** | | | | |
| ALS-SMB1 | 7/19/2019 | 402 | 737 | 2C5 |
| ALS-SMB2 | 7/19/2019 | 350 | 550 | |
| ALS-SMB3 | 7/19/2019 | 348 | 515 | |
| ALS-SMB4 | 7/19/2019 | 350 | 488 | |
| ALS-SMB5 | 7/19/2019 | 412 | 888 | |
| ALS-SMB6 | 7/19/2019 | 394 | 860 | |
| ALS-SMB7 | 7/19/2019 | 392 | 726 | |
| ALS-SMB8 | 8/20/2019 | 467 | 1155 | |
| ALS-SMB9 | 8/20/2019 | 400 | 737 | |
| ALS-SMB10 | 8/20/2019 | 320 | 462 | |
| | | | | |
| | | | | |
| KENNEBEC RIVER | | | | |
| | | | | |
| **ANSON= KMD Madison in EGAD** | | | | |
| KAN-SMB1 | 6/14/2019 | 310 | 372 | 2CX |

| | | | | |
|---|---|---|---|---|
| KAN-SMB2 | 7/12/2019 | 434 | 1048 | |
| KAN-SMB3 | 7/12/2019 | 406 | 884 | |
| KAN-SMB4 | 8/1/2019 | 298 | 359 | |
| KAN-SMB5 | 8/1/2019 | 286 | 274 | |
| KAN-SMB6 | 8/1/2019 | 274 | 294 | |
| KAN-SMB7 | 8/1/2019 | 280 | 279 | |
| KAN-SMB8 | 8/1/2019 | 276 | 300 | |
| KAN-SMB9 | 8/1/2019 | 310 | 435 | |
| | | | | |
| KAN-WHS1 | 6/14/2019 | 430 | 937 | 2C5 |
| KAN-WHS2 | 6/14/2019 | 470 | 1020 | |
| KAN-WHS3 | 6/18/2019 | 506 | 1361 | |
| KAN-WHS4 | 6/18/2019 | 462 | 1066 | |
| KAN-WHS5 | 6/18/2019 | 480 | 1113 | |
| KAN-WHS6 | 6/18/2019 | 478 | 1041 | |
| KAN-WHS7 | 6/18/2019 | 436 | 954 | |
| KAN-WHS8 | 6/18/2019 | 474 | 1150 | |
| KAN-WHS9 | 6/18/2019 | 452 | 943 | |
| KAN-WHS10 | 6/18/2019 | 440 | 1057 | |
| | | | | |
| | | | | |
| **NORRIDGEWOCK** | | | | |
| KNW-SMB1 | 6/18/2019 | 384 | 654 | 2C4 |
| KNW-SMB2 | 6/20/2019 | 352 | 593 | |
| KNW-SMB3 | 6/20/2019 | 320 | 431 | |
| KNW-SMB4 | 6/21/2019 | 310 | 342 | |
| KNW-SMB5 | 7/11/2019 | 296 | 293 | |
| KNW-SMB6 | 7/11/2019 | 348 | 436 | |
| KNW-SMB7 | 8/1/2019 | 330 | 424 | |
| KNW-SMB8 | 8/1/2019 | 298 | 351 | |
| KNW-SMB9 | | | | |
| KNW-SMB10 | | | | |
| | | | | |
| **SKOWHEGAN** | | | | |
| KSK-SMB-1 | 6/24/2019 | 330 | 409 | 2C5 |
| KSK-SMB-2 | 6/24/2019 | 276 | 261 | |
| KSK-SMB-3 | 6/24/2019 | 316 | 370 | |
| KSK-SMB-4 | 6/24/2019 | 492 | 1622 | |
| KSK-SMB-5 | 6/24/2019 | 358 | 600 | |
| KSK-SMB-6 | 6/24/2019 | 332 | 421 | |
| KSK-SMB-7 | 6/24/2019 | 440 | 1024 | |

| | | | | |
|---|---|---|---|---|
| KSK-SMB-8 | 6/24/2019 | 300 | 350 | |
| KSK-SMB-9 | 6/24/2019 | 302 | 325 | |
| KSK-SMB-10 | 6/24/2019 | 326 | 400 | |
| | | | | |
| **FAIRFIELD** | | | | |
| KFF-SMB1 | 7/8/2019 | 348 | 477 | 2C5 |
| KFF-SMB2 | 7/8/2019 | 330 | 413 | |
| KFF-SMB3 | 7/8/2019 | 364 | 601 | |
| KFF-SMB4 | 7/8/2019 | 400 | 662 | |
| KFF-SMB5 | 7/8/2019 | 390 | 648 | |
| KFF-SMB6 | 7/8/2019 | 385 | 769 | |
| KFF-SMB7 | 7/8/2019 | 394 | 690 | |
| KFF-SMB8 | 7/8/2019 | 430 | 1118 | |
| KFF-SMB9 | 7/8/2019 | 426 | 1189 | |
| KFF-SMB10 | 7/8/2019 | 402 | 814 | |
| | | | | |
| KFF-WHS1 | 7/8/2019 | 428 | 1006 | 2C5 |
| KFF-WHS2 | 7/8/2019 | 432 | 1030 | |
| KFF-WHS3 | 7/8/2019 | 519 | 1603 | |
| KFF-WHS4 | 7/9/2019 | 470 | 1218 | |
| KFF-WHS5 | 7/9/2019 | 486 | 1375 | |
| KFF-WHS6 | 7/9/2019 | 448 | 1026 | |
| KFF-WHS7 | 7/9/2019 | 512 | 1513 | |
| KFF-WHS8 | 7/9/2019 | 420 | 1022 | |
| KFF-WHS9 | 7/9/2019 | 430 | 1008 | |
| KFF-WHS10 | 7/9/2019 | 440 | 1041 | |
| | | | | |
| **SIDNEY** | | | | |
| KSD-SMB1 | 7/3/2019 | 300 | 314 | 2C5 |
| KSD-SMB2 | 7/3/2019 | 308 | 323 | |
| KSD-SMB3 | 7/3/2019 | 340 | 470 | |
| KSD-SMB4 | 7/3/2019 | 294 | 316 | |
| KSD-SMB5 | 7/9/2019 | 300 | 320 | |
| KSD-SMB6 | 7/9/2019 | 294 | 288 | |
| KSD-SMB7 | 7/9/2019 | 316 | 333 | |
| KSD-SMB8 | 7/9/2019 | 294 | 295 | |
| KSD-SMB9 | 7/9/2019 | 291 | 281 | |
| KSD-SMB10 | 7/9/2019 | 288 | 275 | |
| | | | | |
| KSD-WCF1 | 7/9/2019 | 360 | 618 | 2C5 |
| KSD-WCF2 | 7/9/2019 | 381 | 697 | |

| | | | | |
|---|---|---|---|---|
| KSD-WCF3 | 7/9/2019 | 440 | 1231 | |
| KSD-WCF4 | 7/9/2019 | 390 | 922 | |
| KSD-WCF5 | 7/9/2019 | 392 | 866 | |
| KSD-WCF6 | 7/9/2019 | 354 | 535 | |
| KSD-WCF7 | 7/9/2019 | 370 | 661 | |
| KSD-WCF8 | 7/9/2019 | 354 | 543 | |
| KSD-WCF9 | 7/9/2019 | 350 | 506 | |
| KSD-WCF10 | 7/9/2019 | 330 | 478 | |
| | | | | |
| **Gardiner =KGD in EGAD** | | | | |
| KRG-SMB1 | 6/11/2019 | 310 | 343 | 2C5 |
| KRG-SMB2 | 6/11/2019 | 294 | 303 | |
| KRG-SMB3 | 6/11/2019 | 300 | 315 | |
| KRG-SMB4 | 6/11/2019 | 284 | 271 | |
| KRG-SMB5 | 6/11/2019 | 308 | 336 | |
| KRG-SMB6 | 6/11/2019 | 312 | 357 | |
| KRG-SMB7 | 6/11/2019 | 304 | 293 | |
| KRG-SMB8 | 6/11/2019 | 316 | 378 | |
| KRG-SMB9 | 6/11/2019 | 299 | 290 | |
| KRG-SMB10 | 6/11/2019 | 267 | 211 | |
| | | | | |
| KRG-WCF1 | 6/11/2019 | 362 | 575 | 2C5 |
| KRG-WCF2 | 6/11/2019 | 386 | 758 | |
| KRG-WCF3 | 6/11/2019 | 375 | 736 | |
| KRG-WCF4 | 6/11/2019 | 300 | 438 | |
| KRG-WCF5 | 6/11/2019 | 348 | 574 | |
| KRG-WCF6 | 6/11/2019 | 350 | 523 | |
| KRG-WCF7 | 6/11/2019 | 322 | 434 | |
| KRG-WCF8 | 6/11/2019 | 360 | 570 | |
| KRG-WCF9 | 6/11/2019 | 320 | 364 | |
| KRG-WCF10 | 6/11/2019 | 318 | 398 | |
| | | | | |
| | | | | |
| **HALFMOON STREAM** | | | | |
| | | | | |
| **KNOX above Larrabee farm = HMK IN EGAD** | | | | |
| HMA-BKT1 | 6/3/2019 | 240 | 146 | 2C5 |
| HMA-BKT2 | 6/3/2019 | 220 | 88 | |
| HMA-BKT3 | 6/3/2019 | 224 | 113 | |
| HMA-BKT4 | 6/3/2019 | 220 | 115 | |
| HMA-BKT5 | 6/3/2019 | 204 | 94 | |

| | | | | |
|---|---|---|---|---|
| HMA-BKT6 | 6/3/2019 | 192 | 72 | |
| HMA-BKT7 | 6/3/2019 | 192 | 78 | |
| HMA-BKT8 | 6/3/2019 | 172 | 51 | |
| HMA-BKT9 | 6/4/2019 | 200 | 82 | |
| HMA-BKT10 | 6/4/2019 | 182 | 60 | |
| | | | | |
| **THORNDIKE below Larrabee farm = HMT in EGAD** | | | | |
| HMB-BKT1 | 5/24/2019 | 232 | 128 | 2C5 |
| HMB-BKT2 | 5/24/2019 | 232 | 132 | |
| HMB-BKT3 | 5/24/2019 | 198 | 83 | |
| HMB-BKT4 | 5/24/2019 | 220 | 104 | |
| HMB-BKT5 | 5/24/2019 | 204 | 84 | |
| HMB-BKT6 | 5/29/2019 | 172 | 54 | |
| HMB-BKT7 | 6/3/2019 | 234 | 164 | |
| HMB-BKT8 | 6/3/2019 | 228 | 135 | |
| HMB-BKT9 | 6/3/2019 | 232 | 138 | |
| HMB-BKT10 | 6/3/2019 | 188 | 47 | |
| | | | | |
| | | | | |
| **KENNEBUNK RIVER** | | | | |
| | | | | |
| **Days Mill above Stone farm = KND in EGAD** | | | | |
| KBRAS-BKT1 | 9/16/2019 | 216 | 116 | 1C2 |
| KBRAS-BKT2 | 9/16/2019 | 186 | 67 | |
| KBRAS-BKT3 | 9/16/2019 | 296 | 279 | 1 |
| KBRAS-EEL1 | 9/16/2019 | 620 | 498 | 1 |
| | | | | |
| **ARUNDEL below Stone farm = KNA in EGAD** | | | | |
| KBRBS-EEL1 | 9/16/2019 | 400 | 117 | 1C9 |
| KBRBS-EEL2 | 9/16/2019 | 495 | 220 | |
| KBRBS-EEL3 | 9/16/2019 | 310 | 61 | |
| KBRBS-EEL4 | 9/16/2019 | 340 | 66 | |
| KBRBS-EEL5 | 9/16/2019 | 290 | 53 | |
| KBRBS-EEL6 | 9/16/2019 | 332 | 66 | |
| KBRBS-EEL7 | 9/16/2019 | 300 | 52 | |
| KBRBS-EEL8 | 9/16/2019 | 275 | 42 | |
| KBRBS-EEL9 | 9/16/2019 | 280 | 43 | |
| | | | | |
| KBRBS-BNT1 | 10/7/2019 | 210 | 89.2 | 1C2 |
| KBRBS-BNT2 | 10/7/2019 | 234 | 108.1 | |

| Appendix 2. SWAT fish sample date, lengths and weights 2020 | | | |
|---|---|---|---|
| SWAT SAMPLES 2020 | DATE | L | W |
| FIELD ID | SAMPLED | mm | g |
| | | | |
| **CHINA LAKE-LK5448** | | | |
| China Lake-LK5448-SWAT-SMB1 | 5/29/2020 | 382 | 755 |
| China Lake-LK5448-SWAT-SMB2 | 5/29/2020 | 384 | 789 |
| China Lake-LK5448-SWAT-SMB3 | 5/29/2020 | 448 | 1091 |
| China Lake-LK5448-SWAT-SMB4 | 5/29/2020 | 442 | 1253 |
| China Lake-LK5448-SWAT-SMB5 | 5/29/2020 | 388 | 756 |
| China Lake-LK5448-SWAT-SMB6 | 5/29/2020 | 324 | 419 |
| China Lake-LK5448-SWAT-SMB7 | 5/29/2020 | 384 | 819 |
| China Lake-LK5448-SWAT-SMB8 | 5/29/2020 | 378 | 677 |
| China Lake-LK5448-SWAT-SMB9 | 5/29/2020 | 330 | 428 |
| China Lake-LK5448-SWAT-SMB10 | 5/29/2020 | 344 | 492 |
| | | | |
| China Lake-LK5448-SWAT-WHP1 | 8/12/2020 | 260 | 207 |
| China Lake-LK5448-SWAT-WHP2 | 8/12/2020 | 240 | 183 |
| China Lake-LK5448-SWAT-WHP3 | 8/12/2020 | 240 | 178 |
| China Lake-LK5448-SWAT-WHP4 | 8/12/2020 | 240 | 163 |
| China Lake-LK5448-SWAT-WHP5 | 8/12/2020 | 248 | 178 |
| China Lake-LK5448-SWAT-WHP6 | 8/12/2020 | 230 | 158 |
| China Lake-LK5448-SWAT-WHP7 | 8/12/2020 | 230 | 155 |
| China Lake-LK5448-SWAT-WHP8 | 8/12/2020 | 232 | 165 |
| China Lake-LK5448-SWAT-WHP9 | 8/12/2020 | 230 | 158 |
| China Lake-LK5448-SWAT-WHP10 | 8/12/2020 | 224 | 134 |
| | | | |
| | | | |
| **MOUSAM LAKE-LK3838** | | | |
| Mousam Lake-LK3838-SWAT-LMB1 | 6/5/2020 | 318 | 382 |
| Mousam Lake-LK3838-SWAT-LMB2 | 6/5/2020 | 323 | 430 |
| Mousam Lake-LK3838-SWAT-LMB3 | 6/5/2020 | 368 | 604 |
| Mousam Lake-LK3838-SWAT-LMB4 | 6/5/2020 | 338 | 524 |
| Mousam Lake-LK3838-SWAT-LMB5 | 6/5/2020 | 366 | 607 |
| Mousam Lake-LK3838-SWAT-LMB6 | 6/5/2020 | 388 | 786 |
| Mousam Lake-LK3838-SWAT-LMB7 | 6/5/2020 | 352 | 584 |
| Mousam Lake-LK3838-SWAT-LMB8 | 6/5/2020 | 360 | 657 |
| Mousam Lake-LK3838-SWAT-LMB9 | 6/5/2020 | 296 | 373 |
| Mousam Lake-LK3838-SWAT-LMB10 | 6/5/2020 | 404 | 832 |

| | | | |
|---|---|---|---|
| **NUMBER ONE POND-LK3848** | | | |
| Number One Pond-LK3848-SWAT-LMB1 | 6/4/2020 | 380 | 820 |
| Number One Pond-LK3848-SWAT-LMB2 | 6/4/2020 | 306 | 396 |
| Number One Pond-LK3848-SWAT-LMB3 | 6/4/2020 | 354 | 655 |
| Number One Pond-LK3848-SWAT-LMB4 | 6/4/2020 | 382 | 777 |
| Number One Pond-LK3848-SWAT-LMB5 | 6/4/2020 | 313 | 457 |
| Number One Pond-LK3848-SWAT-LMB6 | 6/4/2020 | 360 | 659 |
| Number One Pond-LK3848-SWAT-LMB7 | 6/4/2020 | 410 | 948 |
| Number One Pond-LK3848-SWAT-LMB8 | 6/4/2020 | 375 | 780 |
| Number One Pond-LK3848-SWAT-LMB9 | 6/4/2020 | 390 | 836 |
| Number One Pond-LK3848-SWAT-LMB10 | 6/4/2020 | 370 | 754 |
| | | | |
| **ESTES LAKE-LK0007** | | | |
| Estes Lake-LK0007-SWAT-LMB1 | 6/2/2020 | 455 | 1111 |
| Estes Lake-LK0007-SWAT-LMB2 | 6/2/2020 | 460 | 1415 |
| Estes Lake-LK0007-SWAT-LMB3 | 6/2/2020 | 435 | 985 |
| Estes Lake-LK0007-SWAT-LMB4 | 6/2/2020 | 380 | 803 |
| Estes Lake-LK0007-SWAT-LMB5 | 6/2/2020 | 342 | 525 |
| Estes Lake-LK0007-SWAT-LMB6 | 6/2/2020 | 332 | 476 |
| Estes Lake-LK0007-SWAT-LMB7 | 6/2/2020 | 360 | - |
| Estes Lake-LK0007-SWAT-LMB8 | 6/2/2020 | 321 | - |
| Estes Lake-LK0007-SWAT-LMB9 | 6/2/2020 | 317 | - |
| Estes Lake-LK0007-SWAT-LMB10 | 6/2/2020 | 334 | - |
| | | | |
| **ESTES LAKE-LK0007** | | | |
| Estes Lake-LK0007-SWAT-WHP1 | 6/2/2020 | 240 | - |
| Estes Lake-LK0007-SWAT-WHP2 | 6/2/2020 | 262 | - |
| Estes Lake-LK0007-SWAT-WHP3 | 6/2/2020 | 242 | - |
| Estes Lake-LK0007-SWAT-WHP4 | 6/18/2020 | 283 | 268 |
| Estes Lake-LK0007-SWAT-WHP5 | 6/18/2020 | 252 | 211 |
| Estes Lake-LK0007-SWAT-WHP6 | 6/18/2020 | 250 | 195 |
| Estes Lake-LK0007-SWAT-WHP7 | 6/18/2020 | 266 | 240 |
| Estes Lake-LK0007-SWAT-WHP8 | 6/18/2020 | 258 | 218 |
| Estes Lake-LK0007-SWAT-WHP9 | 6/18/2020 | 252 | 200 |
| Estes Lake-LK0007-SWAT-WHP10 | 6/18/2020 | 228 | 161 |
| | | | |
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| | | | |
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|---|---|---|---|
| **HALFMOON STREAM** | | | |
| | | | |
| **KNOX above Larrabee farm = HMK IN EGAD** | | | |
| HMK-BKT1 | 5/7/2020 | 186 | |
| HMK-BKT2 | 5/7/2020 | 177 | |
| HMK-BKT3 | 5/13/2020 | 178 | |
| HMK-BKT4 | 5/13/2020 | 181 | |
| HMK-BKT5 | 5/13/2020 | 197 | |
| HMK-BKT6 | 5/13/2020 | 165 | |
| HMK-BKT7 | 5/13/2020 | 192 | |
| HMK-BKT8 | 5/13/2020 | 192 | |
| HMK-BKT9 | 5/13/2020 | 230 | |
| HMK-BKT10 | 5/20/2020 | 176 | |
| | | | |
| **THORNDIKE below Larrabee farm = HMT in EGAD** | | | |
| HMT-BKT1 | 5/7/2020 | 200 | 68 |
| HMT-BKT2 | 5/7/2020 | 230 | 127 |
| HMT-BKT3 | 5/7/2020 | 212 | 85 |
| HMT-BKT4 | 5/7/2020 | 330 | 373 |
| HMT-BKT5 | 5/7/2020 | 174 | 49 |
| HMT-BKT6 | 5/7/2020 | 210 | 82 |
| HMT-BKT7 | 5/11/2020 | 220 | |
| HMT-BKT8 | 5/13/2020 | 238 | 149 |
| HMT-BKT9 | 5/13/2020 | 253 | 162 |
| HMT-BKT10 | 5/13/2020 | 212 | 97 |
| | | | |
| | | | |
| **KENDUSKEAG STREAM** | | | |
| KRK-SMB1 | 5/12/2020 | 470 | 1087 |
| KRK-SMB2 | 5/12/2020 | 400 | 850 |
| KRK-SMB3 | 5/12/2020 | 402 | 855 |
| KRK-SMB4 | 5/12/2020 | 380 | 779 |
| KRK-SMB5 | 5/12/2020 | 330 | 462 |
| KRK-SMB6 | 5/12/2020 | 420 | 965 |
| KRK-SMB7 | 5/12/2020 | 382 | 807 |
| KRK-SMB8 | 5/12/2020 | 424 | 1030 |
| KRK-SMB9 | 5/13/2020 | 424 | 955 |
| KRK-SMB10 | 5/13/2020 | 406 | 960 |
| | | | |

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|---|---|---|---|
| **PENOBSCOT RIVER** | | | |
| PBG-SMB1 | 7/20/2020 | 368 | 541 |
| PBG-SMB2 | 7/20/2020 | 340 | 586 |
| PBG-SMB3 | 7/20/2020 | 362 | 584 |
| PBG-SMB4 | 7/20/2020 | 426 | 979 |
| PBG-SMB5 | 7/20/2020 | 370 | 633 |
| PBG-SMB6 | 7/20/2020 | 455 | 1135 |
| PBG-SMB7 | 7/20/2020 | 388 | 821 |
| PBG-SMB8 | 7/20/2020 | 440 | 1114 |
| PBG-SMB9 | 7/20/2020 | 360 | 620 |
| PBG-SMB10 | 7/20/2020 | 366 | 577 |
| | | | |
| PBW-SMB1 | 7/15/2020 | 326 | |
| PBW-SMB2 | 7/15/2020 | 346 | |
| PBW-SMB3 | 7/15/2020 | 370 | |
| PBW-SMB4 | 7/15/2020 | 348 | |
| PBW-SMB5 | 7/15/2020 | 340 | |
| PBW-SMB6 | 7/15/2020 | 368 | |
| PBW-SMB7 | 7/15/2020 | 404 | |
| PBW-SMB8 | 7/15/2020 | 368 | |
| PBW-SMB9 | 7/15/2020 | 316 | |
| PBW-SMB10 | 7/15/2020 | 324 | |
| | | | |
| PBL-SMB1 | 6/30/2020 | 390 | 787 |
| PBL-SMB2 | 6/30/2020 | 326 | 495 |
| PBL-SMB3 | 6/30/2020 | 350 | 572 |
| PBL-SMB4 | 6/30/2020 | 374 | 629 |
| PBL-SMB5 | 6/30/2020 | 320 | 444 |
| PBL-SMB6 | 6/30/2020 | 322 | 467 |
| PBL-SMB7 | 6/30/2020 | 322 | 445 |
| PBL-SMB8 | 6/30/2020 | 400 | 914 |
| PBL-SMB9 | 6/30/2020 | 350 | 538 |
| PBL-SMB10 | 6/30/2020 | 318 | 443 |
| | | | |
| PBV-SMB1 | 7/22/2020 | 340 | 452 |
| PBV-SMB2 | 7/22/2020 | 324 | 424 |
| PBV-SMB3 | 7/23/2020 | 348 | 457 |
| PBV-SMB4 | 7/23/2020 | 354 | 534 |
| PBV-SMB5 | 7/23/2020 | 374 | 660 |
| PBV-SMB6 | 7/23/2020 | 342 | 514 |

| | | | |
|---|---|---|---|
| PBV-SMB7 | 7/23/2020 | 346 | 556 |
| PBV-SMB8 | 7/28/2020 | 316 | 498 |
| PBV-SMB9 | 7/28/2020 | 324 | 426 |
| PBV-SMB10 | 7/28/2020 | 360 | 574 |
| | | | |
| | | | |
| **ST CROIX RIVER** | | | |
| | | | |
| SCW-SMB1 | 7/21/2020 | 410 | 920 |
| SCW-SMB2 | 7/21/2020 | 328 | 471 |
| SCW-SMB3 | 7/21/2020 | 356 | 569 |
| SCW-SMB4 | 7/21/2020 | 330 | 489 |
| SCW-SMB5 | 7/21/2020 | 310 | 430 |
| SCW-SMB6 | 7/21/2020 | 392 | 776 |
| SCW-SMB7 | 7/21/2020 | 374 | 699 |
| SCW-SMB8 | 7/21/2020 | 410 | 915 |
| SCW-SMB9 | 7/21/2020 | 310 | 402 |
| SCW-SMB10 | 7/21/2020 | 344 | 519 |
| | | | |
| SCB-SMB1 | 7/30/2020 | 380 | 731 |
| SCB-SMB2 | 7/30/2020 | 388 | 803 |
| SCB-SMB3 | 7/30/2020 | 335 | 488 |
| SCB-SMB4 | 7/30/2020 | 360 | 606 |
| SCB-SMB5 | 7/30/2020 | 368 | 648 |
| SCB-SMB6 | 7/30/2020 | 356 | 607 |
| SCB-SMB7 | 7/30/2020 | 320 | 439 |
| SCB-SMB8 | 7/30/2020 | 348 | 502 |
| SCB-SMB9 | 7/30/2020 | 318 | 417 |
| SCB-SMB10 | 7/30/2020 | 332 | 451 |
| | | | |
| | | | |
| **PRESUMPSCOT RIVER** | | | |
| | | | |
| **WINDHAM** | | | |
| PWD-SMB1 | 6/29/2020 | 420 | 1083 |
| PWD-SMB2 | 6/29/2020 | 310 | 336 |
| PWD-SMB3 | 6/29/2020 | 326 | 390 |
| PWD-SMB4 | 6/29/2020 | 288 | 310 |
| PWD-SMB5 | 6/29/2020 | 290 | 287 |
| PWD-SMB6 | 6/29/2020 | 290 | 314 |
| PWD-SMB7 | 6/29/2020 | 302 | 309 |

| | | | |
|---|---|---|---|
| PWD-SMB8 | 6/29/2020 | 298 | 315 |
| PWD-SMB9 | 6/29/2020 | 286 | 245 |
| PWD-SMB10 | 6/29/2020 | 254 | 207 |
| | | | |
| **WESTBROOK** | | | |
| PWB-SMB1 | 7/6/2020 | 277 | 223 |
| PWB-SMB2 | 7/6/2020 | 264 | 223 |
| PWB-SMB3 | 7/10/2020 | 306 | 369 |
| PWB-SMB4 | 7/10/2020 | 290 | 305 |
| PWB-SMB5 | 7/10/2020 | 305 | 363 |
| PWB-SMB6 | 7/10/2020 | 382 | 760 |
| PWB-SMB7 | 7/10/2020 | 314 | 373 |
| PWB-SMB8 | 7/11/2020 | 306 | 323 |
| PWB-SMB9 | 7/11/2020 | 380 | 647 |
| PWB-SMB10 | 7/11/2020 | 330 | 448 |
| | | | |
| | | | |
| **GREAT EAST LAKE-LK3922** | | | |
| Great East Lake-LK3922-SWAT-LMB1 | 6/24/2020 | 350 | 679 |
| Great East Lake-LK3922-SWAT-LMB2 | 6/24/2020 | 358 | 695 |
| Great East Lake-LK3922-SWAT-LMB3 | 6/24/2020 | 380 | 696 |
| Great East Lake-LK3922-SWAT-LMB4 | 6/24/2020 | 326 | 498 |
| Great East Lake-LK3922-SWAT-LMB5 | 6/24/2020 | 374 | 317 |
| Great East Lake-LK3922-SWAT-LMB6 | 6/24/2020 | 284 | 356 |
| Great East Lake-LK3922-SWAT-LMB7 | 6/24/2020 | 338 | 531 |
| Great East Lake-LK3922-SWAT-LMB8 | 6/24/2020 | 308 | 427 |
| Great East Lake-LK3922-SWAT-LMB10 | 6/24/2020 | 347 | |
| Great East Lake-LK3922-SWAT-LMB9 | 6/24/2020 | 406 | 979 |
| | | | |
| **SALMON FALLS RIVER at SOUTH BERWICK** | | | |
| SFS-LMB1 | 6/17/2020 | 316 | 469 |
| SFS-LMB2 | 6/17/2020 | 330 | 513 |
| SFS-LMB3 | 6/23/2020 | 400 | 850 |
| SFS-LMB4 | 6/23/2020 | 320 | 510 |
| SFS-LMB5 | 6/23/2020 | 318 | 415 |
| SFS-LMB6 | 6/25/2020 | 346 | 563 |
| SFS-LMB8 | 6/25/2020 | 310 | 422 |
| SFS-LMB9 | 6/25/2020 | 330 | 392 |
| SFS-LMB10 | 6/25/2020 | 334 | |
| SFS-LMB7 | 6/25/2020 | 302 | 408 |