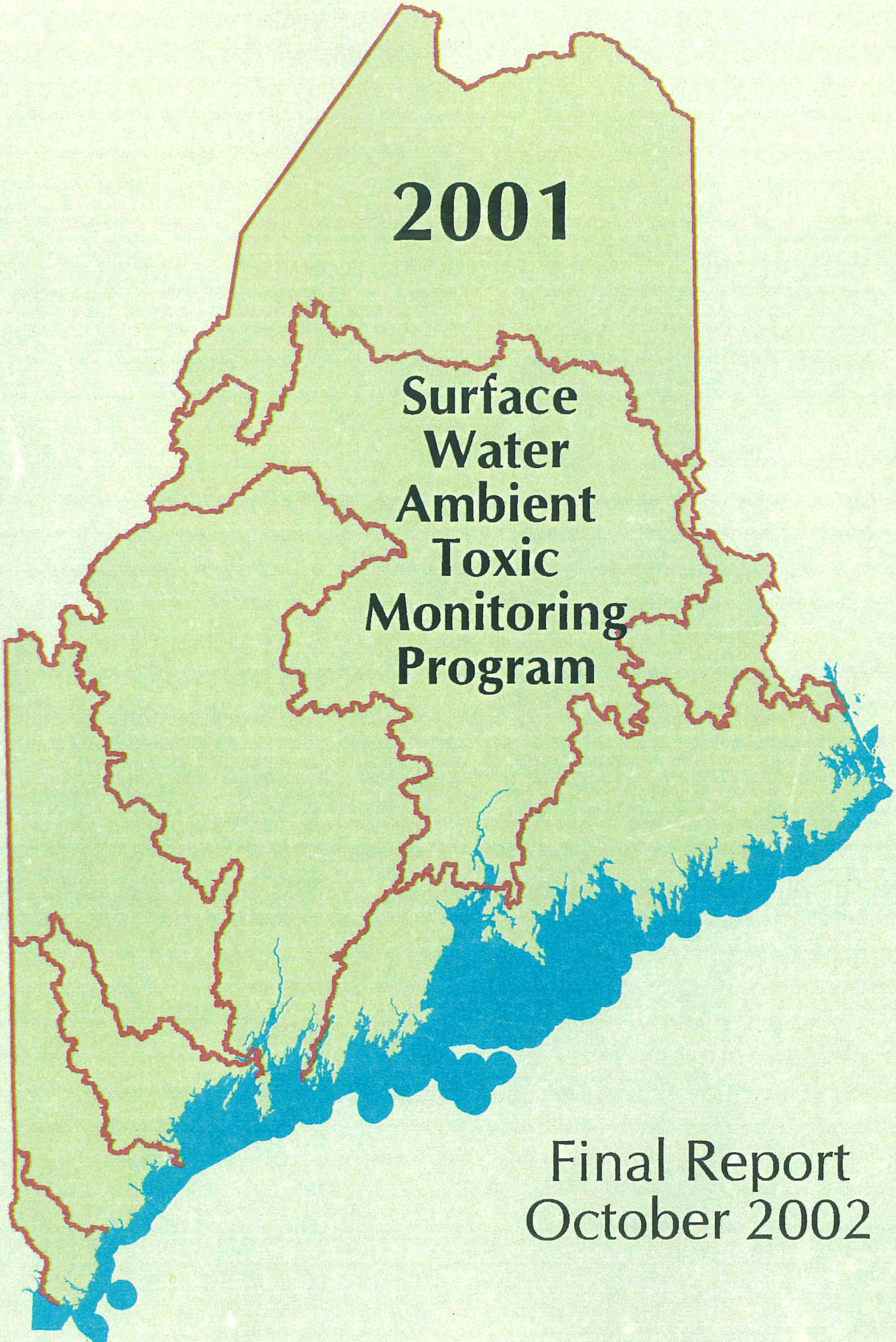
2001

Surface Water Ambient Toxic Monitoring Program



Final Report
October 2002

DEPLW0546

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

ANGUS S. KING, JR.
GOVERNOR

MARTHA KIRKPATRICK
COMMISSIONER

December 16, 2002

The Honorable John Martin
The Honorable Scott Cowger
Joint Standing Committee on Natural Resources
Room 437 State House
Augusta, Maine 04333

Dear Senator Martin, Representative Cowger and Members of the Committee:

The Department of Environmental Protection has completed the final report for the 2001 Surface Water Ambient Toxic (SWAT) monitoring program. The document includes data for mercury and other metals, PCBs and pesticides in fish, shellfish, loons and other birds, rainwater and sediment. It also includes biological community assessment and data on atmospheric deposition of mercury at four locations in Maine.

Enclosed are copies of the Executive Summary, Introduction and Table of Contents. Since the report itself largely consists of data tables, we have not printed 400-page copies for individual distribution. You can access in its entirely at http://www.state.me.us/dep/blwq/monitoring.htm. However, if you prefer, we can send you a printout upon request.

We regret the delay in getting this report to you. Unfortunately, the University of Maine Environmental Chemistry Lab, which prepares the data for us, underwent a significant reorganization during 2001. The lab was unable to produce what we needed until spring 2002. Once we received the material, we were able to produce a draft report for the SWAT Technical Advisory Group. This final report reflects their review.

We expect the 2002 report to be timelier.

If you have any questions, we are happy to answer them at your convenience.

Sincerely,

Martha G. Kirkpatrick
Commissioner

Enc.

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DEPLW0546

2001
SURFACE WATER AMBIENT TOXIC MONITORING PROGRAM

EXECUTIVE SUMMARY

DIVISION OF ENVIRONMENTAL ASSESSMENT
MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
AUGUSTA, MAINE 04333

October 2002

INTRODUCTION

The 2001 Surface Water Ambient Toxic (SWAT) monitoring program final report is organized into an executive summary and 4 modules, 1) Marine and Estuarine, 2) Lakes, 3) Rivers and Streams, and 4) Special Studies. Within each module results are presented in the order of the 2001 workplan. There are also a separate appendix with fish lengths and weights for all modules.

The full report is available on DEP's website at
http://www.state.me.us/dep/blwq/monitoring.htm

Click on "programs", then scan down the page to "Surface Water Ambient Toxics Monitoring Program (SWAT)" and choose the module of your interest.

Questions may be directed to authors of each study or to Barry Mower, DEP, SHS 17, Augusta, Maine 04333, tel: 207-287-7777, email: barry.f.mower@state.me.us

Acknowledgements
Collection of samples was conducted by the principal investigators and technical assistants listed (DEP staff unless otherwise specified) assisted by the Department of Inland Fisheries and Wildlife, Department of Marine Resources, Penobscot Indian Nation.

Most chemical analyses were performed by the Senator George J. Mitchell Center for Environmental and Watershed Research Environmental Chemistry Laboratory at the University of Maine. Other analyses were conducted as listed in reports of individual sections.

EXECUTIVE SUMMARY

Maine's Surface Water Ambient Toxics (SWAT) monitoring program was established in 1993 (38 MRSA §420-B) to determine the nature, scope and severity of toxic contamination in the surface waters and fisheries of the State. 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. This 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 5 year workplan that outlines monitoring objectives for the following 5 years. The Commissioner must also develop an annual workplan that defines the work to be accomplished each year. A Technical Advisory Group (TAG), composed of 10 individuals with scientific backgrounds representing various interests and 1 legislator, is established to advise the Commissioner on the development of the 5-year and annual workplans.

The first 5-year plan, for the period 1994-1998, was an initial survey of waterbodies from watersheds around the entire state. The current 5-year plan, for the period 1999-2003, is focused on problems discovered in the initial sampling and is designed to confirm the initial findings and establish background conditions. Once those are established and a sufficient amount of time has elapsed, 5-10 years depending on what if any action has occurred to solve the problem, repeat sampling may be conducted to establish trends. The program also explores new issues.

The SWAT program is divided into 4 modules, 1) Marine and Estuarine, 2) Lakes, 3) Rivers and Streams, and 4) Special Studies. This annual report follows the outline of the 2000 workplan.

Following is a summary of key findings from the 2000 SWAT program for each module.

1. MARINE AND ESTUARINE

- Levels of mercury in blue mussels were elevated in the Sheepscot, Pepperell Cove in Kittery and at the mouth of the Penobscot River in 2001 and in the late 1980s. The latter two sites have local potential sources of mercury and the Sheepscot is presumed to be elevated because of historic sources. Levels of other metals were lower in 2001 than in the late 1980s at many sites including the Sheepscot and the Penobscot. Pepperell Cove near the naval base in Kittery had elevated or high normal range metals at both sampling periods. At the mouth of an abandoned mine in Cape Rosier a number of metals were elevated in the 1989 and 2001 samplings. One area of concern is Diamond Cove, on Great Diamond Island in Casco Bay where levels of lead are much higher than in 1989. Other locations had lower levels of metals or normal levels at both samplings with some exceptions. Nickel was elevated in some of the 2001 samples but the individual replicates had variable results. Silver was elevated at two locations and also had variable results for individual replicates.

- Mercury and PCB levels in striped bass and bluefish have been monitored from a number of waters over the last few years. Levels of both contaminants in fish from most rivers exceed the Maine Bureau of Health Fish Tissue Action Levels. Monitoring in 2001 showed mercury levels in bluefish from the Kennebec River, and in striped bass from the Penobscot River and York River similar to those of previous years. PCBs, however were the highest ever measured in these species. Comprehensive monitoring of these fish from up to 7 rivers will be conducted in 2002.

- While limited by the relatively small number of seals sampled from each region, regional comparisons suggest that seals that breed and pup along southern and mid-coast Maine have body burdens of PCBs, OC pesticides, and mercury comparable to or higher than levels in seals in polluted industrial areas along the Northeast coast. PCB levels detected in seals (predominantly harbor seals) throughout the Gulf of Maine are comparable to or higher than the known threshold level for adverse immune, reproductive, and endocrine effects documented in captive feeding studies on harbor seals and an order of magnitude higher than levels associated with reduced immune responses and endocrine alterations in some species of seals. These levels are of concern given the declining pupping rates observed among harbor seals in southern and mid-coast Maine.

2. LAKES

- Despite being a dry year, in 2001 monitoring of mercury in rain, snow, and sleet at 4 locations in Maine as part of the national Mercury Deposition Network continued to document that coastal areas receive more mercury deposition than do inland areas. These results implicate the US eastern seaboard as well as other upwind states as significant sources of mercury to Maine. National data show that deposition is higher in most other eastern and mid-western states that are in the program and presumably closer to major sources.

- A total of 23 samples of one to five fish each of trout and salmon were collected from 18 lakes and ponds by the Department of Inland Fisheries and Wildlife for mercury analysis. A total of 8 samples of one to five fish each were also collected by the Lakes Environmental Association from 4 lakes in the Brigdton area for mercury analysis. Concentrations of mercury in all lake trout, brown trout, landlocked salmon, largemouth bass, smallmouth bass and all but one brook trout and splake exceeded the Maine Bureau of Health's Fish Tissue Action Level (0.2 ppm). Concentrations of mercury in chain pickerel from 4 lakes were the highest of all species and correlated with length.

- Studies of the effects of mercury on loons indicate that loons with high concentrations of mercury exhibit impacts to survival and behavior. As a result they fledge 40% fewer young than loons with low concentrations of mercury. This translates to placing 26% of Maine's loons at risk, predicting an erosion of the birds providing a reproductive buffer and leading to an unsustainable population. Monitoring of fish gathered limited data for establishment of a statewide bioaccumulation factor. This study is part of a multi-year effort to establish a wildlife criterion for mercury as required under state statute.

3. RIVERS AND STREAMS

- Dioxin concentrations in trout from the Androscoggin River at Gilead and the Kennebec River at Fairfield, and suckers from the Androscoggin River at Rumford and Riley exceeded the Maine Bureau of Health's Fish Tissue Action Level for cancer. Coplanar PCB concentrations exceeded the Fish Tissue Action Level for cancer for many samples as well. The combination of dioxins and dioxin-like coplanar PCBs resulted in all fish sampled from the Androscoggin River and fish from many other stations as well exceeding the Fish Tissue Action Level for reproductive effects. Dioxin concentrations were slightly higher than those in 2000 in 8 samples, slightly lower in 8 samples, and similar in the remainder. CTEh concentrations were similar to those from 2000 at most stations.

- Preliminary studies of the effects of endocrine disruption on reproduction of fish downstream of major discharges from municipal treatment plants and pulp and paper mills on the Androscoggin River indicated some reduction, but not elimination of effects since a similar study in 1994. The study will be repeated in 2002.

- A significant finding from the SWAT biological monitoring program is the extent of detrimental impacts to small streams, caused by non-point source toxics and physical disturbance in urban areas. Although only ten of thirty-five stations have been processed for the year 2001, six of the stations analyzed fail to attain minimum aquatic life standards of their assigned class. All of these are stations located on small urban strteams.

4. SPECIAL STUDIES

- Development of the use of semi-permeable membrane devices, SPMDs, as a potential surrogate for the fish above/below test for discharge of dioxins from bleached kraft pulp mills continued at the University of Maine in 2001. Unlike the 2000 study, the 2001 study resulted in detection of 2378-TCDD. As in 2000, 2378-TCDF was measured in all samples also. Within-site variability in concentrations was slightly better than in 2000 in some samples, as a result of improvements in the analyses, but was still no better than that measured in fish; therefore, sensitivity of SPMD tests were generally no better than that of fish. Development of the SPMD method continued in 2002.

- Mercury levels were found to be greater in mink vs. otter, interior vs. coastal populations, and females vs. males. Respective mean mercury levels in otter and mink fur, 19.6 and 21.8 ppm, were near concentrations considered to have adverse effects in other studies. The proportion of sampled populations exceeding 20 ppm in the fur was 61% for otter and 47% for mink, yet brain and liver Hg levels were well below published lethal levels. Studies will continue in 2002 toward establishment of a wildlife criterion for mercury.

- Preliminary studies at the University of Maine have resulted in increased efficiency and lower detection of methylmercury. This effort is part of the development of a bioaccumulation factor for regulatory use with Maine's new fish Tissue Residue Criterion for mercury. Studiies will continue in 2002.

CONTENTS

MODULE 1 MARINE AND ESTUARINE

1.1

SHELLFISH TISSUE ANALYSES

Shellfish Tissue Analyses
This project addresses multiple needs identified after analysis of historical data collected by SWAT and other studies.

In 1998, interim action levels for shellfish were developed by the State Toxicologist, Bureau of Health that enable data from mussel samples to be evaluated in the context of human health. In the 1980s and early 1990s, blue mussel sample results suggest that human health advisories may be warranted in some areas of the coast due to levels of lead and mercury. Although environmental lead levels have declined nationally in various media since its removal from automotive fuels, it is reasonable to resample these areas to determine if current lead and mercury levels warrant an advisory. When these older samples were taken, organic analyses were not affordable. Many of these areas are near human population centers and/or industry and commerce. To complete the human health assessment, both organic and metal analyses should be conducted.

The Departments of Marine Resources and Environmental Protection have an active program to restore shellfish beds to harvestable conditions by removing sources of human sewage. Once sanitary pollution criteria are met, the DMR can open the area if it is assured that toxic contaminants do not pose a human health threat. In cases where the historical clam population is no longer present, direct sampling of clams makes that assurance impossible. Since a clam restoration project is an expensive commitment, there is a need to have tool available that can predict what tissue levels might likely be once clams have been restored to the area. Blue mussels are found almost everywhere along the coast, even where clams are not. Since mussels can be used to reflect local conditions, it may be possible to develop a relationship between clams, mussels, and perhaps sediment in order to predict levels expected in clams.

In the original Five-Year Plan, establishment of benchmark stations to be monitored over time was identified as a high priority. Those stations have been established and sampled at least once.

During the 2001 sampling season the ME DEP sampled blue mussels from:

Location	Date Sampled
Sandy Point, Stockton Springs	10/07/01
Sears Island, Searsport	09/18/01
Castine-Brooksville (Cape Rosier)	10/06/01
Clough Point, Sheepscot R.	10/16/01
Damariscotta R., Goose Ledge	10/04/01
Englishman's Bay, Great Cove, Roque Bluffs	10/18/01
Medomak R.	10/24/01
Little Kennebec Bay, Johnson-Marston Point, Machiasport	10/18/01
Pepperell Cove, Kittery	10/21/01
Long Island, Casco Bay	11/08/01
Great Diamond Island, Casco Bay	11/08/01

The following text and table gives results for metals in 2001 and compares those results to previous samples taken in the late 1980s. The samples from the late 1980s consisted of a single sample while the 2001 results are based on four replicate samples. Levels of metals are compared to the normal baseline range for Maine. Aluminum and iron are not included in the analysis and are reported as elevated in the table to give an indication of the amount of sediment in the gut of the mussel. When compared to NOAA Status and Trends elevated levels, PAHs were not elevated. The PAHs maybe underestimated due to loss of some of the lighter weight PAHs and other quality assurance issues that are noted on the tables. PCBs and pesticides are not reported because of quality assurance issues during analysis.

Elevated Metals (X) in Mussels Sampled in 2001

	Al	As	Cd	Cr	Cu	Fe	Ni	Pb	Zn	Ag	Hg
Castine-Brooksville			X		X			X	X		
Clough Point, Sheepscot R. estuary	X					X					X
Englishman's Bay, Roque Bluffs	X										
Great Diamond Is., Casco Bay	X	X				X		X		X	
Goose Ledge, Damariscotta R. estuary							X				
Kittery, Pepperell Cove	X	X		X	X	X		X			X
Little Kennebec Bay, Machiasport	X					X				X	
Long Island, Casco Bay							X				
Medomak R. estuary							X*			X	
Sandy Point, Stockton Springs	X										X
Sears Island, Searsport							X				

*without outlier, not elevated

Mercury was elevated in the Sheepscot, at Pepperell Cove in Kittery and at the mouth of the Penobscot River at Sandy Point, Stockton Springs. The one sample that was taken previously at Sandy Point in 1989 had elevated cadmium, chromium and slightly elevated nickel as well as elevated mercury. Levels of cadmium and chromium were in the high end of the normal range in 2001 and nickel was normal and over one third less that it was previously.

The one sample that was taken previously in the Sheepscot at Clough Cove in 1989 had slightly elevated cadmium as well as elevated mercury. In 2001, cadmium was in the high end of the normal range and the mercury was still elevated.

Pepperell Cove near the naval base in Kittery in the one sample taken in 1987 had elevated chromium, lead and mercury. Zinc, cadmium, and copper were in the high normal range. In 2001 mercury, chromium, copper, lead and arsenic were elevated.

Arsenic was not measured in 1987. Cadmium and zinc were in the high normal range in 2001 but slightly lower than in 1989.

Metals in Englishman's Bay were in the normal range in 2001 as they were in 1987.

Metals in the Medomak were in the normal range except for elevated silver that had varied results between the replicates. There was an outlier in one of the nickel replicates and was not considered in the results. Cadmium was elevated in the one sample taken in 1989 but was not elevated in the 2001 sampling.

Goose Ledge in the Damariscotta, Sears Island and Long Island in Casco Bay were in the normal range in 2001 with the exception of elevated nickel. Although the levels of nickel were higher in 2001 than the one sample taken in 1989 in the Damariscotta, the results of replicates were highly variable. Two replicates were in the elevated range and two were in the normal range. At Sears Island the levels of silver and cadmium were greatly lower than the one sample taken in 1989 but the level of nickel was higher. Levels of cadmium, lead and zinc were lower than the one sample taken in 1989 at Long Island while the level of nickel was higher.

In Little Kennebec Bay, the metals were in the normal range in 2001 with the exception of silver that was not measured in 1987. Also the lead levels that were in the high end of the normal range in the one 1987 sample were lower in 2001.

Diamond Cove, Great Diamond Island had elevated arsenic, silver, and lead in 2001. In the one sample taken in 1988 all metals analyzed were in the normal range. Silver and arsenic were not measured in 1988. Lead was in the upper part of the normal range. Lead was almost twice as high in 2001 as it was in 1988.

On Cape Rosier near the abandoned mine cadmium, copper, lead and zinc were elevated in 2001. In the one sample taken in 1989, cadmium, lead and zinc were elevated. Levels of cadmium and lead were lower and levels of copper and zinc were higher in 2001 compared to the 1989 sample.

In summary, levels of mercury were elevated in the Sheepscot, Pepperell Cove in Kittery and at the mouth of the Penobscot River in 2001 and in the late 1980s. The latter two sites have local potential sources of mercury and the Sheepscot is presumed to be elevated because of historic sources. Levels of other metals were lower in 2001 than in the late 1980s at many sites including the Sheepscot and the Penobscot. Pepperell Cove near the naval base in Kittery had elevated or high normal range metals at both sampling periods. At the mouth of an abandoned mine in Cape Rosier a number of metals were elevated in the 1989 and 2001 samplings. One area of concern is Diamond Cove where levels of lead are much higher than in 1989.

Other locations had lower levels of metals or normal levels at both samplings with some exceptions. Nickel was elevated in some of the 2001 samples but the individual replicates had variable results. Silver was elevated at two locations and also had variable results for individual replicates.

The human health assessment has not yet been evaluated.

TABLE 1.2.1 LEVELS OF MERCURY AND % SOLIDS IN 2001 MUSSEL TISSUE SAMPLES

Sample ID	Hg wet(mg/Kg)	Hg dry(mg/Kg)	% solid
Castine-Brooksville 1	0.0079	0.1059	7.50
Castine-Brooksville 2	0.0101	0.1192	8.44
Castine-Brooksville 3	0.0085	0.1120	7.58
Castine-Brooksville 4	0.0084	0.1065	7.92
Clough Point, Sheepscot R. 1	0.0432	0.4246	10.17
Clough Point, Sheepscot R. 2	0.0434	0.6346	6.84
Clough Point, Sheepscot R. 3	0.0382	0.5780	6.61
Clough Point, Sheepscot R. 4	0.0307	0.4367	7.04
Englishman's Bay, Roque Bluffs 1	0.0099	0.0773	12.86
Englishman's Bay, Roque Bluffs 2	0.0100	0.0794	12.60
Englishman's Bay, Roque Bluffs 3	0.0101	0.0746	13.49
Englishman's Bay, Roque Bluffs 4	0.0094	0.0740	12.77
Damariscotta R., Goose Ledge 1	0.0128	0.1516	11.75
Damariscotta R., Goose Ledge 2	0.0109	0.1449	11.60
Damariscotta R., Goose Ledge 3	0.0136	0.1664	12.86
Damariscotta R., Goose Ledge 4	0.0111	0.1432	12.02
Great Diamond Is., Casco Bay 1	0.0160	0.1361	8.42
Great Diamond Is., Casco Bay 2	0.0124	0.1067	7.53
Great Diamond Is., Casco Bay 3	0.0177	0.1378	8.20
Great Diamond Is., Casco Bay 4	0.0140	0.1161	7.72
Pepperell Cove, Kittery 1	0.0313	0.4011	7.81
Pepperell Cove, Kittery 2	0.0344	0.4907	7.02
Pepperell Cove, Kittery 3	0.0291	0.3656	7.95
Pepperell Cove, Kittery 4	0.0316	0.4307	7.34
Little Kennebec Bay, Machiasport 1	0.0101	0.0826	12.21
Little Kennebec Bay, Machiasport 2	0.0109	0.0926	11.73
Little Kennebec Bay, Machiasport 3	0.0114	0.0852	13.39
Little Kennebec Bay, Machiasport 4	0.0117	0.0846	13.79
Long Island, Casco Bay 1	0.0209	0.2605	8.02
Long Island, Casco Bay 2	0.0208	0.2518	8.25
Long Island, Casco Bay 3	0.0176	0.2196	8.03
Long Island, Casco Bay 4	0.0168	0.2015	8.35
Medomak R. 1	0.0087	0.0925	9.41
Medomak R. 2	0.0078	0.0781	9.95
Medomak R. 3	0.0075	0.0789	9.46
Medomak R. 4	0.0071	0.0751	9.50
Sandy Point, Stockton Springs 1	0.0402	0.4067	9.88
Sandy Point, Stockton Springs 2	0.0387	0.4471	8.66
Sandy Point, Stockton Springs 3	0.0391	0.4376	8.93
Sandy Point, Stockton Springs 4	0.0416	0.4214	9.88
Sears Island, Searsport 1	0.0194	0.1739	11.18
Sears Island, Searsport 2	0.0201	0.1570	12.81
Sears Island, Searsport 3	0.0199	0.1677	11.86
Sears Island, Searsport 4	0.0202	0.1639	12.33

TABLE 1.2.2 HEAVY METALS IN 2001 BLUE MUSSEL TISSUE SAMPLES

Values on a dry weight basis
All elements except Ag analyzed by ICP-AES, Ag analyzed by GFAA

	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg
Castine 1	283.37	15.13	7.31	1.63	16.02	445.66	3.29	11.43	223.87	<DL
Castine 2	371.02	11.97	6.60	1.20	10.68	438.67	3.03	8.21	167.52	<DL
Castine 3	381.38	11.89	6.46	1.52	11.16	456.21	0.99	9.72	171.38	<DL
Castine 4	198.26	16.50	6.99	1.50	11.36	388.43	<DL	11.22	202.54	<DL
Clough Point 1	477.38	11.06	1.99	1.72	6.91	636.51	1.56	2.57	77.89	<DL
Clough Point 2	804.98	13.93	2.71	2.32	8.11	990.25	2.49	3.56	93.27	<DL
Clough Point 3	811.01	15.49	2.41	2.82	<DL	1023.73	2.85	3.16	91.74	0.60
Clough Point 4	816.18	15.95	2.79	3.28	7.67	995.49	2.71	4.56	118.10	<DL
Englishman's Bay 1	352.91	9.09	1.25	1.19	6.11	404.74	1.16	2.50	61.07	<DL
Englishman's Bay 2	424.81	10.03	1.39	1.55	6.43	474.79	1.36	2.88	58.90	0.80
Englishman's Bay 3	412.14	8.24	1.28	1.04	6.34	415.60	1.41	2.59	54.72	<DL
Englishman's Bay 4	541.35	8.65	1.41	1.34	7.39	534.54	3.14	3.05	56.52	<DL
Great Diamond Is. 1	350.37	14.32	1.81	1.69	6.41	555.58	2.45	4.33	78.58	<DL
Great Diamond Is. 2	334.92	18.20	2.45	2.14	10.41	707.91	2.59	8.51	120.17	<DL
Great Diamond Is. 3	417.17	17.95	2.29	2.74	10.03	718.17	3.07	8.66	123.04	0.51
Great Diamond Is. 4	786.82	18.83	2.45	2.79	9.72	938.57	2.47	10.12	129.83	0.48
Goose Ledge 1	270.21	13.82	1.37	0.98	8.04	321.88	4.31	2.87	97.59	<DL
Goose Ledge 2	341.32	12.19	1.39	0.69	6.21	407.61	1.09	2.75	79.62	<DL
Goose Ledge 3	194.03	11.29	1.04	0.61	6.72	215.48	9.73	2.06	78.05	<DL
Goose Ledge 4	317.93	12.98	1.42	1.09	8.19	343.06	1.10	2.97	83.00	0.48
Kittery-Pepperell 1	1391.22	17.38	2.54	6.09	13.91	1548.82	2.45	14.18	167.38	0.69
Kittery-Pepperell 2	798.51	19.82	2.45	4.17	12.94	979.20	1.99	9.27	127.65	0.50
Kittery-Pepperell 3	516.89	19.93	3.08	3.15	10.24	740.41	2.10	9.87	224.45	<DL
Kittery-Pepperell 4	613.12	15.27	1.64	2.71	8.10	694.10	1.20	6.71	101.80	0.41
Little Kennebec Bay 1	657.70	7.29	1.20	1.59	9.28	586.29	1.41	2.05	53.37	0.21
Little Kennebec Bay 2	829.57	9.79	1.82	2.10	10.08	821.48	1.51	4.82	76.48	0.54
Little Kennebec Bay 3	1360.69	8.39	1.40	2.09	9.17	1075.60	1.63	2.90	91.04	<DL
Little Kennebec Bay 4	573.62	7.90	1.34	1.52	6.85	570.70	1.36	2.28	65.26	0.17
Long Island 1	497.80	17.09	2.21	1.83	7.35	586.24	5.83	4.89	117.73	<DL
Long Island 2	205.38	15.23	2.18	1.25	7.61	295.68	5.90	3.58	76.13	0.28
Long Island 3	209.65	14.59	1.75	1.14	7.10	275.66	2.27	2.82	88.74	<DL
Long Island 4	158.65	15.26	1.89	1.34	6.04	243.19	2.77	2.46	87.28	0.45
Medomak 1	213.46	11.69	1.65	0.88	7.13	307.37	1.20	2.28	116.95	0.77
Medomak 2	217.27	11.72	1.48	0.83	7.01	295.53	1.08	3.19	97.09	0.51
Medomak 3	280.91	12.05	1.41	1.06	7.07	312.13	18.53	3.03	93.64	<DL
Medomak 4	311.78	12.41	1.46	1.14	6.45	310.81	2.89	2.68	92.86	<DL
Sandy Point 1	366.25	13.00	2.10	2.26	8.85	592.94	1.55	3.52	92.59	<DL
Sandy Point 2	356.89	15.54	2.59	2.43	7.11	695.38	1.74	3.92	91.52	<DL
Sandy Point 3	420.98	13.52	2.69	2.59	8.99	665.26	1.66	3.48	93.67	<DL
Sandy Point 4	515.55	12.82	2.02	2.38	8.24	608.08	1.71	2.88	63.89	<DL
Sears Island 1	100.74	11.86	1.44	<DL	7.23	181.25	2.12	2.31	78.18	<DL
Sears Island 2	168.43	9.68	1.28	0.82	5.95	210.77	6.10	1.72	93.40	0.15
Sears Island 3	138.72	9.03	1.22	0.67	6.73	205.72	5.99	1.51	82.35	0.16
Sears Island 4	134.58	9.29	1.09	0.63	5.69	199.06	12.34	1.37	58.48	0.16

<DL= Less than detection limit

TABLE 1.2.3 HEAVY METALS IN 2001 BLUE MUSSEL TISSUE SAMPLES

Values on a wet weight basis

All elements except Ag analyzed by ICP-AES, Ag analyzed by GFAA

	Al mg/kg	As mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg	Ag mg/kg
*reporting limit**	*0.40*	*0.08*	*0.10*	*0.08*	*0.40*	*0.20*	*0.08*	*0.08*	*0.20*	*0.020*
Blank Ck	<0.40	<0.08	<0.10	<0.08	<0.40	<0.20	<0.08	<0.08	<0.20	<0.020
Castine 1	21.25	1.14	0.55	0.12	1.20	33.42	0.25	0.86	16.79	<0.020
Castine 2	31.31	1.01	0.56	0.10	0.90	37.02	0.26	0.69	14.14	<0.020
Castine 3	28.91	0.90	0.49	0.12	0.85	34.58	0.08	0.74	12.99	<0.020
Castine 4	15.70	1.31	0.55	0.12	0.90	30.76	<0.08	0.89	16.04	<0.020
Clough Point 1	48.55	1.12	0.20	0.17	0.70	64.73	0.16	0.26	7.92	<0.020
Clough Point 2	55.06	0.95	0.19	0.19	0.55	67.73	0.17	0.24	6.38	<0.020
Clough Point 3	53.61	1.02	0.16	0.19	<0.40	67.67	0.19	0.21	6.06	0.040
Clough Point 4	57.46	1.12	0.20	0.23	0.54	70.08	0.19	0.32	8.31	<0.020
Englishman's Bay 1	45.38	1.17	0.16	0.15	0.79	52.05	0.15	0.32	7.85	<0.020
Englishman's Bay 2	53.53	1.26	0.17	0.20	0.81	59.82	0.17	0.36	7.42	0.101
Englishman's Bay 3	55.60	1.11	0.17	0.14	0.85	56.06	0.19	0.35	7.38	<0.020
Englishman's Bay 4	69.13	1.10	0.18	0.17	0.94	68.26	0.40	0.39	7.22	<0.020
Great Diamond Is. 1	29.50	1.21	0.15	0.14	0.54	46.78	0.21	0.36	6.62	<0.020
Great Diamond Is. 2	25.22	1.37	0.18	0.16	0.78	53.31	0.19	0.64	9.05	<0.020
Great Diamond Is. 3	34.21	1.47	0.19	0.22	0.82	58.39	0.25	0.71	10.09	0.041
Great Diamond Is. 4	60.74	1.45	0.19	0.22	0.75	72.46	0.19	0.78	10.02	0.037
Goose Ledge 1	31.75	1.62	0.16	0.11	0.94	37.82	0.51	0.34	11.47	<0.020
Goose Ledge 2	39.59	1.41	0.16	0.08	0.72	47.28	0.13	0.32	9.24	<0.020
Goose Ledge 3	24.95	1.45	0.13	0.08	0.86	27.71	1.25	0.26	10.04	<0.020
Goose Ledge 4	38.22	1.56	0.17	0.13	0.98	41.24	0.13	0.36	9.98	0.058
Kittery-Pepperell 1	108.65	1.40	0.20	0.48	1.09	120.96	0.19	1.11	13.07	0.054
Kittery-Pepperell 2	56.06	1.39	0.17	0.29	0.91	68.74	0.14	0.65	8.96	0.035
Kittery-Pepperell 3	41.09	1.58	0.24	0.25	0.81	58.86	0.17	0.78	17.84	<0.020
Kittery-Pepperell 4	45.00	1.12	0.12	0.20	0.59	50.95	0.09	0.49	7.47	0.030
Little Kennebec Bay 1	80.30	0.89	0.15	0.19	1.13	71.59	0.17	0.25	6.52	0.025
Little Kennebec Bay 2	97.31	1.15	0.21	0.25	1.18	96.36	0.18	0.56	8.97	0.063
Little Kennebec Bay 3	182.20	1.12	0.19	0.28	1.23	144.02	0.22	0.39	12.19	<0.020
Little Kennebec Bay 4	79.10	1.09	0.18	0.21	0.94	78.70	0.19	0.31	9.00	0.024
Long Island 1	39.92	1.37	0.18	0.15	0.59	47.02	0.47	0.39	9.44	<0.020
Long Island 2	16.94	1.26	0.18	0.10	0.63	24.39	0.49	0.30	6.28	0.023
Long Island 3	16.84	1.17	0.14	0.09	0.57	22.14	0.18	0.23	7.13	<0.020
Long Island 4	13.25	1.27	0.16	0.11	0.50	20.31	0.23	0.21	7.29	0.037
Medomak 1	20.09	1.10	0.16	0.08	0.67	28.82	0.11	0.21	11.00	0.072
Medomak 2	21.62	1.17	0.15	0.08	0.70	29.41	0.11	0.32	9.66	0.051
Medomak 3	26.57	1.14	0.13	0.10	0.67	29.53	1.75	0.29	8.86	<0.020
Medomak 4	29.62	1.18	0.14	0.11	0.61	29.53	0.27	0.25	8.82	<0.020
Sandy Point 1	36.19	1.28	0.21	0.22	0.87	58.58	0.15	0.35	9.15	<0.020
Sandy Point 2	30.91	1.35	0.22	0.21	0.62	60.22	0.15	0.34	7.93	<0.020
Sandy Point 3	37.59	1.21	0.24	0.23	0.80	59.41	0.15	0.31	8.36	<0.020
Sandy Point 4	50.94	1.27	0.20	0.24	0.81	60.08	0.17	0.28	6.31	<0.020
Sears Island 1	11.26	1.33	0.16	<0.08	0.81	20.26	0.24	0.26	8.74	<0.020
Sears Island 2	21.58	1.24	0.16	0.11	0.76	27.00	0.78	0.22	11.96	0.020
Sears Island 3	16.45	1.07	0.14	0.08	0.80	24.40	0.71	0.18	9.77	0.020
Sears Island 4	16.59	1.15	0.13	0.08	0.70	24.54	1.52	0.17	7.21	0.020

*reporting limit based on a 2.0 g sample weight

TABLE 1.2.4 PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Englishman's Bay, Roque Bluffs 1	Englishman's Bay, Roque Bluffs 2	Englishman's Bay, Roque Bluffs 3	Englishman's Bay, Roque Bluffs 4
Sample ID#		01-MUS-21	01-MUS-22	01-MUS-23	01-MUS-24
Extraction ID		1659	1660	1661	1662
Analytes	DL (ug/Kg				
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	0.53	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalen	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthal	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	1.38(a)	<DL(a)	<DL(a)	<DL(a)
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	0.83(a)	<DL(a)	<DL(a)	<DL(a)
fluoranthrene	1.0	<DL	<DL	<DL	<DL
pyrene	1.0	<DL	<DL	<DL	<DL
benz(a)anthracene	1.0	1.06	<DL	<DL	<DL
chrysene	1.0	<DL	<DL	<DL	<DL
benzo(b)fluoranthene	2.0	<DL	<DL	<DL	<DL
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	<DL	<DL	<DL	<DL
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		0.6	0.7	0.7	0.8
Sample weight (g, dry weight)		39.6	48.8	38.9	42.6
% Solids		13.4	13.9	13.4	13.0
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	38.9	33.48	35.86	33.7
	65-135%	129.6	111.6	119.53	112.27

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for these samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Medomak R. 1	Medomak R. 2	Medomak R. 3	Medomak R. 4
Sample ID#		01-MUS-25	01-MUS-26	01-MUS-27	01-MUS-28
Extraction ID		1620	1663	1622	1623
Analytes	DL (ug/Kg weight)				
naphthalene	1.0	<DL	<DL	0.48	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	<DL(a)	0.92(a)	1.56(a)	<DL(a)
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	<DL(a)	1.06(a)	1.74(a)	0.86(a)
fluoranthrene	1.0	<DL	1.47	2.11	1.01
pyrene	1.0	4.96	1.16	1.87	1.08
benz(a)anthracene	1.0	<DL	0.58	<DL	0.58
chrysene	1.0	<DL	<DL	<DL	0.79
benzo(b)fluoranthene	2.0	<DL	<DL	<DL	<DL
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	<DL	<DL	<DL	<DL
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		1.17	1.3	1.14	1.72
Sample weight (g, dry weight)		14.1	29.2	16.6	13.9
% Solids		9.8	9.76	10.1	10.3
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg 65-135%				

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Great Diamond Is., Casco Bay 1	Great Diamond Is., Casco Bay 2	Great Diamond Is., Casco Bay 3	Great Diamond Is., Casco Bay 4
Sample ID#		01-MUS-41	01-MUS-42	01-MUS-43	01-MUS-44
Extraction ID		1627	1628	1629	1630
Analytes	DL (ng/Kg weight)				
			(b)		
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	4.40(a)	3.80(a)	2.26(a)	3.60(a)
anthracene	1.0	<DL	2.81	<DL	<DL
1-methylphenanthrene	1.0	4.06(a)	3.31	2.62	2.51
fluoranthrene	1.0	20.68	29.00(a)	21.41(a)	16.55(a)
pyrene	1.0	13.56	18.43	14.68	11.53
benz(a)anthracene	1.0	4.66	4.46	3.97	3.99
chrysene	1.0	25.34	28.02	19.72	14.21
benzo(b)fluoranthene	2.0	7.80	10.33	11.21	7.98
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	2.54	4.05	4.18	5.85
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	2.64	1.99	1.86
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		2.99	3.02	2.70	2.13
Sample weight (g, dry weight)		11.8	12.1	14.1	18.3
% Solids		8.2	6.9	10.4	8.8
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	27.53	48.31	33.7	31.85
	65-135%	91.8	161.0	112.3	106.2

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Sandy Pt., Stockton Springs 1	Sandy Pt., Stockton Springs 2	Sandy Pt., Stockton Springs 3	Sandy Pt., Stockton Springs 4
Sample ID#		01-MUS-01	01-MUS-02	01-MUS-03	01-MUS-04
Extraction ID		1631	1632	1633	1634
Analytes	DL (ug/Kg weight)				
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	2.47(a)	1.70(a)	<DL(a)	1.16(a)
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	1.73	2.09	<DL	1.12
fluoranthrene	1.0	5.20(a)	7.86(a)	3.40(a)	3.97(a)
pyrene	1.0	6.31	7.96	3.88	4.78
benz(a)anthracene	1.0	3.54	6.45	1.94	3.04
chrysene	1.0	2.73	5.50	2.59	3.21
benzo(b)fluoranthene	2.0	1.62	2.89	<DL	3.44
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	1.07	1.61	<DL	1.12
perylene	2.0	<DL	0.66	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	0.92	1.00	<DL	0.63
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		0.64	1.59	0.95	0.82
Sample weight (g, dry weight)		27.1	21.1	23.2	22.4
% Solids		10.3	9.9	10.2	9.8
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	28.7	31.0	23.3	31.8
	65-135%	95.7	103.2	77.5	105.9

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Castine-Brooksville 1	Castine-Brooksville 2	Castine-Brooksville 3	Castine-Brooksville 4
Sample ID#		01-MUS-09	01-MUS-10	01-MUS-11	01-MUS-12
Extraction ID		1635	1636	1637	1638
Analytes	DL (ug/Kg weight)				
		(b)			
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	0.73(a)	0.76(a)	1.34(a)	2.33(a)
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	<DL	<DL	0.84	1.44
fluoranthrene	1.0	0.80(a)	0.92(a)	1.45(a)	2.28(a)
pyrene	1.0	0.60	0.64	1.00	1.36
benz(a)anthracene	1.0	<DL	<DL	1.00	0.89
chrysene	1.0	<DL	<DL	0.77	1.23
benzo(b)fluoranthene	2.0	<DL	<DL	0.77	1.53
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	<DL	<DL	<DL	<DL
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		0.37	0.43	0.94	1.21
Sample weight (g, dry weight)		30.0	31.2	26.1	23.6
% Solids		8.2	8.3	8.4	8.6
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	14.7	19.95	21.14	20.62
	65-135%	48.9	66.5	70.47	68.73

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

		Sears Is., Searsport	Sears Is., Searsport	Sears Is., Searsport	Sears Is., Searsport
DEP ID		1	2	3	4
Sample ID#		01-MUS-05	01-MUS-06	01-MUS-07	01-MUS-08
Extraction ID		1639	1640	1646	1642
Analytes	DL (ug/Kg weight)				
		(b)	(b)		
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	2.07(a)	1.59(a)	<DL(a)	<DL(a)
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	<DL	0.61	<DL	<DL
fluoranthrene	1.0	2.96(a)	2.48(a)	1.50(a)	2.71(a)
pyrene	1.0	1.05	0.83	1.03	2.05
benz(a)anthracene	1.0	0.98	1.16	0.57	0.73
chrysene	1.0	<DL	0.67	0.59	1.41
benzo(b)fluoranthene	2.0	<DL	<DL	0.52	0.61
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	<DL	<DL	<DL	<DL
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		0.69	0.52	0.73	0.69
Sample weight (g, dry weight)		57.0	50.8	40.60	52.3
% Solids		13.0	12.6	12.76	12.6
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	14.4	17.12	29.32	23.18
	65-135%	48.07	57.07	97.73	77.27

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Little Kennebec Bay, Machiasport 1	Little Kennebec Bay, Machiasport 2	Little Kennebec Bay, Machiasport 3	Little Kennebec Bay, Machiasport 4
Sample ID#		01-MUS-29	01-MUS-30	01-MUS-31	01-MUS-32
Extraction ID		1651	1645	1641	1647
Analytes	DL (ug/Kg weight)				
			(b)		(b)
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	1.00
2-methylnaphthalene	1.0	<DL	<DL	<DL	0.75
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	0.57
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	<DL	0.81(a)	<DL(a)	2.57(a)
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	0.53	0.50	0.54	1.86
fluoranthrene	1.0	0.74	0.59(a)	0.93(a)	3.28(a)
pyrene	1.0	0.62	<DL	0.61	1.96
benz(a)anthracene	1.0	<DL	<DL	<DL	0.68
chrysene	1.0	0.53	<DL	0.57	1.82
benzo(b)fluoranthene	2.0	<DL	<DL	<DL	1.43
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	<DL	<DL	<DL	0.93
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		0.54	0.41	0.11	2.74
Sample weight (g, dry weight)		33.80	40.30	46.0	28.00
% Solids		11.57	12.71	12.6	13.61
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	30.1	19.4	27.22	46.8
	65-135%	100.4	64.53	90.73	155.97

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Damariscotta R., Goose Ledge 1	Damariscotta R., Goose Ledge 2	Damariscotta R., Goose Ledge 3	Damariscotta R., Goose Ledge 4
Sample ID#		01-MUS-17	01-MUS-18	01-MUS-19	01-MUS-20
Extraction ID		1652	1648	1649	1653
Analytes	DL (ng/Kg weight)				
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	0.50	0.74(a)	1.36(a)	<DL
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	<DL	0.72	0.52	<DL
fluoranthrene	1.0	1.57	1.71(a)	4.80(a)	1.10
pyrene	1.0	1.10	1.59	2.92	0.91
benz(a)anthracene	1.0	<DL	<DL	1.93	0.78
chrysene	1.0	0.99	0.63	2.09	0.75
benzo(b)fluoranthene	2.0	0.80	<DL	<DL	<DL
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	0.83	<DL	<DL	<DL
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		1.23	0.84	0.96	1.07
Sample weight (g, dry weight)		36.30	41.40	42.50	30.80
% Solids		10.89	13.42	11.62	11.00
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	33.82	34.8	34.2	29.23
	65-135%	112.73	115.87	114	97.43

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Pepperell Cove, Kittery 1	Pepperell Cove, Kittery 2	Pepperell Cove, Kittery 3	Pepperell Cove, Kittery 4
Sample ID#		01-MUS-33	01-MUS-34	01-MUS-35	01-MUS-36
Extraction ID		1654	1664	1657	1650
Analytes	DL (ug/Kg weight)				
			(b)		
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	<DL	2.19	<DL	3.93
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	<DL	1.79	<DL	2.40
fluoranthrene	1.0	4.78	10.40	2.02	12.53
pyrene	1.0	4.98	9.85	2.10	11.67
benz(a)anthracene	1.0	4.67	12.84	5.21	6.80
chrysene	1.0	5.14	6.12	1.25	10.00
benzo(b)fluoranthene	2.0	5.33	5.92	<DL	11.27
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	0.80	<DL	1.20
benzo(e)pyrene	2.0	2.63	4.03	<DL	6.73
perylene	2.0	<DL	<DL	<DL	2.20
ideno(1,2,3-cd)pyrene	2.0	<DL	4.33	0.62	5.13
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	3.58	0.78	3.80
% Lipids		0.72	1.26	0.35	1.68
Sample weight (g, dry weight)		25.50	20.1	25.70	15.00
% Solids		11.06	10.15	10.28	13.72
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	32.62	46.36	24.18	28.5
	65-135%	108.73	154.5	80.6	95.0

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.
** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.
Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.
(a) There are hits at or above the detection level in the blank for thses samples
(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

		Long Island, Casco	Long Island, Casco	Long Island, Casco	Long Island, Casco
DEP ID		Bay 1	Bay 2	Bay 3	Bay 4
Sample ID#		01-MUS-37	01-MUS-38	01-MUS-39	01-MUS-40
Extraction ID		1665	1655	1656	1658
Analytes	DL (ng/Kg weight)				
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	<DL	<DL	<DL	<DL
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	0.75	<DL	<DL	<DL
fluoranthrene	1.0	1.42	1.78	1.34	1.42
pyrene	1.0	1.30	1.41	0.98	1.03
benz(a)anthracene	1.0	1.00	1.84	1.91	1.81
chrysene	1.0	<DL	<DL	<DL	<DL
benzo(b)fluoranthene	2.0	<DL	<DL	<DL	<DL
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	<DL	<DL
benzo(e)pyrene	2.0	<DL	<DL	<DL	<DL
perylene	2.0	<DL	<DL	<DL	<DL
ideno(1,2,3-cd)pyrene	2.0	<DL	<DL	<DL	<DL
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	<DL	<DL	<DL	<DL
% Lipids		0.58	0.88	0.46	0.46
Sample weight (g, dry weight)		23.9	18.50	24.60	23.2
% Solids		9.31	11.53	10.72	11.33
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg	26.7	26.42	27.88	37.26
	65-135%	89.0	88.07	92.93	124.20

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.

** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.

Values below the detection limit are estimated values and should be considered qualitative.

They are provided for information only.

(a) There are hits at or above the detection level in the blank for thses samples

(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

TABLE 1.2.4 (CONTINUED) PAHS IN 2001 BLUE MUSSEL TISSUE SAMPLES

DEP ID		Clough Point, Sheepscot R. 1	Clough Point, Sheepscot R. 2	Clough Point, Sheepscot R. 3	Clough Point, Sheepscot R. 4
Sample ID#		01-MUS-13	01-MUS-14	01-MUS-15	01-MUS-16
Extraction ID		1667	1666	1668	1669
Analytes	DL (ug/Kg weight)				
			(b)	(b)	
naphthalene	1.0	<DL	<DL	<DL	<DL
1-methyl naphthalene	1.0	<DL	<DL	<DL	<DL
2-methylnaphthalene	1.0	<DL	<DL	<DL	<DL
biphenyl	1.0	<DL	<DL	<DL	<DL
2,6-dimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
acenaphthylene	1.0	<DL	<DL	<DL	<DL
acenaphthene	1.0	<DL	<DL	<DL	<DL
2,3,5-trimethylnaphthalene	1.0	<DL	<DL	<DL	<DL
fluorene	1.0	<DL	<DL	<DL	<DL
phenanthrene	1.0	0.91	0.80	1.13	1.11
anthracene	1.0	<DL	<DL	<DL	<DL
1-methylphenanthrene	1.0	0.84	1.05	1.13	1.11
fluoranthrene	1.0	4.25	6.05	6.91	5.41
pyrene	1.0	3.67	6.20	6.74	5.02
benz(a)anthracene	1.0	4.16	11.05	5.64	9.76
chrysene	1.0	2.79	3.48	4.23	5.31
benzo(b)fluoranthene	2.0	2.66	2.72	3.68	3.72
benzo(k)fluoranthene	*				
benzo(a) pyrene	2.0	<DL	<DL	1.13	0.58
benzo(e)pyrene	2.0	1.85	1.78	2.37	2.32
perylene	2.0	0.68	0.80	1.27	1.30
ideno(1,2,3-cd)pyrene	2.0	1.14	2.25	1.62	1.59
dibenz(a,h)anthracene	**				
benzo(g,h,i)perylene	2.0	0.65	1.88	0.69	1.26
% Lipids		0.30	0.77	0.62	0.85
Sample weight (g, dry weight)		30.8	27.6	29.1	20.7
% Solids		7.02	8.32	7.46	7.47
Surrogates					
p-Terphenyl	19.5-40.5 ug/Kg 65-135%				

* Benzo(k)fluoranthrene coelutes with Benzo(b)fluoranthrene.

** Dibenz(a,h)anthracene coelutes with ideno(1,2,3-cd)pyrene.

Values below the detection limit are estimated values and should be considered qualitative.
They are provided for information only.

(a) There are hits at or above the detection level in the blank for thses samples

(b) The values are considered estimated concentrations due to out of bounds surrogate recoveries

1.2

MARINE SPORTFISH HEALTH ADVISORY

MARINE SPORTFISH HEALTH ADVISORY

Mercury and PCBs in Striped Bass- From previous years in the SWAT program, there are some data on concentrations of mercury and PCBs from striped bass from the Androscoggin River, Kennebec River, Scarorough River, Sheepscot River and Saco River. The results support the current fish consumption advisory issued by the Maine Bureau of Health. There is some variation geographically, but not all regions of the state have been sampled. The highest value for mercury was in large legal-sized(<40in=1016 mm) striped bass collected in 1995 from the lower Kennebec River, while smaller 'schoolies' from the same time and location had lower concentrations (Table 1.2.1). Striped bass collected from York Harbor and the Penobscot River in 2001 exhibited concentrations near the lower end of the range shown for other rivers in previous years. To the contrary, PCB concentrations were higher than found previously in other rivers. Concentrations in fish from both rivers were below the Maine Bureau of Health's Fish Tissue Action Level (FTAL=0.2 ppm) for mercury but greatly exceed the FTAL (11 ppb) for PCB. It is curious that mercury levels are more similar among stations than are PCB. Additional sampling of all rivers will be conducted in 2002 to gather data from the same year.

Mercury and PCBs in Bluefish. We had only two data points for this species for mercury and only one for PCBs. Bluefish seem to have higher concentration PCBs than do striped bass. But to keep the advisory simple, the current Maine Bureau of Health fish consumption advisory has the same recommendation as for striped bass, 2 meals/month. More data are needed. We attempted to catch bluefish of 2 sizes from 2 different areas. Runs of bluefish have been spotty in recent years and 2001 we were able to collect adults from the lower Kennebec River only. The concentration of mercury was within the range of previous years and similar to those of striped bass Table 1.2.1). However, the concentration of PCBs was much higher than measured previously. The concentration exceeded the Maine Bureau of Health's Fish Tissue Action Level (FTAL=0.2 ppm) for mercury and greatly exceeded the the FTAL (11 ppb) for PCB. It is curious that mercury levels are more similar among stations than are PCB. Additional data will be collected in 2002.

Table 1.2.1 Mercury and PCB concentrations in striped bass and bluefish

WATER & LOCATION	STATION CODE	SPECIES CODE	1995 HG ppm	1996 HG ppm	1997 HG ppm	1998 HG ppm	1999 HG ppm	2000 HG ppm	2001 HG ppm
Androscoggin R									
Brunswick	ARB	STB				0.38		0.22	
Kennebec R									
Augusta	KAG	STB			0.33	0.4	0.32		
Phippsburg	KRP	STB	0.17, 0.53						
	KRP	BLF	0.53						0.39
Penobscot R									
Orrington	PBO	STB							0.15
Saco Bay									
Saco		STB						0.18	
Scarborough R									
Scarborough		STB				0.37			
		BLF				0.33			
Sheepscot R									
Wiscasset	SRW	STB						0.22	
York R									
York	YRY	STB							0.12

WATER & LOCATION	STATION CODE	SPECIES CODE	1995 PCB ppb	1996 PCB ppb	1997 PCB ppb	1998 PCB ppb	1999 PCB ppb	2000 PCB ppb	2001 PCB ppb
Androscoggin R									
Brunswick	ARB/ABK	STB				40.7			
Kennebec R									
Augusta	KAG	STB			11.8	15.8	10.7		
Phippsburg	KRP	STB	17.4, 22.4						
	KRP	BLF	48.8						276
Penobscot R									
Orrington	PBO	STB							83.5
Saco Bay									
Saco		STB				16.3		25	
Scarborough R									
Scarborough		STB							
		BLF							
Sheepscot R									
Wiscasset	SRW	STB							
York R									
York	YRY	STB							64.3

Raw data

ID	LENGTH mm	HG mg/kg
Kennebec R, Bath		
KRP-BLF-1	762	0.2215
KRP-BLF-2	762	0.2714
KRP-BLF-3	762	0.2800
KRP-BLF-4	813	0.6376
KRP-BLF-5	838	0.5156
mean	**787**	**0.39**
Penobscot R, Orrington		
PBO-STB-1	625	0.1343
PBO-STB-2	640	0.2019
PBO-STB-3	620	0.1488
PBO-STB-4	585	0.1202
PBO-STB-5	540	0.1223
mean	**602**	**0.15**
York R, York		
YRY-STB-1	622	0.1196
YRY-STB-2	660	0.1472
YRY-STB-3	527	0.0966
YRY-STB-4	578	0.1010
YRY-STB-5	559	0.1376
mean	**589**	**0.12**

Raw data

ID	LENGTH mm	PCB ug/kg
Kennebec R, Bath		
KRP-BLF-1	762	354
KRP-BLF-2	762	155
KRP-BLF-3	762	296
KRP-BLF-4	813	386
KRP-BLF-5	838	188
mean	**787**	**276**
Penobscot R, Orrington		
PBO-STB-1	625	47.9
PBO-STB-2	640	46.2
PBO-STB-3	620	122
PBO-STB-4	585	76.3
PBO-STB-5	540	125
mean	**602**	**83.5**
York R, York		
YRY-STB-1	622	63.0
YRY-STB-2	660	75.8
YRY-STB-3	527	33.6
YRY-STB-4	578	71.9
YRY-STB-5	559	77.4
mean	**589**	**64.3**

1.3

CONTAMINANTS IN SPARROWS IN COASTAL MARSHES

Mercury Exposure Profile for Sharp-tailed Sparrows Breeding in Coastal Maine Salt Marshes

(BRI 2002-11)

BioDiversity Research Institute is a Maine-based nonprofit research group dedicated to progressive environmental research and education that furthers global sustainability and conservation policies. Fundamental studies involve avian conservation and aquatic toxicology. We believe high trophic level piscivorous wildlife are vital indicators of aquatic integrity.

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Hg Exposure Profile for Sharp-tailed Sparrows Breeding in Coastal Maine Salt Marshes

(BRI 2002 – 11)

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INTRODUCTION

Sharp-tailed sparrows (*Ammodramus* spp.) inhabit wet meadows, marshes, and salt marshes of central and eastern North America. The taxonomy, distribution, and evolutionary history of this group has been debated for over a century. In 1995, based on morphological and genetic evidence, the American Ornithologists Union committee on classification and nomenclature voted to separate this single species with five known sub-species into two species: a northern species, *Ammodramus nelsoni*, with 3 sub-species (*A. n. nelsoni, A. n. alterus*, and *A. n subvirgatus*) and a southern species, *A. caudacutus* with two sub-species (*A. c. caudacutus and A. c. diverus*), limited to coastal wetlands. *A. n. subvirgatus* (hereafter Nelson’s Sparrow) and *A. c. caudacutus* (hereafter Saltmarsh Sparrow) are sympatric in coastal Maine, New Hampshire, and the northeast shore of Massachusetts.

The biomagnification of mercury (Hg) in aquatic biota is well known (Watras and Huckabee 1994), however its expression in insectivorous birds is not well studied (see review in Thompson 1996). Terrestrial species have recently been selected to serve as potential bioindicators of contaminants including Tree Swallows (*Tachycineata bicolor*) for Hg exposure (Gerrard and St. Louis 2001) and organochlorines (Secord et al. 1999) and American Robins (*Turdus migratorius*) for lead (Johnson et al. 1999).

We believe sharp-tailed sparrows are an appropriate indicator of methylmercury availability in coastal marshes. Our two target species spend their entire life-cycle in salt marsh habitats of the Atlantic coast. Their small breeding territories afford an excellent opportunity to determine contaminant exposure for target marshes and even specific areas within a marsh. Because of increasing urbanization surrounding these habitats a better understanding of contaminant ecological impacts has been identified and is of national interest (Newman et al. 2002).

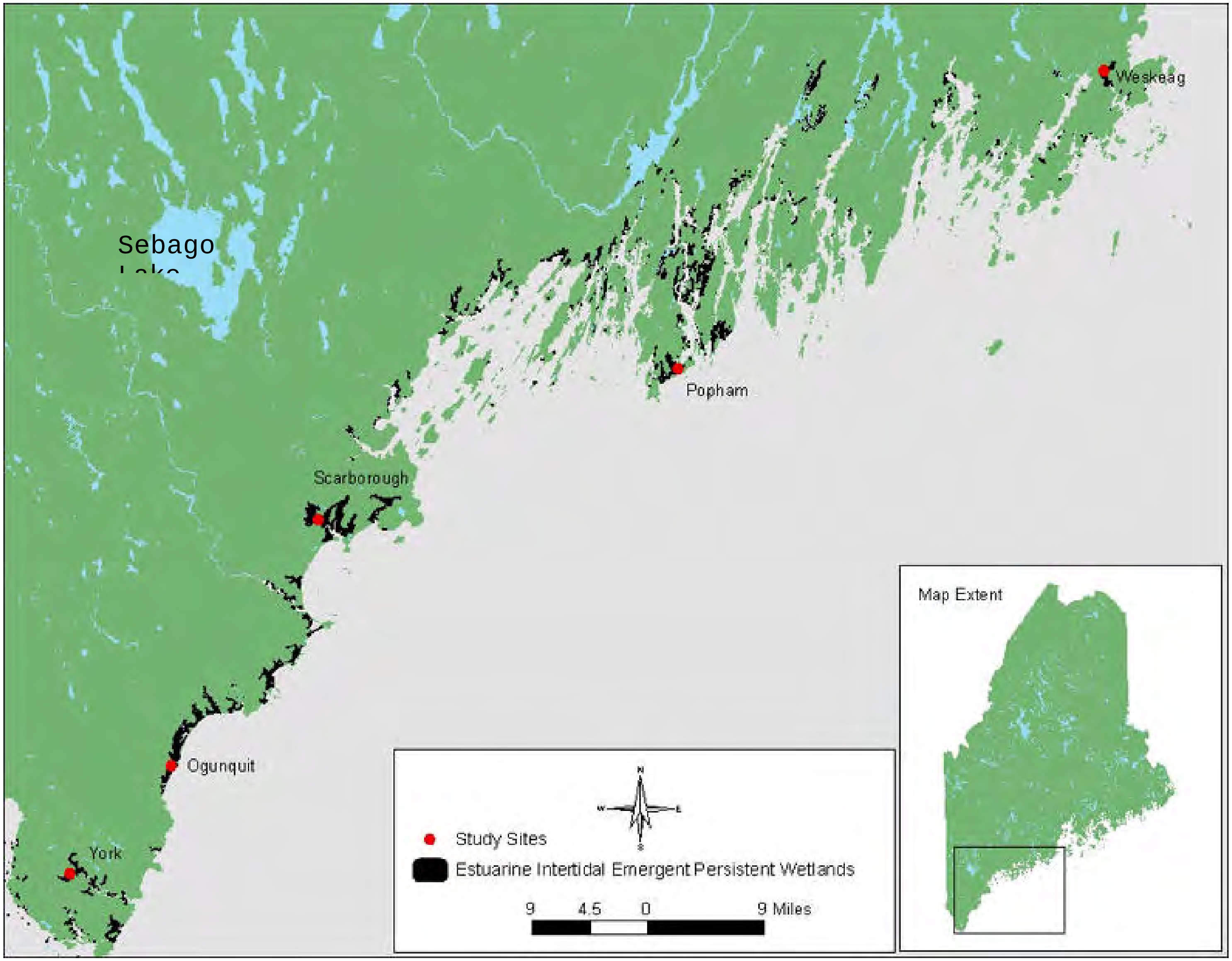
The objectives of this study were to 1) determine the extent of Hg exposure in two species of sharp-tailed sparrows in coastal Maine salt marshes, 2) compare blood Hg between Saltmarsh and Nelson's sparrows, and 3) determine if there were differences in Hg exposure among five Maine salt marshes.

STUDY AREA & METHODS

We sampled sharp-tailed sparrows from 5 marshes along the Maine coast during the breeding seasons (15 June-1 August 2001) of 2000 and 2001 (Figure 1). We used mist nets to capture sparrows and attached a U.S. Fish and Wildlife Service band and three color-bands to each individual. We used a wing cord ruler to measure unbended wing cord and dividers to measure tarsus length. We weighed all sparrows using a spring scale to the nearest 0.25 gm. We collected 30 µl – 50 µl of blood from the cutaneous ulnar vein for Hg contamination analysis using a micro-pipette. Micro-pipettes were stored in a test-tube and placed in a cooler immediately after collection. All samples were frozen on the day of collection and were maintained at <25^{o} (F) until contamination analyses were conducted. Blood Hg levels are generally not compromised by body burden Hg levels during the breeding season (Evers et al. 1998).

We used independent *t* tests to determine differences in blood Hg levels between species and sex. If differences were significant between species or sex we then conducted further analyses separately. We used ANOVA with Tukey's post-hoc tests to determine if differences existed in blood Hg levels among the 5 sites. If there were differences among sites we then used ANOVA to determine if there were weight (g) or wing cord (mm) differences between high and low Hg level sites. All means are presented ± 1 SE.

Figure 1. Study sites with estuarine wetlands.



RESULTS

We captured and drew blood from 81 sharp-tailed sparrows (28 Nelson's and 54 Saltmarsh) in 5 marshes on the Maine coast (Table 1). Saltmarsh Sparrows (mean = 0.69 $\pm$ 0.03) had 41% greater blood Hg levels than Nelson's Sparrows (mean = 0.41 +/- 0.03) (t = 6.338, df = 79, P < 0.001, Figure 2). There was no difference in blood Hg levels between males and females for either species (Nelson's t = 1.69, df = 23, P = 0.171; Saltmarsh t = 0.848, df = 48, P = 0.401). We detected a difference in blood Hg levels among sites for both species (Nelson's F = 7.402, df = 4, P = 0.001; Saltmarsh F = 6.154, df = 4, P < 0.001, Figure 3 A and B). Popham beech and Ogunquit were highest in blood Hg for both species (Figure 3A and B). Sparrow weight and wing cord did not differ between high and low Hg level sites for either species (Nelson's weight F = 0.128, df = 1, P = 0.723, Nelson's wing cord F = 4.097, df =1, P = 0.053; Saltmarsh weight F = 1.219, df = 1, P = 0.275, Saltmarsh wing cord F = 1.542, df = 1, P = 0.220). There was a significant difference in weight between sparrow species.

Figure 2. Differences in blood Hg between Nelson's Sparrow and Saltmarsh Sparrow. Saltmarsh Sparrows had significantly more blood Hg than Nelson's Sparrow. (mean+-se ppm)

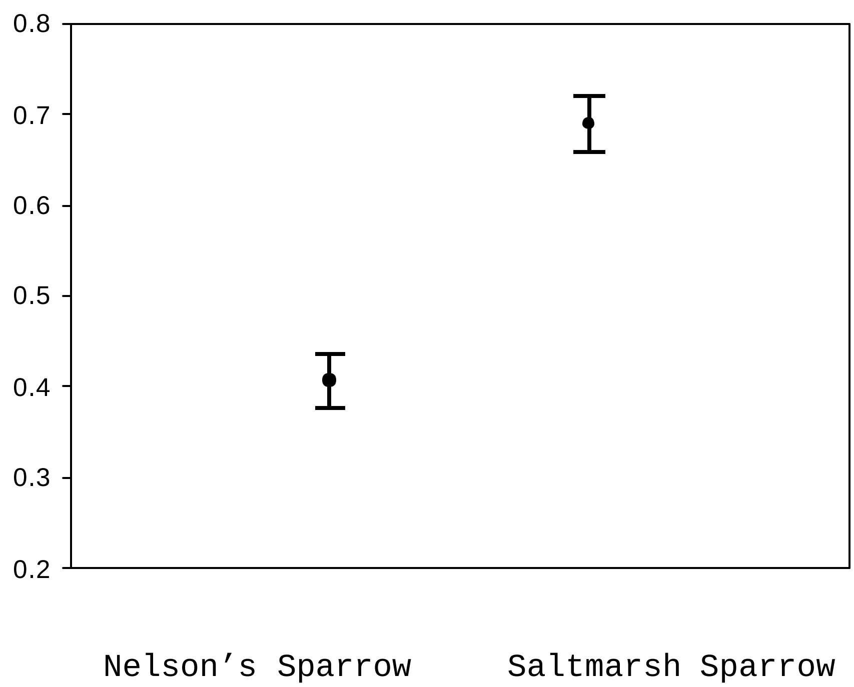
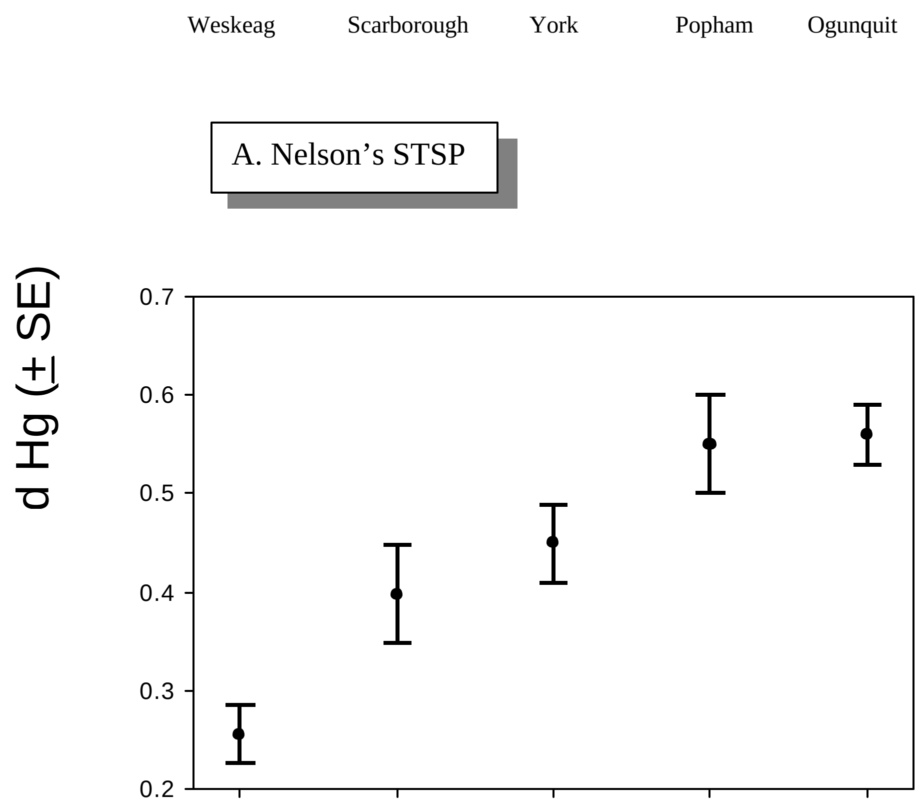
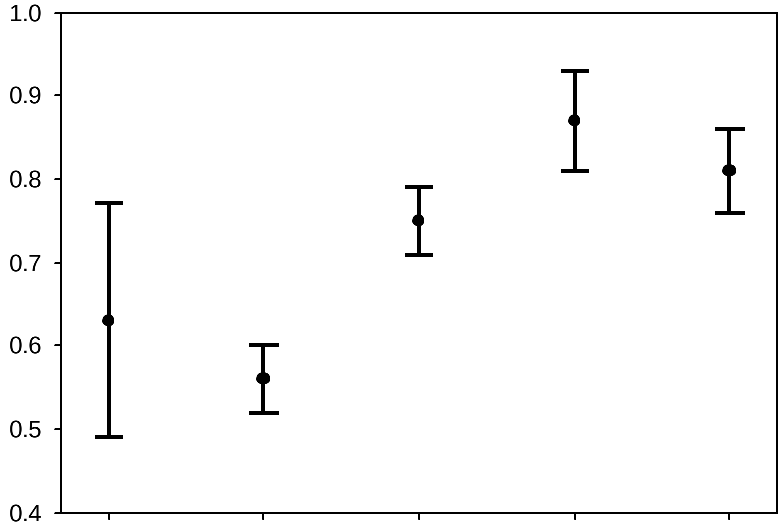


Figure 3. Differences in blood Hg between sites for A) Nelson's Sparrow and B) Saltmarsh Sparrow. Blood Hg levels were highest at Popham and Ogunquit for both species





B SALTMARSH STSP

Table 1. Sampling locations, sample sizes and mean weight and wing cord for Saltmarsh and Nelson's Sharp-tailed Sparrows in coastal Maine (2000-2001).

		Saltmarsh Sharp-tailed Sparrow					Nelson's Sharp-tailed Sparrow				
Site	Lat / Long	Male	Female	Juvs	Mean Weight (g)	Mean Wing Cord (mm)	Males	Females	Juvs.	Mean Weight (g)	Mean Wing Cord (mm)
Weskeag	N 44 04.680 W 69 08.625	4	1	0	21.1 (0.6)	57.9 (2.2)	6	0	3	18.0 (0.8)	57.1 (1.1)
Popham	N 43 44.37 W 69 48.247	6	0	0	22.6 (0.5)	59.8 (0.8)	4	2	0	19.3 (0.7)	55.9 (1.6)
Scarborough	N 43 33.90 W 70 21.67	16	6	0	20.3 (1.6)	57.2 (1.3)	6	2	0	17.7 (1.7)	57.3 (2.1)
Ogunquit	N 43 17.02 W 70 34.92	7	4	0	20.3 (1.6)	57.6 (2.7)	3	0	0	18.3 (1.5)	56.8 (1.0)
York	N 43 09.64 W 70 44.01	6	1	3	19.2 (1.9)	56.9 (2.1)	2	0	0	18.4 (0.9)	57.0 (1.4)
TOTAL		39	12	3	20.7 +/- 1.3	57.9 +/- 1.1	21	4	3	18.3 +/- 0.6	56.8 +/- 0.5

DISCUSSION

We found nearly twice the Hg blood levels in Saltmarsh Sparrows than we did in Nelson's Sparrows at all five sites. This pattern was not predicted as both species spend their entire life-cycle in salt marsh habitat, presumably exposed to the same levels of contamination. Differential prey selection by sparrows could explain differences in the observed blood Hg levels. If Saltmarsh Sparrows, which are larger and have larger beaks, selected carnivorous prey while the smaller Nelson's Sparrows selected herbivorous prey, then we would expect to see higher levels of blood Hg in Saltmarsh Sparrows. Because these sparrows were recently split into two separate species (1995), little is known about dietary differences between them that may explain differences in blood Hg levels we found during this study.

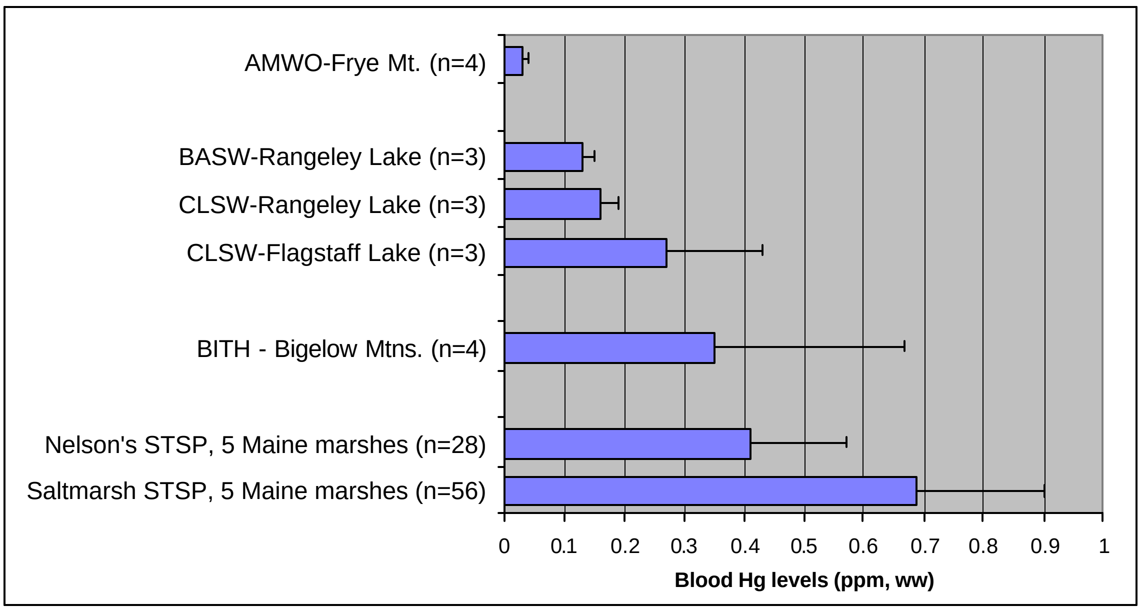
We also found differences among the five salt marshes we sampled; indicating that blood Hg levels in sharp-tailed sparrows may be used as an index to Hg contamination in the salt marshes. This finding was supported by the similar pattern in Hg levels within each species across the five sites. For both species, blood Hg levels were highest in Popham and Ogunquit, intermediate at York, and lowest in Scarborough and Weskeag. This consistency in blood Hg levels in the two species across the five sites indicates that these sparrows may be potential indicators of salt marsh and estuarine Hg contamination.

Comparing our sparrow blood Hg levels with other related species is difficult. The handful of terrestrial bird Hg studies are not based on blood, rather their assessments use whole body analysis and/or organs (i.e., lethal sampling). However, our non-lethal sampling strategy for this project is comparable with other such collection efforts with insectivorous birds in Maine. BioDiversity Research Institute staff have sampled terrestrial birds including American Woodcock (*Scolopax minor*) (AMWO), Barn Swallow (*Hirundo rustica*) (BASW), Cliff Swallow (Petrochelidon pyrrhonota) (CLSW), and Bicknell's Thrush (Catharus bicknelli) (BITH) (Figure 4).

The sampling efforts with the swallows are particularly informative as a reference for Hg exposure. Swallows were sampled from two lakes that have thorough biotic Hg risk assessments based on fish and the Common Loon (*Gavia immer*) (Evers et al. 2002). Because swallow sample sizes are minimal statistical comparisons were not attempted. Barn and Cliff Swallows from Rangeley Lake, a low Hg risk system, had mean blood Hg levels considerably less than those found from both sharp-tailed sparrow species in each of the five marshes. Assuming a relationship exists between fish Hg levels and associated emerging insects, reference blood Hg levels for insectivorous birds are possibly less than 0.20 ppm (ww). Flagstaff Lake is well known for its elevated biotic Hg levels (Evers et al. 2002). Cliff Swallow blood Hg levels tended to be less on Flagstaff Lake than sharp-tailed sparrow blood Hg levels.

Further efforts with swallow species in areas with known biotic Hg assessments as well as at the sharp-tailed sparrow locations will provide further context for assessing hazards related to Hg levels in coastal Maine's salt marshes.

Figure 4. Blood Hg levels in selected insectivorous birds in



New England

RECOMMENDATIONS

1. Determine Hg exposure for sharp-tailed sparrows in other Maine coastal marshes with large breeding populations;
2. Determine Hg exposure for Tree Swallows with breeding territories in coastal marshes with sharp-tailed sparrows at some locations for comparative purposes;
3. Determine Hg exposure for swallow species with breeding territories in areas with known biotic Hg levels;
4. Determine prey base of sharp-tailed sparrows and analyze prey items for Hg;
5. Measure levels of other contaminants including polychlorinated biphenyls in sharp-tailed sparrows.

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Raw Data

Note	Flag	Hg, ppm	MDL, ppm	Weight	
Blood, Juvenile, Unk, SSTS, 2001, York		0.68	0.00335	0.0326	Y
Blood, Juvenile, Unk, SSTS, 2001, York		0.784	0.00575	0.0377	Y
Blood, Juvenile, Unk, SSTS, 2001, York		0.734	0.00601	0.0357	Y
Blood, Juvenile, Unk, NSTS, 2001, Weskeag		0.107	0.012	0.0088	W
Blood, Juvenile, Unk, NSTS, 2001, Weskeag		0.131	0.00447	0.0584	W
Blood, Juvenile, Unk, NSTS, 2001, Weskeag		0.201	0.00222	0.0408	W
Blood, Adult, Male, SSTS, 2001, York		0.921	0.00486	0.0458	Y
Blood, Adult, Male, SSTS, 2001, York		0.758	0.00617	0.0362	Y
Blood, Adult, Male, SSTS, 2001, York		0.49	0.00469	0.0464	Y
Blood, Adult, Male, SSTS, 2001, York		0.887	0.00498	0.0438	Y
Blood, Adult, Male, SSTS, 2001, York		0.758	0.00584	0.0367	Y
Blood, Adult, Male, SSTS, 2001, York		0.757	0.00572	0.0371	Y
Blood, Adult, Male, SSTS, 2001, Weskeag; LAB NOTE: slight clot		1.17	0.0813	0.0013	W
Blood, Adult, Male, SSTS, 2001, Weskeag		0.414	0.00263	0.0414	W
Blood, Adult, Male, SSTS, 2001, Weskeag		0.479	0.00434	0.0503	W
Blood, Adult, Male, SSTS, 2001, Weskeag		0.499	0.00336	0.0319	W
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh; LAB NOTE: slight clot		0.665	0.0288	0.0037	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh: NOT ANALYZED, MAY			0.00005		
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.486	0.00326	0.0338	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.581	0.0047	0.0465	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.528	0.00583	0.0371	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.523	0.00511	0.0428	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.545	0.00328	0.0332	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.552	0.00679	0.0159	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.453	0.00361	0.0297	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.424	0.00619	0.0348	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.461	0.00452	0.0479	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.485	0.00609	0.0351	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.488	0.00367	0.0291	S
Blood, Adult, Male, SSTS, 2001, Scarborough Marsh		0.42	0.00521	0.0202	S
Blood, Adult, Male, SSTS, 2001, Popham		0.824	0.00477	0.0452	P
Blood, Adult, Male, SSTS, 2001, Popham		0.816	0.0072	0.0296	P
Blood, Adult, Male, SSTS, 2001, Popham		0.788	0.0045	0.0478	P
Blood, Adult, Male, SSTS, 2001, Popham		1.15	0.00546	0.0393	P
Blood, Adult, Male, SSTS, 2001, Popham		0.773	0.00754	0.0284	P
Blood, Adult, Male, SSTS, 2001, Popham		0.851	0.00525	0.0495	P
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.625	0.00849	0.025	O
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.762	0.007	0.0306	O
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.865	0.00674	0.0158	O
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.782	0.0155	0.0068	O
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.68	0.0053	0.0483	O
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.781	0.00704	0.0446	O
Blood, Adult, Male, SSTS, 2001, Ogunquit		0.813	0.00681	0.0456	O
Blood, Adult, Male, SSTS, 2001,		0.529	0.00542	0.0409	
Blood, Adult, Male, SSTS (Hy), 2001, Popham		0.599	0.00731	0.0302	P
Blood, Adult, Male, SSTS (Hy), 2001, Ogunquit		0.707	0.00595	0.0371	O
Blood, Adult, Male, Otter, 2001, Chain of Ponds - Lower		0.244	0.00434	0.0601	
Blood, Adult, Male, NSTS, 2001, York		0.414	0.00244	0.0525	Y
Blood, Adult, Male, NSTS, 2001, York		0.485	0.00406	0.026	Y
Blood, Adult, Male, NSTS, 2001, Weskeag		0.325	0.00219	0.059	W
Blood, Adult, Male, NSTS, 2001, Weskeag		0.282	0.00321	0.0332	W
Blood, Adult, Male, NSTS, 2001, Weskeag		0.296	0.00221	0.0409	W
Blood, Adult, Male, NSTS, 2001, Weskeag		0.323	0.00237	0.0381	W
Blood, Adult, Male, NSTS, 2001, Weskeag		0.267	0.00298	0.0299	W
Blood, Adult, Male, NSTS, 2001, Weskeag		0.373	0.00352	0.0517	W
Blood, Adult, Male, NSTS, 2001, Scarborough Marsh; LAB NOTE: slight clot		0.484	0.0036	0.0249	S
Blood, Adult, Male, NSTS, 2001, Scarborough Marsh; LAB NOTE: slight clot		0.203	0.00511	0.0134	S
Blood, Adult, Male, NSTS, 2001, Scarborough Marsh		0.431	0.00509	0.0351	S
Blood, Adult, Male, NSTS, 2001, Scarborough Marsh		0.31	0.00328	0.0272	S
Blood, Adult, Male, NSTS, 2001, Scarborough Marsh		0.419	0.00666	0.0268	S
Blood, Adult, Male, NSTS, 2001, Popham		0.599	0.00538	0.0335	P
Blood, Adult, Male, NSTS, 2001, Popham		0.494	0.00516	0.0346	P
Blood, Adult, Male, NSTS, 2001, Popham		0.553	0.00454	0.0397	P
Blood, Adult, Male, NSTS, 2001, Popham		0.546	0.0105	0.0065	P
Blood, Adult, Male, NSTS, 2001, Ogunquit		0.616	0.00795	0.0086	O
Blood, Adult, Male, NSTS, 2001, Ogunquit		0.527	0.0117	0.0058	O
Blood, Adult, Male, NSTS, 2001, Ogunquit		0.539	0.0204	0.0455	O
Blood, Adult, Female, SSTS, 2001, York		0.744	0.00462	0.0468	Y
Blood, Adult, Female, SSTS, 2001, Weskeag		0.569	0.00599	0.0522	W
Blood, Adult, Female, SSTS, 2001, Scarborough Marsh		0.446	0.00378	0.0289	S
Blood, Adult, Female, SSTS, 2001, Scarborough Marsh		0.806	0.0267	0.004	S

1.4

PERSISTENT ORGANIC POLLUTANTS IN SEALS

Final Report to the Surface Water Ambient Toxic Monitoring Program
State of Maine Department of Environmental Protection

An Investigation of Persistent Organic Pollutants (POPs) and Heavy Metals in Tissues of Harbor Seals and Gray Seals in the Gulf of Maine

Susan D. Shaw, Dr.P.H., Marine Environmental Research Institute (MERI)

Background

Levels of environmental contaminants have not been extensively investigated in Gulf of Maine seals despite the fact that they are at the top of the marine food web and are likely to be exposed to polluted habitats and prey in their range. PCBs, dioxins, and mercury (Hg) are prevalent in Maine's marine environment and are of concern because of their documented immune and endocrine-disrupting potential in seals, other marine wildlife, and humans (Shaw and De Guise, 2000; De Guise, Shaw *et al*, 2001). Over the past three decades, endocrine disrupting contaminants have been linked with deleterious impacts on the reproductive and immune systems of seals in the Baltic Sea, the North Sea, and other polluted waters.

This project was initiated in 2001 as part of a multiyear investigation of the impacts of environmental pollutants on the health of Gulf of Maine seal populations. Because the habitat of seals breeding in Maine extends southward past Long Island, NY, in order to ensure that our samples were representative we made an effort to obtain samples from seals throughout the range. A major goal of the first phase of the research is to generate baseline information about contaminant levels in seals and identify some of the factors (age, gender, geographic) influencing their contaminant burdens. The study also includes baseline measures of immune and endocrine function in live animals as possible biomarkers of health status that may be related to contaminant loads.

Sample Collection 2001-2002

From April – February 2001-2002, samples were collected from a total of 64 seals -- 51 harbor seals (*Phoca vitulina concolor*) and 13 gray seals (*Halichoerus grypus*)-- in 5 regions of the Gulf of Maine: mid-coast Maine, southern Maine, Massachussetts Bay, Nantucket/Long Island Sounds, and eastern Long Island (Figure 1). No samples were obtained from downeast Maine. Samples were collected from both freshly dead and live stranded seals (Table 1). Blubber, hair, liver, kidney, and skin samples were collected from dead stranded seals (n=51). Blood and hair samples were collected from live stranded seals (n=13) during rehabilitation. Detailed biometric information was obtained for each study animal. Gender was nearly equally distributed (32 males, 28 females, 4 unknown). Pups and juveniles outnumbered adults.

Tissue Analysis

In dead stranded seals, PCBs, coplanar PCBs, PCDD/Fs, and 22 organochlorine pesticides were quantified in blubber samples. Mercury and inorganics were measured in hair and liver samples. In live stranded seals, metals and inorganics were measured in hair samples. Blood samples were used in assays of immune function (lymphocyte proliferative responses to mitogens). Thyroid hormones, sex hormones, cortisol, and retinol (vitamin A) levels were measured in seal plasma samples. Although in general, sample quality was good, samples were lost in some cases due to sampling limitations and inconsistencies (for example, limited blood samples taken during live animal restraint); in addition, a small fraction of samples deteriorated during shipment and could not be analyzed.

Results and Discussion

The initial focus of the analysis was on exposure assessments, comparing mean levels of organochlorines and metals in stranded seals from different regions, and looking at factors (age, species, sex, condition) influencing contaminant burdens. More preliminary data are presented on *in vitro* lymphocyte proliferative responses to mitogens, thyroid hormones, reproductive hormones, cortisol, and retinol (vitamin A) levels in a small subset of live seals. Analysis of these data are in the early stages, and with larger sample sizes, they will be used in an overall assessment of health risks that may be associated with contaminant burdens in these seals.

Organochlorine Contaminant Levels in Dead Stranded Seals

The dead stranded animals were predominantly harbor seals (92.2%) with 4 gray seals (7.8%). The majority were yearlings (51%) and pups (22%), with 7 adults and 3 fetuses. Four seals were of unknown ages. Gender was equally distributed.

Blubber concentrations of total PCB (sum of 28 congeners) detected in the dead stranded seals (whole group, n=37) was relatively high (mean 25.2 ± 30.4, range 3-150 µg/g, lipid weight) (Table 2). Five animals including two yearlings and two pups had total PCB levels >50 ppm (lipid basis). To assess the potential toxicity of 4 non-*ortho* coplanar PCBs and eight mono-*ortho* semi-coplanar PCBs, their dioxin toxic equivalents (TEQs) were calculated for individual blubber samples. The total TEQ of seals in this study ranged from 14.8 to 391.6 pg/g (ppt). Comparing the total TEQs contributed by non-*ortho* and mono-*ortho* PCBs, the highly toxic non-*ortho* PCBs were predominant in these samples.

Of 22 OC pesticides analyzed in seal blubber (Table 3), six compounds were found at higher (ppm) levels (in descending order)– *p,p*'-DDE, *trans*-nonachlor, oxychlordane, *cis*-nonachlor, endosulfan sulfate, and *p,p*'-DDT. The pesticides heptachlor epoxide, *p,p*'-DDD, ?-chlordane, *a*-BHC, mirex, and dieldrin were detected in seal blubber at lower (ppb) levels. Aldrin, ß-BHC, *d*-BHC, ?-BHC, a-chlordane, endosulfan, endrin, endrin aldehyde, endrin ketone, heptachlor, hexachlorobenzene, methoxychlor, *o,p*-DDD, *o,p*-DDE, *o,p*-DDT, and were detected in seal blubber at trace levels.

Looking at regional distributions (Table 4), mean concentrations of total PCBs were higher in blubber of seals from southern Maine (mean PCB 34.6 µg/g, lipid weight) and levels of *p,p*'-DDE, *p,p*'-DDT, and *trans*-nonachlor were higher in seals from the mid-Maine coast, but the differences were not significant. Several compounds found at trace levels including a-chlordane, *d*-BHC, endosulfan, endrin aldehyde, heptachlor, methoxychlor, *o,p*-DDD, *o,p*-DDE, and *o,p*-DDT were significantly higher in mid-coast Maine seals (p=.038). The reasons for the higher pesticide levels in mid-coast Maine seals are not clear, and may be an artifect of the relatively small number of seals in each regional group.

The influence of age, sex, species, and condition on contaminant burdens was examined. Only samples considered to be in good condition were included in the analysis. In general, higher levels of PCBs and OC pesticides were found in pups (mean 35.1 and 19.8 μg/g, lipid basis, for PCBs and *p,p'*-DDE) followed by yearlings, but the differences were not significant with the exception that a-BHC levels were significantly higher in pups (p=.045). No significant differences were found in OC contaminant loads with respect to gender or species.

Little data have been generated on contaminant levels in seals along the US Northeast coast since 1972 when the Marine Mammal Protection Act was passed, thus temporal and spatial trends are not clear. Comparisons with data from the early 1970s must be viewed with caution because sampling locations are not identical and analytical methods have changed substantially. The mean blubber concentrations of PCBs (25.2 μg/g, lipid weight [21.5 μg/g, wet weight]) and *p,p'*-DDE (9.9 μg/g, lipid weight [7.9 μg/g, wet weight]) found in this study were considerably lower than those found in Gulf of Maine harbor seals in 1972 (mean PCB 92.5 and *p,p'*-DDE 35-53 μg/g, wet weight) (Gaskin *et al*, 1973), suggesting a general decrease in PCB and *p,p'*-DDE levels in Gulf of Maine seals over a thirty-year period. However, the PCB levels found in this study are somewhat higher than levels found in Sable Island, Nova Scotia gray seals (15.7 μg/g, wet weight) (Addison *et.al*., 1984) in the mid-1980s.

A more recent study (Lake *et. al.* 1995) analyzed contaminant levels in blubber of 6 stranded dead harbor seals from Cape Cod sampled in 1980 and 9 stranded (live and dead) harbor seals from Long Island, NY, sampled in 1990-92 and found that OC levels had decreased in harbor seals over the period. However, the mean blubber concentrations of PCBs reported in both the 1980 Cape Cod samples (12 μg/g, wet weight) and the 1990-92 Long Island samples (6.7 μg/g, wet weight) were lower than the levels found in this study. Levels of *p,p'*-DDE found in this study were slightly lower than those reported for the 1980 samples (10.9 μg/g, wet weight) but almost two-fold higher than the *p,p'*-DDE levels reported for harbor seals sampled off Long Island in 1990-92 (4.1 μg/g, wet weight). Levels of hexachlorobenzene, trans-nonachlor, and mirex were also higher in seal blubber in this study compared with levels reported in the 1990-92 samples. Although limited by the small sample sizes per region, regional comparisons in this study showed that seals from southern Maine had the highest blubber PCB concentrations and seals from the mid-Maine coast had the highest levels of *p,p'*-DDE, *p,p'*-DDT, and *trans*-nonachlor, suggesting that levels of persistent organochlorines may not be decreasing in seals uniformly across the region. This also underlines the need for more research to clarify temporal and spatial trends in contaminant burdens of Gulf of Maine seals.

Metals and Trace Elements in Stranded Seals

The metals of greatest toxicological concern in seals are mercury (Hg), cadmium (Cd), and lead (Pb) (reviewed by Papa and Becker, 1998). There is little reported information about the levels or toxicological significance of metals other than mercury (arsenic, cadmium, chromium, lead, and silver) and trace elements (selenium, copper, and zinc) in seals from the Gulf of Maine. Until this study, levels of trace elements and toxic metals other than Hg have not been reported in seals along the US Northeast coast.

Mercury

Generally, metals and trace elements in hair of these seals were found at concentrations of minor concern with the exception of Hg. Hg is a known neurotoxin, causing damage to the cerebellum (area of the brain that controls balance) and occipital cortex area (area that controls vision). In seals, low dose Hg exposure causes appetite reduction and weight loss, while high doses result in death from renal failure.

Hair is considered a conservative estimate of the Hg burden in seals, with levels in liver being much higher, and increasing with age. Hepatic concentrations of Hg in the dead stranded seals (n=38) were more than three-fold higher than hair levels (mean 14.5, range 0.2-113.6) (Table 5). Hg levels found in hair of the live seals (mean 2.8, range 0.4-10.2 μg/g dry weight) were similar to the levels found in hair samples of live stranded harbor seal pups from southern Maine (Harris, 1999). Hg levels in hair of the dead stranded seals (predominantly yearlings and pups) were slightly higher (mean 3.7, range 0.7-23 μg/g dry weight), some animals having Hg levels >10 ppm. The Hg levels in hair for both groups (live and dead) are higher than those previously reported in harbor seals from eastern Canada (Sargent and Armstrong, 1973).

Hg levels in hair directly reflect levels in blood during the period of hair growth, thus hair samples taken from pups reflect their blood Hg levels during fetal and neonatal development. Hg passes freely through the placenta and through milk during lactation, and the clearance of ingested Hg is relatively rapid for most mammals. Thus, the Hg level in hair of seal pups reflects the mother's exposure to Hg during late pregnancy and lactation, and the level of Hg in food (fish) if the pup has has begun to feed independently. The threshold level for toxic effects of Hg in young seals is unknown. In humans, maternal hair Hg levels above 10 ppm are associated with neurobehavioral dysfunction in children (Grandjean *et.al*., 1994). In laboratory animals (mice), exposure to low-level Hg contamination has resulted in subtle behavioral changes. Since the seals in this study are predominantly pups and yearlings, maternal transfer of Hg is of concern.

Comparing regional distributions of total Hg, body burdens in hair of the live and dead stranded seals did not vary significantly (Table 6). In the live seals, Hg levels were higher in mid-Maine and Long Island East than in southern Maine, but the differences were not significant. Liver Hg levels in the dead stranded seals were much higher in seals from mid-coast Maine (mean 28.7, range 0.3-113.6 μg/g wet weight) and Long Island Sound (mean 27, range 0.4-104 μg/g dry weight) than in seals from southern Maine and Long Island East, but these differences were not significant. Looking at age differences, liver Hg levels were significantly higher in adults compared with levels in the fetus (p=.004). No significant differences were found in Hg burdens with respect to gender or species.

In this study, some of the adult seals showed total hepatic Hg concentrations (mean 93.1 μg/g wet weight, range 51-133.6) that exceed the threshold levels of 60 mg/kg for liver damage in mammals (AMAP, 1998). However, high Hg is known to be common in livers of marine mammals, and in most cases is not associated with any pathology as marine mammals have apparently evolved biochemical mechanisms involving selenium to detoxify and store Hg. Levels as high as 751 ppm (wet weight) have been reported in Wadden Sea harbor seals (Reijnders, 1980) and 1097 ppm (wet weight) in UK gray seals (Simmonds *et.al*, 1993). It is proposed that the tolerance of marine mammals to high Hg exposure involves distribution of Hg from sensitive organs to muscle and other tissue, formation of stable Hg-selenium complexes, conversion of toxic (methylated) Hg to less toxic forms (i.e., divalent), and prevention of oxidative damage (reviewed by O'Shea, 1999). Whereas Hg in fish muscle is mostly in the highly toxic methylated form, in marine mammals the proportion of methylated Hg in liver is low (5-15%), but high in muscle and epidermis. The inactive Hg-Se complexes are stored mainly in the liver and prevent harm to the animal. If selenium levels are inadequate, Hg may be bound to and detoxified by metallothioneins. There is evidence, however that the ability to de-toxify mercury may not be present in newborn and young seals. It is unclear to what extent this places young and developing seals at risk for Hg toxicoses.

Along the US Northeast coast, Lake *et.al.* (1995) reported lower hepatic Hg levels in a subset of Cape Cod harbor seals (n=4) sampled in 1980 (mean 38.5, range 31.6-49.3 µg/g wet weight) compared with levels in Long Island harbor seals (n=3) sampled in 1990-92 (mean 69.9, range 16-138 µg/g wet weight). The hepatic Hg levels found in adults seals in this study exceed levels reported for both the 1980 and 1990-92 groups, suggesting that Hg accumulation may be increasing in Gulf of Maine seals.

Other Metals and Trace Elements

Metals (other than Hg) and trace elements were measured in hair samples from both dead and live stranded seals (dead seals,n=37/live seals, n=12) (Table 7). There were few differences between the two groups. Levels of arsenic were slightly higher in dead stranded seals (p=.047), while the live seals had higher levels of selenium (p=.046), and zinc (p=.033). Levels of the toxic metals Cd, Pb, Ag, As, and Cr were found at relatively low concentrations in both groups.

Some regional differences were found in levels of chromium (Cr), selenium (Se), and zinc (Zn) in hair samples of dead stranded seals (Table 8). Most of these consisted of differences between levels in seals at both locations in Maine versus seals located further south. In mid-coast Maine seals, mean levels of Cr were significantly lower compared with seals from Mass Bay (p=.049) and Long Island East (p=.013). Cr levels in seals from southern Maine were also lower than levels in seals from Long Island East (p=.028). Se levels were higher in seals from southern Maine compared with seals from Mass Bay (p=.028). Zn levels were higher in seals from southern Maine than levels in seals from Long Island Sound (p=.033) and Long Island East (p=.003). No differences were found between levels of metals in seals from regions outside Maine with the exception that Zn levels were slightly higher in seals from Mass Bay versus Long Island East (p=.046).

In the dead stranded seals, levels of nickel (Ni) were significantly higher in pups (p=.014) and yearlings (p=.001) compared with levels in the fetus. Cadmium (Cd) levels were higher in yearlings (p=.05) and adult seals (p=.024) compared with levels in the fetus. No significant differences were found in body burdens of heavy metals or trace elements with respect to gender or species.

Because of the small number of samples obtained from live stranded seals, the utility of the data analysis by region is very limited. Samples were obtained only from southern and mid-coast Maine and Long Island East; other regions (downeast Maine, Massachusetts Bay, Long Island Sound) are not represented. However, some variability by region and age was evident, and the data suggest that live stranded seals along southern and mid-coast Maine have body burdens of toxic metals comparable to or higher than levels in seals along the eastern shore of Long Island, NY.

Table 9 shows that seals from southern Maine had higher As levels compared with seals from Long Island East ($p=.033$), the latter group having higher levels than those in seals from the mid-Maine coast ($p<.0001$). Seals from southern Maine also had higher Cd levels compared with seals from Long Island East ($p=.038$). Seals from southern Maine had higher Cr levels than seals in other regions, but the differences were not significant. Higher Pb levels were found in hair of seals from Long Island East compared with in seals in southern Maine ($p=.045$). Zn levels were higher in seals from the mid-Maine coast, but the differences were not significant.

In the live seals, no differences were found with respect to species and gender. Significantly higher levels of silver (Ag) were found in pups versus yearlings ($p=.031$). Compared with pups, yearlings had much higher levels of Se in hair, but the differences were not significant.

Markers of Immune Function in Live Stranded Seals

Immune function was examined in a small subset of live animals ($n=6$) comprised entirely of gray seal pups. The assay measures the proliferative response of seal lymphocytes to stimulation by 3 mitogens *in vitro* by quantifying the uptake by blast cells of bromodeoxyuridine (BrDU), a non-radioactive analogue of tritiated thymidine. Results are given as the Stimulation Index (SI), a qualitative measure reflecting the ratio of stimulated to unstimulated cells in culture (Table 10). The preliminary data show that seal lymphocytes responded well to the T cell mitogens Concanavalin A (Con A) and phytohemmaglutinin (PHA) and the B cell mitogen lipopolysaccharide (LPS) at optimal mitogen concentrations.

Looking at the SI for each mitogen, the order of responses was Con A > LPS > PHA in these seals, which agrees with previous studies of mitogen responses in seals. Mitogen responses were not significantly different by region or sex, but this likely reflects the small sample size measured to date. The lymphocyte mitogenic response assay is a promising and important tool available for application in mammalian toxicology studies. It yields unique information about overall health status and nonspecific immune resilience of individuals against pathogenic infections and parasite infestations which in some cases have caused population-level impacts. We plan to apply this assay to a much larger sample size in 2002-2003 comprising all age classes and regions to develop the assay as a marker of health that may be associated with contaminant burdens and associated risks in the populations.

Markers of Endocrine Function in Live Stranded Seals

Thyroid hormones, retinol (vitamin A), estradiol, and cortisol levels were measured in plasma samples from 9 live stranded seals comprising 7 gray seal pups and 2 harbor seal yearlings. Looking at mean concentrations for the whole group (Table 11), triiodothyronine (T3) and retinol (vitamin A) levels appear to be relatively low, while cortisol and free T3 levels are relatively high compared with ranges reported for grey seal pups and harbor seal yearlings in the literature. Comparative data for estradiol levels in young seals was not available. Thyroid hormones and retinol are important for development (somatic and brain) and immune resilience in young animals, and thus the low levels of T3, the metabolically active form of thyroid, and retinol (vitamin A) found in these seals are of concern. High cortisol levels in plasma could reflect the stress of capture and restraint while sampling the animals.

Looking at mean levels of hormones in seals by region (Table 12), estradiol levels are three-fold higher in seals from Long Island East (mean 23.1 pg/ml) compared with seals in Maine (8.1 pg/ml) ($p=.001$), which could reflect gender differences between regions (2 females, 3 males in NY vs 3 females, 1 male in ME). Vitamin A levels were extremely low in the Long Island seals (mean 4.2 ng/ml), significantly lower compared with levels in Maine seals (mean 90 ng/ml) ($p<.001$). Baseline data on normal ranges of vitamin A in young seals are not available, but the normal range of vitamin A in most young mammals is about 100-300 ng/ml. Alterations of hormones and retinol are established markers of exposure to endocrine-disrupting contaminants (*e.g.*, PCBs, DDE, other pesticides) in seals and other wildlife. We plan to expand the sample size in 2002-2003 in order to examine endocrine function in relation to contaminant loads in these seals.

Summary

While preliminary, these data are the first extensive data reported on organochlorine contaminants and metals in Gulf of Maine seals in 25 years. With the exception of one study involving a small number of harbor seals from Cape Cod and Long Island, the data mainly derive from studies of seals from eastern Canada in the early 1970s. Results of the present study indicate that Gulf of Maine seals may accumulate relatively high body burdens of organochlorines and metals through the marine food chain, in some cases levels that place them at risk for health effects

Because seals are long-lived (30-50 years) and feed at high trophic levels (mainly consuming fish), they have the potential for relatively high contaminant concentrations in their tissues and are excellent indicators of bioaccumulation. While gray seals are more pelagic (as adults), harbor seals are sedentary animals that feed, reproduce, and rest near or on shore. They occur primarily in coastal waters within 20 km of shore, often aggregate in estuaries and protected waters, and are thought to have strong affinity to specific haulout sites.

It is notable that PCB levels detected in seals (predominantly harbor seals) throughout the Gulf of Maine are comparable to or higher than the known threshold level for adverse immune, reproductive, and endocrine effects documented in captive feeding studies on harbor seals (~17-25 ppm) (De Swart *et.al.*, 1994; Reijnders, 1986; Brouwer *et.al*., 1989), and an order of magnitude higher than levels associated with reduced immune responses and endocrine alterations in 4-week old Pacific harbor seal pups (~3 ppm) (Shaw, 1998). Seal pups in this study had much higher levels of PCBs and OC pesticides (mean 35.1 and 19.8 µg/g, lipid basis, for PCBs and *p,p*'-DDE) compared with other age groups, reflecting the importance of maternal transfer of lipophilic OCs to the OC burden of the young seal. These levels are of concern given the declining pupping rates observed among harbor seals in southern and mid-coast Maine (Gilbert and Guldager, 1998).

While limited by the relatively small number of seals sampled from each region, regional comparisons suggest that seals that breed and pup along southern and mid-coast Maine have body burdens of PCBs, OC pesticides, and mercury comparable to or higher than levels in seals in polluted industrial areas along the Northeast coast. In this study, some of the adult seals showed total hepatic Hg concentrations that exceed the threshold levels of 60 mg/kg for liver damage in mammals (AMAP, 1998). High Hg is known to be common in livers of marine mammals, as they have evolved biochemical mechanisms involving selenium to detoxify (demethylate) and store Hg in less toxic (divalent) forms. However, the ability to de-toxify Hg may not be present in newborn and young seals following exposure to the mother's burden *in utero* and in milk, thus young and developing seals may be at risk for Hg toxicoses. Since the seals in this study are predominantly pups and yearlings, maternal transfer of Hg is of concern.

These findings underline the need for additional research on contaminant levels and associated health risks in Gulf of Maine seals. Clearly, additional data are needed to provide a basis for assessing long-term health risks posed by toxic pollutants to these populations.

To date, this study has shown that that seals are appropriate indicators of contaminants that bioaccumulate in the marine environment and with effort, a large number of tissue samples can be obtained for analysis. We are confident that the relationships, protocols, and training developed during the first year will facilitate the collection of analyzeable tissue samples in 2002-2003. The study objectives in 2002-2003 are to enlarge the sample size in order to be representative of all regions in Maine (including downeast Maine) to improve data on age, sex, and condition of the animals, to compare contaminant levels in stranded and wild seals, and to examine relationships between contaminant loads and immune and endocrine markers. The results of this research will provide useful information for sound ecological risk assessment and future monitoring of the the populations.

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APPENDIX: Tables

Table 1. Sampling efforts for Gulf of Maine harbor and gray seals 2001-2002

Location	No. Sampled	Dead	Alive
Mid-coast Maine	11	9	2
Southern Maine	9	7	2
Mass Bay	18	18	-
Nantucket/Long I. Sound	8	8	-
E. Long I. Coast	18	9	9
All Regions	64	51	13

Table 2. Mean Concentrations of PCBs (μg/g lipid basis) and TCDD TEQ (pg/g) of Dioxin-Like PCBs in Dead Stranded Seals (whole group, n=37)

Total PCB_{soc} (ppm)	TEQ Non-*ortho* (ppt)	TEQ Mono-*ortho* (ppt)	Total TEQ (ppt)
25. 2 ± 30.4 3-150.1	60.5.± 73.6 11.5-377.2	27.8.± 32.7 3.2-146.5	88.3 ± 81.5 14.8-391.6

Table 3. Mean Concentrations of OC Pesticides (ng/g, lipid weight) in Blubber of Dead Stranded Seals (n=37)

p,p'-DDE	*Trans*-nonachlor	Oxychlordane	*Cis*-nonachlor	Endosulfan sulfate	*p,p'*-DDT
9920.2 ± 11260.1 392.8-50386	1780.5 ± 2291.3 188.3-10074.1	1133.7 ± 1241 2.8-5715.4	1036.7 ± 1698.5 1.2-6721.2	613.1 ± 1139.3 1-5248.9	602.4 ± 1292.2 1-5628.2

Heptachlor epoxide	*p,p'*-DDD	?-chlordane	a-BHC	Mirex	Dieldrin
164.5 ± 311.5 1.8-1518.3	119.2 ± 173.7 2.6-998.2	89.6 ± 526.4 1-3205.2	85.6 ± 73.7 3.7-372	56.1 ± 241.6 1-1358.5	43 ± 185.6 1.2-1064.2

Table 4. Regional Distribution of OCs (μg/g, lipid weight) in Dead Stranded Seals

Region	So Maine (n=5)	Mid Maine (n=5)	Mass Bay (n=16)	Nan/LI Sd (n=4)	LI East (n=7)
Total PCB	34.6. ± 42 3-107.5	24.8 ± 23.4 4.1-64.4	23.8 ± 37.9 4.4-150.1	31.5 ± 16.7 11.7-51.2	18.5 ± 10.7 8-37.3
p,p'-DDE	12.2 ± 10.9 2.2-30.4	13.8 ± 18.7 1.2-46.8	12.2 ± 10.9 2.2-30.4	9.6 ± 9.4 2.2-23.2	8.9 ± 4.6 4.3-17.0
p,p'-DDT	1.2 ± 1.1 .003-3.1	1.4 ± 2.4 0.003-5.6	1.2 ± 1.2 0.003-3.1	0.1 ± 0.2 0.002-0.4	0.003 ± 0.001 0.001-0.003
Cis-nonachlor	0.4 ± 0.6 0.003-1.5	1.3 ± 2.8 0.003-6.3	0.4 ± 0.6 0.003-1.5	1.6 ± 1.5 0.004-3.3	1.1 ± 1.1 0.002-2..5
Endosulfan sulfate	0.2 ± 0.4 0.003-0.8	0.7 ± 1.3 0.003-3.1	0.2 ± 0.4 0.003-0.8	1.2 ± 1.5 0.002-3.0	0.9 ± 0.8 0.003-1.9
Oxychlordane	1.4 ± 1.2 0.2-3.4	1.4 ± 1.9 0.01-4.7	1.4 ± 1.2 0.2-3.4	1.3 ± 0.6 0.5-1.8	1.1 ± 0.6 0.5-2.0
Trans-nonachlor	1.7 ± 1.4 0.3-3.8	2.4 ± 3.4 0.2-8.4	1.7 ± 1.4 0.3-3.8	1.8 ± 1.8 0.3-4.4	1.4 ± 0.7 0.6-2.6

Table 5. Mean Levels of Total Mercury in Hair (mg/g, dry weight) and in Liver

(mg/g, wet weight) of Stranded Seals

Hg	Hair	Liver
Live Seals Mean ± SD Range n	2.8 ± 3.1 0.4-10.2 (12)	-
Dead Seals Mean ± SD Range n	3.7 ± 4 0.7-23 (37)	14.5 ± 32.4 0.2-113.6 (38)

Table 6. Regional Distribution of Total Mercury in Hair (mg/g, dry weight) and in Liver

(mg/g, wet weight) of Stranded Seals

Region	So Maine	Mid Maine	Mass Bay	Nan/LI Sd	LI East

Live Seals (Hair) (µg/g dry weight	0.6 ± 0.03 0.5-0.6 (2)	2 ± 1.6 0.9-3.1 (2)	-	-	2.2 ± 2 0.7-5.6 (5)
Dead Seals (Hair) (µg/g dry weight	4.4. ± 3.8 1.7-12 (6)	2.4 ± 1.3 0.7-4.9 (8)	4.6 ± 5.7 1-23 (13)	4.1 ± 3.5 0.8-10 (5)	2 ± 0.9 1.5-2.9 (5)
Dead Seals (Liver) (µg/g wet weight	1 ± 0.8 0.4-2.6 (7)	28.7 ± 56.6 0.3-113.6 (5)	17.5 ± 35.3 0.2-102.8 (15)	27 ± 51.3 0.4-104 (5)	8 ± 10.2 1-28.7 (7)

Table 7. Mean Levels of Other Metals and Trace Elements in Hair (mg/g, dry weight) of Stranded Seals

Metal	Dead	Live
Silver (Ag)	0.3 ± 0.6 0.08-2.7 (36)	0.1 ± 0.02 0.08-0.1 (9)
Arsenic (As)	1.7 ± 1.6 1.8-2.3 (37)	0.7 ± 0.7 0.1-2.3 (12)
Cadmium (Cd)	0.4 ± 0.3 0.04-1.4 (37)	0.3 ± 0.3 0.05-1 (12)
Chromium (Cr)	3.4 ± 0.4 2.6-4.5 (37)	3.6 ± 1.1 2.9-2.9 (12)
Copper (Cu)	7.4 ± 6.8 2.2 -46.5 (37)	6.1 ± 5.3 3-20.1 (9)
Nickel (Ni)	1.3 ± 1 0.1-6.2 (37)	1 ± 0.7 0.1-2.1 (9)
Lead (Pb)	1.3 ± 1.5 0.3-7.5 (37)	0.7 ± 0.7 0.2-2.1 (12)
Selenium (Se)	3.3 ± 1.3 1.5-6.5 (37)	7.4 ± 6.3 2.7-24.6 (12)
Zinc (Zn)	115.3 ± 48.2 42.9-250.7 (37)	160.5 ± 79.3 66.1-322.1 (9)

Table 8. Regional Distribution of Other Metals and Trace Elements in Hair (mg/g, dry weight) of Dead Stranded Seals

Region/ Metal	So Maine (n=6)	Mid Maine (n=8)	Mass Bay (n=13)	Nan/LI Sd (n=5)	LI East (n=5)
Silver (Ag)	ND	0.09 ± 0.02 0.07-0.1	0.3 ± 0.7 0.08-2.7	0.4 ± 0.8 0.08-1.9	0.7 ± 1.1 0.1-2.4
Arsenic (As)	1.6 ± 1.8 0.5-5.2	1.6 ± 1.4 0.2-3.9	2.1 ± 2.1 0.8-8	2 ± 1.1 0.5-3.3	0.8 ± 0.3 0.6-1.2
Cadmium (Cd)	0.4 ± 0.3 0.1-0.8	0.3 ± 0.2 0.04-0.6	0.3 ± 0.2 0.04-0.7	0.3 ± 0.07 0.2-0.4	0.7 ± 0.5 0.2-1.4
Chromium (Cr)	3.2 ± 0.4 2.7-3.6	3.2 ± 0.4 2.6-3.7	3.4 ± 0.2 3.1-3.7	3.6 ± 0.6 3.1-4.5	3.8 ± 0.3 3.5-4.1
Copper (Cu)	5.7 ± 1.6 3.1-7.6	6 ± 1.8 4-8.5	6.4 ± 2.1 2.2-10.4	6.6 ± 1.6 4.3-8.4	14.6 ± 17.9 4.4-46.5
Nickel (Ni)	1 ± 0.3 0.6-1.5	1.5 ± 1.9 0.2-6.2	1.1 ± 0.7 0.1-2.4	1.6 ± 0.6 0.7-2.1	1.5 ± 0.5 1-2.2
Lead (Pb)	0.7 ± 0.6 0.3-1.9	0.9 ± 0.5 0.4-2.1	1.6 ± 2.2 0.3-7.5	2 ± 1.7 0.6-4.8	1.2 ± 0.8 0.6-2.5
Selenium (Se)	3.8 ± 0.6 3.3-4.8	4.2 ± 1.9 1.5-6.5	2.8 ± 0.9 1.5-4.8	2.8 ± 0.8 1.9-3.9	3 ± 1.1 1.9-4.7
Zinc (Zn)	135.1 ± 19.1 112.8-164.4	98.8 ± 46.6 63.7-209	132.2 ± 64.2 42.9-250.7	99.6 ± 27.7 61.9-122.7	90.1 ± 17.4 64.5-111.3

ND= not detected

Table 9. Regional Distribution of Other Metals and Trace Elements (mg/g dry weight) in Hair of Live Stranded Seals

Region/ Metal	So Maine (n=2)	Mid Maine (n=2)	LI East (n=5)
Silver (Ag)	.09 ± .005 0.08-0.09	ND	ND
Arsenic (As)	2.1 ± 0.4 1.8-2.3	0.2 ± 0.07 0.2-0.3	0.4 ± 0.3 0.1-0.8
Cadmium (Cd)	0.6 ± 0.6 0.2-1	0.09 ± 0.007 0.08-0.1	0.4 ± 0.3 0.05-0.7
Chromium (Cr)	3.9 ± 0.8 3.3-4.4	2.9 ± 0.006 2.9-2.9	3.5 ± 1.2 2.6-5.6
Copper (Cu)	3.6 ± 0.9 3-4.3	4.5 ± 0.3 4.3-4.7	7.8 ± 7 3.1-20.1
Nickel (Ni)	1.1 ± 1 0.4-1.8	0.3 ± 0.04 0.3-0.3	1.2 ± 0.7 0.1-2.1
Lead (Pb)	0.6 ± 0.2 0.5-0.8	0.2 ± 0.01 0.2-0.2	1.2 ± 0.7 0.1-2.1
Selenium (Se)	2.9 ± 0.3 2.7-3.2	6.1 ± 0.9 5.4-6.7	5.2 ± 1.6 3-7.2
Zinc (Zn)	167.3 ± 79 111.5-223.2	238.4 ± 118.3 154.7-322.1	126.5 ± 54.8 66.1-185

ND= not detected

Table 10. Lymphocyte Proliferative Responses to Mitogens (SI) in Seal Blood

Mitogen	Con A	PHA	LPS
Mean ± SD Range n	6.7 ± 1.9 4.2-8.7 (6)	1.9 ± 0.6 1.1-2.6 (6)	3 ± 1.1 1.3-4.6 (6)

Table 11. Mean Levels of Hormones and Retinol (Vitamin A) Levels in Seal Plasma

Hormone	TT4 (μg/dl)	TT3 (ng/dl)	FT4 (ng/dl)	FT3 (pg/ml)	Vitamin A (ng/ml)
Mean ± SD Range n	1.3 ± 0.7 0-28 (9)	36.9 ± 36.8 13-130.2 (9)	2.9 ± 1.4 0.2-4.7 (9)	3.5 ± 1.2 1-4.7 (9)	42.3 ± 48.5 1.5-124 (9)

Hormone	Estradiol (μg/dl))	Cortisol (μg/dl)
Mean ± SD Range n	0.8 ± 0.7 0.3-2.4 (9)	12.9 ± 9.2 6.6-36.6 (9)

Table 12. Mean Levels of Hormones and Retinol in Seal Plasma by Region

Region/ Hormone	Maine * (n=4)	Long I East (n=5)
TT4 (µg/dl)	1.5 ± 1 0-2.2	1.8 ± 0.3 0.8-1.5
TT3 (ng/dl)	57 ± .50.8 13-139.2	20.8 ± 7.1 13-26
FT4 (ng/dl)	2.7± 2 0.2-5	3 ± 1 1.9-4.7
FT3 (pg/ml)	2.7 ± 1.4 1-4.5	4.2 ± 0.5 3.4-4.7
Cortisol (µg/dl)	16.6 ± 13.8 6.6-36.6	9.9 ± 1.4 8.2-11.8
Estradiol (pg/ml)	8.1 ± 2.7 4.4-10.4	23.1 ± 4.7 18.8-30.8
Vitamin A (ng/ml)	90 ± 28.7 56-124	4.2 ± 3.2 1.5-8.7

*Southern and Mid-Maine combined

1.5

MERCURY IN SEALS AND THEIR PREY

MERCURY BIOACCUMULATION AND TOXICITY IN GULF OF MAINE HARBOR SEALS AND THEIR PREY FISH

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Summary

Considerable progress has been made on the research objectives of our study of mercury bioaccumulation and the trophic transfer of mercury from prey fish to harbor seals in the Gulf of Maine.

Harbor seal haulout site observations of the roughly 700 – 900 seals frequenting Mt. Desert Rock (MDR) documented the site's primary use by adult male harbor seals during the summer 2001 field season Approximately 300 scat samples were collected from known haulout areas for seal prey analysis and selected scat samples were further processed for fecal mercury and hormone metabolite determination.

In the roughly 50 scat samples processed to date, 80% contained identifiable prey hard parts representing 13 separate species of prey fish. Redfish (*Sebastes capensis*), Atlantic herring (*Clupea harengus*), and silver hake (*Merluccius bilinearis*) comprised over 90% of the individual fish consumed. Meal sizes were highly variable and were greatest when redfish were eaten as part of the meal. In addition to otoliths and eye lenses, vertebrae and other prey remains were recovered for future reference.

Initial collections of prey fish from the general populations in the vicinity of Mt. Desert Rock were made from the Department of Marine Resources Fall Trawl Survey in October 2001. Representative samples of six species of fish were collected from each of three depth contours from nearshore to the deep waters adjacent to Mt. Desert Rock. Five species were adequately sampled in one to two depth contours and partial collections of 13 additional fish species and two squid species were completed. An otolith and squid beak reference collection was created from all 26 species sampled for species identification and size estimates from prey hard parts recovered from seal scat.

Preliminary mercury residue analyses refined the acid digestion and analytical methods and documented the expected range in mercury residues for several sample types. Trials of fecal hormone metabolite methods are scheduled for early summer.

METHODS

Seal Counts and Observations

All work was done at Mt. Desert Rock, a three acre granite ledge located approximately 20 miles south of Mt. Desert Island in the central Gulf of Maine. The island is owned by the College of the Atlantic and operated as a marine research station.

Harbor seal counts and observations were used to classify the age structure and sex of haulout groups prior to scat collection. Fifteen haulout areas on the shoreline of the main island were divided into quadrants subject to similar surf conditions depending on surface wind and swell conditions.

The northwest (NW) quadrant, a series of strongly sloping granite ledges, was used primarily when falling tides exposed flat, kelp ledges. Seals had great difficulty hauling there at higher tides or in strong surf. This area also was subject to the highest level of disturbance from human activity around the house and lighthouse tower.

The northeast (NE) quadrant consistently had the highest concentration of seal activity on the island. The gently sloping ledges were accessible at most tides, surf conditions were generally more moderate, and a central ledge provided haulout space even at high spring tides. Random human disturbance was less frequent, although activity on the boathouse ramp flushed seals hauling on the adjacent ledges. At low tide, grey seals occasionally hauled on the seaward tips of small peninsulas jutting to the north.

The southeast (SE) quadrant was primarily a low tide haulout site having deeply furrowed intertidal kelp ledges and pools and a sharply sloping shoreline to the south. Swells from the south creating high surf often limited use to the extreme eastern portion of this quadrant. Unintentional human disturbance was rare.

The southwest (SW) quadrant, used primarily at low tide, was occupied less frequently than other areas. Its kelp covered intertidal ledges were often subject to high surf, even at low tide, and the sharp slope of the upper ledges limited access at high tide. Unintentional human disturbance was not observed at this site.

Natural features that usually created visual barriers between adjacent areas separated the two to five haulout areas within each quadrant. These visual barriers were used to advantage during scat collections by limiting disturbance to those areas where scat was actually being collected.

Observations and counts were made from one of three sites on the island: the 80' lighthouse tower near the center of the island; a wooden platform straddling the ridgeline of the boathouse roof; or a granite ledge that overlooked the SW quadrant.

Following an ebb tide scan of hauled seals from the lighthouse tower, one to four haulout groups were chosen for age and sex determination and subsequent scat collections. This decision was based on the recent disturbance history for scat collection, the time of day and so the angle of the sun from the nearest observation point, and the seals' state of alertness, which significantly effected sex determinations. Counts were made using a 15 – 45 X zoom spotting scope. Detailed counts were not made of seals hauling on the intertidal ledges to the east of the island due to distance from the nearest observation point and the large concentration of grey seals hauling on the ledges, precluding exclusive harbor seal scat collections.

Scat and Fur Collections

On a flood tide, following age and sex determination, selected haulout areas were flushed for scat collections. Haulout areas were systematically searched from the tide line to the upper reaches used by the seals. Scat was not collected from areas where any grey seals were observed hauling. Collection methods varied with the consistency of the sample, using either an inverted Ziploc plastic bag or an acid-washed plastic scoop. Collected samples were placed in an insulated cooler and the haulout area vacated as quickly as possible to minimize disturbance time.

Scat was processed immediately after collection. Fresh scat samples deposited during the most recent tide cycle were selected for additional hormone and mercury analyses. Subsamples were a composite of the gross sample, combining 4 – 6 randomly collected scoops of fecal material, free of undigested prey parts, in clean, acid-washed storage vials. The vials were frozen on dry ice while awaiting transport to a –20°C storage freezer. Gross scat samples were kept cool in sealed Ziploc plastic bags and frozen at –20°C following transport to shore.

Preliminary mercury analyses of small fecal samples collected sequentially along the length of a firm scat confirmed the potential for significant variability in mercury residue levels. To ensure that fecal subsamples accurately represented mercury concentrations in the entire sample, additional fecal subsamples were collected in the lab prior to sieving. Previously subsampled scat samples weighing greater than 60g were diluted 30% by weight with a known amount of deionized water, thoroughly remixed, and re-sampled. Fecal samples for mercury analyses were freeze-dried to a constant weight to guarantee uniform mixing and dryness.

Prey hard parts were flushed from gross scat samples using nested sieves with mesh sizes ranging from 0.5 mm to 3.0 mm and warm tap water. All otoliths and otolith fragments, squid beaks and eye lenses were collected for prey identification and / or mercury analyses. Additional prey hard parts were collected and archived for future reference. Adhered fecal material was removed from the otoliths and squid beaks in a sonicator with deionized water, and the cleaned otoliths were dried with filtered air and stored in glass vials at ambient temperature. Eye lenses were rinsed with deionized water, stored in glass vials and frozen prior to analysis.

Species identifications of recovered otoliths were made by comparison with known otoliths from the reference collection created for this project and, when relevant, published reference guides. Total length and height measurements were recorded for each otolith using electronic digital calipers accurate to 0.02 mm. Once measured and identified, otoliths from each scat sample were separated by species, size and degree of erosion into groups defined by length (1 mm categories) or by width (0.5 mm categories) if broken tips precluded accurate length measurements. Finally, the weight of all otoliths from each scat sample within an individual size grouping was recorded. Minimum estimates of prey number were made using the maximum number of left or right otoliths recovered for each species, and prey size was estimated using regressions relating otolith length (and degree of digestive erosion) to fish length for each species.

The diameter of recovered fish eye lenses was recorded and used to separate lenses into 0.5 mm groups for weighing. Available methods do not allow species identification of fish eye lenses. Squid eye lenses were recognized by their unique half-moon shape, and measured and stored separately.

During the later half of the 2001 field season harbor seals underwent their annual molt at MDR. Seals hasten shedding by rolling and rubbing on the rough granite ledges at the haulout areas, packing shed fur into small crevasses in the rocks samples were it was easily collected. More complicated fur collection methods using Velcro strips and mats proved to be less effective.

Prey Fish Collections

Potential prey fish from the general vicinity of Mt. Desert Rock were collected during the Department of Marine Resources (DMR) Fall Trawl Survey. Trawls conducted on 18 and 19 October 2001 provided collections from three separate depth contours. The trawls encompassed three areas: the shallow, nearshore waters of upper Frenchman's Bay, SSW of Sorrento (DMR tow sites 3A and 7); mid-depth trawls due south of the mouth of Frenchman's Bay, midway between Otter Point on Mt. Desert Island and Schoodic Pt. (DMR tow sites 54 and 94); and deepwater trawls three to six miles WSW of Mt. Desert Rock (DMR tow sites 483 and 501).

At each depth contour, up to 20 fish of each species, representing the range of size classes caught in the trawl, were collected, euthanized if necessary, then immediately bagged and chilled on crushed ice for transport to the lab for processing. At the lab, fish were weighed to 1.0 g, total and fork length was recorded to 1 cm and the fish were individually bagged in Ziplocs and frozen at -20^{o}C.

Subsequently, fish were partially thawed and dissected to remove otolith and eye lens pairs for identification, size relationships and mercury analyses. Removed otoliths were air-dried, measured and weighed and the resulting data used to create regressions of otolith length (height and weight) to total fish length. Eye lenses were also measured and pairs weighed prior to storage at -20^{o}C for mercury analysis. The remaining whole fish was homogenized with a food processor and / or a Tissue Tearer, depending on fish size, and frozen for mercury analyses.

Mercury Analyses

Preliminary mercury analyses were begun on seal fecal samples, scat otolith samples and whole trawl fish samples; analyses of otoliths from trawl fish and eye lenses from both scat and trawl fish remain pending. Acid digestion of samples were done using a CEM MARS-X microwave digestion system. Mercury residues were determined using a MERLIN cold vapor atomic fluorescence spectrometer. Standard calibration and reference procedures were followed.

RESULTS

Harbor Seal Counts and Scat Collections

During the 2001 summer field season 700 to 900 harbor seals hauled regularly on the main island at Mt. Desert Rock, with an additional 100 to 200 harbor and grey seals using the intertidal ledges immediately east of the island. On the island, the NE and SE quadrants were used consistently throughout the summer field season. The NW and SW quadrants were used infrequently by small numbers of seals after mid-July. The reason(s) for this shift in hauling patterns is not known, but surf conditions and unintentional human disturbance from activity near the residence and boathouse may have been factors.

Given this hauling pattern, most detailed observations were made on seals hauling on the more sheltered eastern side of the island. The percent of seals sexed varied between 10 and 50%; averaging 20% in a given haulout area. This number was lower than expected, and reflects the mid summer shift away from the NW and SW quadrants. No consistent pattern was found between the percent of seals sexed within a haulout group and the observed sex ratio ($r^2 = 0.09$)

Table 1 summarizes the sex and age class observations made prior to scat collections at MDR. The NW and SW quadrants had the highest percent of hauled females, ranging from 12 - 45%. Reduced seal activity in these quadrants restricted the number of scat collected to 20 samples.

The NE quadrant had the highest seal counts, averaging 600 seals at low tide. Adult male harbor seals dominated this quadrant, where over 90% of the scat samples were collected. The SE quadrant was also dominated by males, but had the highest percentage (10 – 20 %) of subadult harbor seals. Despite persistent attempts, few scat samples were collected in this area.

During the late summer molt, over 30 fur samples were collected for mercury residue analysis.

Seal Prey Identification

Of the approximately 300 scat samples collected at MDR, 47 samples (15%) have been processed to date. The findings discussed below are preliminary until the remaining scat samples are processed. Over 80% (39) of the scat samples contained identifiable otoliths. Thirteen species of fish have been identified and four otoliths remain unidentified.

Redfish (*Sebastes capensis*) comprised 60% of the individual fish eaten (**Table 2**), followed by Atlantic herring (*Clupea harengus*) and silver hake (*Merluccius bilinearis*). A minimum average of 2.4 fish were eaten per meal, excluding meals containing redfish. When redfish were included in a meal, the average minimum meal size rose to 19 fish per meal.

Preliminary estimates of the prey size of silver hake were made using regressions of otolith length, or height, to total fish length. In the samples processed to date, seals ate silver hake ranging in size from 15 – 25 cm, approximately 1 to 2 year old fish.

Prey Fish Population Samples

Through the gracious cooperation of personnel from DMR's Fall Trawl Survey, potential harbor seal prey fish were collected for measurement and mercury analysis at up to three depth contours found between MDR and the mainland (**Table 3**). Representative samples of six fish species were collected at all three depth contours, and an additional five species were adequately sampled at 1 – 2 depth contours. In addition, partial collections of 13 fish species and two squid species were made.

Otoliths and eye lenses were removed from all trawl fish collected for measurement and subsequent mercury analyses. Silver hake, like other species analyzed, showed a strong correlation between fish total length and otolith length (r^2=0.98, df=48, P=0.000), otolith height (r^2=0.98, df=51, P=0.000) and otolith weight (r^2=0.89, df=53, P=0.000). Similar regressions for each species will be used to estimate prey fish length after compensation for otolith erosion during digestion.

Mercury Analyses

Fresh scat samples collected within one tide cycle of deposition (n = 154) were subsampled and freeze-dried in preparation for mercury residue analysis. Preliminary mercury analyses on a limited number of scat samples (n = 6) established the expected range of total mercury residues in seal fecal samples and confirmed potential residue variability within a single sample. Overall fecal total mercury residues in six separate scat samples collected from the NW and SW quadrants at MDR ranged from 50 ng Hg /g feces (dry wt.) to 460 ng/g (dry wt.). Fecal mercury residues ranging from 250 ng/g to 450 ng/g were found in single firm scat subsampled at 1 cm intervals along its length. The limited number of samples analyzed to date precludes an evaluation of fecal mercury residues in relation to mercury residues in ingested fish.

Over 480 individual otoliths have been recovered and identified from the 47 scat samples processed to date. Otoliths from the same species and size class, when corrected for digestive erosion, will be analyzed separately for total mercury. Based on preliminary mercury analyses of mixed samples of otoliths collected previously, total mercury residues are expected to range from 2 – 90 ng Hg / g otolith (dry wt.).

Representative collections of 11 species of prey fish from fish populations sampled in the vicinity of MDR have been processed in preparation for total mercury residue analyses. The mercury analytical results will establish background mercury levels in the species and age class of prey fish consumed by harbor seals, and allow comparison with mercury levels in prey fish actually ingested by the seals. In addition, for six of those 11 species, regional comparisons will identify variation in whole fish mercury residue levels associated with distance from the mainland. Preliminary mercury analyses of one fish species, collected from the shallow depth contour, found total mercury residues ranging from 10 to > 50 ng Hg/g whole fish (wet wt.).

DISCUSSION

Significant progress has been made in assembling and processing the necessary biological samples required to evaluate the trophic transfer of mercury to harbor seals in the Gulf of Maine. Initial laboratory analyses have been successful and will remain the primary focus of research activities in the coming year.

Final field collections of scat and prey fish will be made this spring and summer with the goal of filling data gaps present in the current sample sets. Scat from mixed gender haulout areas and from areas frequented by subadults will allow comparisons of prey selection and prey mercury residue levels with that found in areas dominated by adult males. Additional prey fish collections are scheduled during DMRs Spring Trawl Survey in late April of 2002.

Mercury Concentrations in prey fish

SPECIES	DMR TOWSITE	DATE COLLECTED	SAMPLE ID #	TOTAL LENGTH (cm)	TOT Hg (ppb)	least squares means	
Atlantic herring	3/7	10/18/2001	1173	9	4.71		
			1153	11	7.42		
			1174	12	6.82		
			1171	13	8.01		
			1016	17	10.73		
			1013	18	12.34		
			1018	20	17.67	14.37	
	94/54	10/19/2001	1498	17	7.18		
			1516	18	19.43		
			1496	19	14.09		
			1501	20	11.35		
			1499	21	10.35		
			1507	22	11.79		
			1497	24	17.50		
			1495	25	15.37	12.23	
	482/501	10/19/2001	1320	19	24.33		
			1322	20	11.52		
			1305	21	13.66		
			1310	22	13.78		
			1317	23	8.46		
			1304	24	22.43		
			1311	25	19.90		
			1314	28	28.50	14.86	
Atlantic cod	3/7	10/18/2001	1069	12	11.62		
			1085	14	21.62		
			1062	15	13.19	15.48	
	94/54	10/19/2001	1451	15	9.90	9.77	
	482/501	10/19/2001	1398	12	14.21		
			1395	13	11.98		
			1397	14	13.67		
			1396	15	10.68	12.66	
alewife	94/54	10/19/2001	1447	13	32.01		
			1448	15	23.81		
			1444	16	17.03		
			1431	17	22.96		
			1433	18	16.01		
			1426	19	21.08		
			1425	20	24.52		
			1438	26	50.02	25.93	
	482/501	10/19/2001	1369	17	24.97		
			1367	18	19.77		
			1368	19	17.77	20.84	

SPECIES	DMR TOWSITE	DATE COLLECTED	SAMPLE ID #	TOTAL LENGTH (cm)	TOT Hg (ppb)	least squares means	
pollock	482/501	10/19/2001	1301	47	25.39	25.39	
redfish	94/54	10/19/2001	1213	5	14.85	14.96	
	482/501	10/19/2001	1394	2	9.91		
			1389	5	8.63		
			1385	11	10.89	9.77	
red hake	482/501	10/19/2001	1329	21	10.23		
			1333	22	15.01		
			1334	24	14.67		
			1332	25	13.44		
			1336	27	13.16		
			1338	28	15.48		
			1339	29	13.44		
			1323	30	18.47		
			1326	34	23.24		
			1325	43	88.87	22.6	
silver hake	3/7	10/18/2001	1164	10	11.67		
			1065	11	6.26		
			1063	12	7.56		
			1058	20	17.80	15.45	
	94/54	10/19/2001	1400	10	7.75		
			1416	19	12.94		
			1407	20	26.50		
			1422	21	25.74		
			1418	22	17.50		
			1405	23	12.80		
			1408	24	10.56		
			1417	25	8.70		
			1403	27	17.44	14.17	
	482/501	10/19/2001	1184	6	6.71		
			1178	9	8.79		
			1192	11	8.08		
			1197	22	22.62		
			1187	23	23.06		
			1182	24	23.36		
			1188	25	20.70		
			1186	26	26.40		
			1189	27	22.83		
			1177	29	24.97	18.14	

Mercury in Alewives

ID #	TOTAL LENGTH (cm)	WEIGHT (g)	[TOT Hg] ng/g
1154	12	16	12.74
1125	13	20	13.39
1028	14	27	27.39
1026	15	31	17.16
1024	16	36	22.64
1038	17	40	23.35
1035	18	50	26.07
1031	20	74	>50.00
1032	22	94	23.60
1015	23	123	30.62
*provisional results pending completion of full data set			

TRAWL FISH COLLECTED - October 2001 *identified harbor seal prey		TOW SITE	n	TOTAL LENGTH (cm)			WEIGHT (g)		
				mean	std. dev.	min - max	mean	std. dev.	min - max
ATLANTIC HERRING *	*Clupea harengus*	3/7 [1]	25	14.64	3.41	9-20	24.92	15.2	5-46
		94/54 [2]	22	20.27	2.07	17-25	59.23	21.67	33-120
		482/501 [3]	21	21.81	2.23	19-28	76.86	24.84	135-1614
ALEWIFE *	*Alosa pseudoharengus*	3/7	31	16.13	3.54	12-24	39.06	28.08	16-123
		94/54	26	17.35	2.15	13-26	43.88	26.1	19-165
		482/501	11	18.64	1.03	17-21	55.82	10.56	46-85
DAB *	*Hippoglossoides platessoides*	3/7							
		94/54							
		482/501	5	22.6	7.54	14-31	114	102.89	20-241
BUTTERFISH *	*Peprilus triacanthus*	3/7	8	11.63	1.19	10-13	24.88	6.03	15-33
		94/54	17	13.06	1.68	9-15	29.18	9.25	10-49
		482/501	3	16.33	2.52	14-19	64.33	32.32	37-100
GREY SOLE *	*Glyptocephalus cynoglossus*	3/7							
		94/54							
		482/501	25	16.4	3.51	9-28	23.6	21.64	3-120
WINDOWPANE	*Scophthalmus aquosus*	3/7	4	15.25	1.5	14-17	48.25	13.72	34-64
		94/54	24	15.33	1.31	13-19	42.71	10.88	25-72
		482/501							
WINTER FLOUNDER	*Pleuronectes americanus*	3/7	32	15.25	5.63	6-27	52.22	57.94	3-256
(blackback)		94/54	23	19.57	5.86	10-33	123.22	123.53	13.461
		482/501	8	29.13	3.4	23-33	278.75	134.03	152-481
REDFISH *	*Sebastes norvegicus*	3/7							
		94/54	3	5	0	5-5	1.5	0.5	1-2
		482/501	10	5.3	2.21	2-11	3.7	5.38	2-19
CUSK	*Brosme brosme*	3/7	1	12			12		
		94/54							
		482/501							
RED HAKE *	*Urophycis chuss*	3/7							
		94/54	5	20.4	7.02	8-25	66.4	35.77	35-91
		482/501	18	27.72	5.06	21-43	144	120.42	15-554
SPOTTED HAKE	*Urophycis regia*	3/7							
		94/54	1	23			105		
		482/501							
WHITE HAKE *	*Urophycis tenuis*	3/7	21	18.76	5.28	12-28	59.05	39.36	13-134
		94/54	24	20.58	3.98	12-25	73.91	32.07	12-112
		482/501	17	28.94	3.86	24-36	173.65	74.61	81-299
SILVER HAKE *	*Merluccius bilinearis*	3/7	9	11.56	3.24	10-20	12.56	14.95	6-52
(WHITING)		94/54	24	21.13	3.08	10-27	62.38	25.71	6-135
		482/501	22	21.73	6.52	6-29	81.41	43.11	2-164

LONGHORN SCULPIN *	*Myoxocephalus octodecemspinosus*	3/7							
		94/54	23	16.87	3.55	12-22	52.74	32.17	15-110
		482/501							
SEAROBIN	*Prionotus carolinus/evolans?*	3/7	2	22.5	3.54	20-25	125.5	48.79	91-160
		94/54							
		482/501							
SEA RAVEN	*Hemitripterous americanus*	3/7	1	12			24		
		94/54	2	18.5	9.19	12-25	112	128.69	21-203
		482/501							
ATLANTIC SILVERSIDE	*Menidia menidia*	3/7							
		94/54	2	11	1.41	10-12	7.5	3.54	5-10
		482/501							
RAINBOW SMELT	*Osmoerus mordax*	3/7	28	16.29	1.82	14-21	26.86	10.18	14-52
		94/54							
		482/501							
ATLANTIC COD *	*Gadus morhua*	3/7	3	13.67	1.53	12-15	21	6.08	14-25
		94/54	2	15	0	15-15	27	5.66	23-31
		482/501	4	13.75	1.71	12-16	19.75	7.04	12-29
HADDOCK *	*Melanogrammus aeglefinus*	3/7	2	15.5	0.71	15-16	30.5	0.71	30-31
		94/54	5	14.8	3.27	9-17	27.4	12.6	5-35
		482/501							
POLLOCK *	*Pollachius virens*	3/7	3	16.33	3.51	13-20	53.3	37.54	20-94
		94/54							
		482/501	1	47			869		
ATLANTIC MACKERAL	*Scomber scombrus*	3/7							
		94/54	9	27	1.58	25-30	150.44	30.05	116-205
		482/501							
ILLEX SQUID	*Illex illecebrosus*	3/7							
		94/54	4	9	2.45	7-12	22	9.7	15-36
		482/501							
LOLIGO SQUID	*Loligo pealei*	3/7	1	9			28		
		94/54	2	7.5	0.71	7-8	24	4.24	21-27
		482/501	1	13			38		
DOGFISH	*Mustelus canis*	3/7							
		94/54	1	618			930		
		482/501							

PREY SPECIES	PREY FREQUENCY	
	MINIMUM # of INDIVIDUALS*	% of TOTAL
REDFISH *Sebastes capensis*	171	60%
ATLANTIC HERRING *Clupea harengus*	56	20%
SILVER HAKE (WHITING) *Merluccius bilinearis*	31	11%
RED HAKE *Urophycis chuss*	7	2%
RED/WHITE HAKE *Urophycis spp.*	7	2%
ATLANTIC COD *Gadus morhua*	2	<1%
GREY SOLE *Glyptocephalus cynoglossus*	2	<1%
LONGHORN SCULPIN *Myxocephalus octodecemspinosus*	2	<1%
ALEWIFE *Alosa pseudoharengus*	1	<1%
DAB *Hippoglossoides platessoides*	1	<1%
BUTTERFISH *Peprilus triacanthus*	1	<1%
UNKNOWN *Tobe identified*	4	1%

QUADRANT	*X* HARBOR SEAL COUNTS (when occupied)	% SEXED	% MALE	% ADULT	# SCAT COLLECTED / SUBSAMPLED
NW	155	20 - 50%	70 - 90%	> 95%	13 / 5
NE	600	18 - 30%	> 95%	> 95%	264 / 151
SE	290	10 - 30%	> 85%	80 - 90%	3 / 2
SW	100	20 - 40%	50 - 70%	> 95%	7 / 1

1.6

ANTIBIOTICS

Antibiotic Compounds

Pharmaceutical chemicals in water has immerged as a world-wide concern. Most studies relate to large municipal waste outfalls and animal feedlots where pharmaceutical inputs are presumably high. Concern is focused on the issue of human health implications by exposure through drinking water. Ecological studies are few yet. Two marine industries in Maine have been the topic of much speculation over the past 10 years, lobster pounds and finfish aquaculture. Both use antibiotics (Oxytetracycline) in medicated feed to control disease, although in the finfish industry, vaccination has dramatically lowered the need for medication. Studies in Washington State have shown antibiotic buildup in sediment under finfish net pens.

Because oxytetracycline does not act solely on the target pathogen but on beneficial bacteria as well that may be ecologically important in nutrient recycling, we proposed an initial survey to determine whether oxytetracycline is present and at what concentrations in and around lobster pounds and finfish aquaculture operations.

The study is being directed by the Maine Department of Marine Resources via a private consultant. The samples have been collected and have been sent for analysis. The data will be reported in a later report.

MODULE 2 LAKES

2.1

MERCURY DEPOSITION NETWORK

MERCURY DEPOSITION NETWORK

Atmospheric deposition is thought to be a significant source of mercury to Maine surface waters. In order to determine the relative significance of sources throughout Maine and the Northeast region, Maine has joined the Mercury Deposition Network (MDN). The MDN was created as an adjunct to the National Atmospheric Deposition Program (NADP), that has been monitoring the effects of atmospheric deposition of other contaminants, including acid rain, across the US for over 10 years. Maine has 4 NADP stations, one each at Bridgton, Acadia National Park (ANP), Greenville, and Caribou.

The MDN measures mercury in wet deposition on a weekly basis and provides a measurement of annual deposition at each station. All stations use similar equipment, the same protocol, and all samples will be analyzed by the same lab. There is also a Northeast regional network of MDN and other types of stations that measures wet deposition, as well as dry and gaseous mercury in some locations, in the New England states and the Canadian Maritime provinces.

One goal of MDN is to continue monitoring for at least 5 years. In Maine there are currently MDN stations at Acadia National Park (ANP, since fall 1995), Bridgton (since July 1997), Greenville (since September 1996), and Freeport (since 1998). The ANP station was supported equally by the National Park Service (NPS) and DEP through SWAT ($6000). The Greenville station was funded entirely by SWAT ($16500). The Bridgton station was funded primarily by an EPA REMAP grant, with DEP providing the station operator and mailing of the samples ($3150 SWAT). The Freeport station was supported entirely by a grant from EPA.

Annual deposition is greatest for the coastal stations, Freeport and Acacia National Park, followed by Bridgton and Greenville. Mean volume weighted concentration generally follows the same pattern. Ratios of annual deposition to mean concentration show that higher deposition along the coast is not entirely due to higher concentrations, but also due to increased precipitation.

TABLE 2.1 MERCURY IN WET DEPOSITION AT MAINE MDN STATIONS

ANNUAL DEPOSITION (ug/m2)

STATION	ID	1995	1996	1997	1998	1999	2000	2001
Bridgton	ME02			5.7e	6.9	6.9	6.9	4.8
Greenville	ME09		5.5e	5.4	6.7	6.9	5.2	4.0
Freeport	ME96				12.0e	8.4	7.9	4.9
ANP	ME98	5.2e	7.8	7.7	9.0	8.0	8.7	5.3

e= estimated, site started during year

MEAN CONCENTRATION (ng/l)

STATION	ID		1996	1997	1998	1999	2000	2001
Bridgton	ME02			8.4e	6.6	6.3	6.4	6.6
Greenville	ME09		4.0e	5.9	5.9	5.5	5.1	6.2
Freeport	ME96				7.8	7.3	6.6	6.9
ANP	ME98	5.2e	6.0	6.8	6.1	6.1	7.0	8.0

e=estimated since station began during the year

Mercury Deposition Network: a NADP Network

MDN Objectives

The objective of the MDN is to dvelop a national database of weekly concentrations of total mercury in precipitation and the easonal and annual flux of total mercury in wet deposition. The data will be used to develop information on spatial and seasonal trends in mercury deposited to surface waters, forested watersheds, and other sensitive receptors.
Analysis of precipitation samples for total- and methylmercury is performed by Frontier Geosciences, Inc., Seattle WA, USA. Frontier Geosciences provides the environmental sciences community with uncompromisingly high-quality contract research, project design and management, and analytical chemistry services concerned with the sources, fate and effects of trace metals.
The MDN began a transition network of 13 sites in 1995. Beginning in 1996, MDN became an official network in NADP with 26 sites in operation. Over 50 sites were in operation during 2000 (see site map). The MDN is anticipated to operate for a minimum of five years and will be managed at the NADP Coordination Office. The network uses standardized methods for collection and analyses. **Weekly** precipitation samples are collected in a modified Aerochem Metrics model 301 collector. The "wet-side" sampling glassware is removed from the collector every Tuesday and mailed to the **Hg Analytical Laboratory (HAL)** at Frontier Geosciences in Seattle, WA for analysis by cold vapor atomic fluorescence. The MDN provides data for total mercury, but also includes methylmercury if desired by a site sponsor. Data are available via this Web page for the transition network (1995) and for 1996 through the second quarter of 2000.
The following journal articles and presentations describe the network design, including the sampling and analytical protocols, used in the MDN:

Lindberg, S. and Vermette, S. 1995. Workshop on Sampling Mercury in Precipitation for the National Atmospheric Deposition Program. Atmospheric Environment. 29, 1219-1220.
Vermette, S., Lindberg, S., and Bloom, N. 1995. Field Tests for a Regional Mercury Deposition Network - Sampling Design and Preliminary Test Results. Atmospheric Environment. 29, 1247-1251.

Welker, M. and Vermette, S.J., 1996. Mercury Deposition Network: QA/QC Protocols. Paper 96-RP129.01, Proceedings of the 89th Annual Meeting of the Air and Waste Management Association, A&WMA, Pittsburgh, PA.
Sweet, C.W. and Prestbo, E. 1999. Wet Deposition of Mercury in the U.S. and Canada. Presented at "Mercury in the Environment Specialty Conference", September 15-17, 1999, Minneapolis, MN. Proceedings published by Air and Waste Management Association, Pittsburgh, PA.
(Available from NADP Program Office)

Image credit: Mackerel On Mercury by Scot F. Hacker , 1995.

MDN DATA FIELDS

SITE CODE: 2-letter state or province designator plus SAROAD county code (US) or sequential number (Canada).

START DATE: (mm/dd/yyyy)

END DATE: (mm/dd/yyyy)

SUBPPT: Rain Gauge (RG) precipitation amount in mm if available, otherwise precipitation amount in mm is calculated from the net rain volume caught in the sample bottle.

PPT: Precipitation amount in mm from the rain gauge (RG), if blank, no RG data.

HG CONC: total mercury concentration reported by the lab in ng/L.

DEPOSITION: product of SUBPPT and HG CONC, units are ng/m2.

Quality rating (QR) CODE: A = fully qualified with no problems

B = valid data with minor problems, used for summary statistics

C = invalid data, not used for summary statistics

BLANK= no sample submitted for this time period

SAMPLE TYPE:

W = wet sample, measurable precipitation (> or = 0.03 in.) on the rain gauge (RG) or net bottle catch (BC) = or > 10.0 mL if RG data are missing. Concentration and deposition data are reported unless the QR Code = C.

D = dry sample, no indication of sampler openings on the RG or net BC < 1.5 mL if RG event recorder data are missing. No concentration data are reported. ppt, subppt, and deposition are set to zero.

T = trace sample, RG shows openings or a trace precipitation amount (<0.03 inches). If the RG data are missing, a net BC between 1.5 and 10.0 mL (inclusive) will be coded as a T sample type. Concentration data may or may not be reported depending whether the BC is 1.5 mL or higher. If BC = 1.5 mL or higher, then ppt is blank , Subppt = BC, and deposition is based on the BC. If BC < 1.5 mL, then ppt subppt and deposition are all set to zero.

Q = sampler was used for a Quality assurance (QA) sample, no ambient sample submitted. No concentration values are reported (QA values will be published in the QA report).

Deposition is only reported where the value is zero (D or T samples with no measurable precipitation).

NOTES:	QR CODE	Valid for Summaries (Y/N)
s = short sample time (< 6days)	B	Y
e = extended sample time (> 8days)	B	Y
d = debris present (previously x)	B	Y

m = missing information (previously, r, no event recorder, and p, missing RG precipitation record)	B	Y
z = site operations problems	B	Y
h = sample handling problems (z and h include equipment and handling problems that don’t seriously compromise the sample)	B	Y
i = low volume sample (1.49mL < net BC < 10.00mL) (Hg conc. Data are reported but they are less certain than those for samples with a net BC of at least 10 mL)	B	Y
b = bulk sample (wet side open the whole time)	C	N
v = RG indicates precipitation occurred but BC < 1 mL or < 10% of indicated RG precipitation amount.	C	N
u = undefined sample (wet side open during dry periods)	C	N
f = serious problems in field operations that compromise sample integrity.	C	N
l = laboratory error	C	N
c = sample compromised due to contamination	C	N
p = no ppt data from either RG or BC	C	N
n = no sample submitted	--	N

Calculation of Deposition:

1. If a valid precipitation amount can be read from the rain gauge chart (RG >= 0.03 inches), the sample type is set to “W” (wet); and the value from the RG chart is used to calculate deposition (RG amount in mm times Hg concentration in ng/mL). If the RG chart event recorder shows no sampler openings, sample type is set to “D” (dry) and precipitation amount and deposition are set to 0.
2. If the precipitation amount from the RG chart is not available, the net bottle catch (BC) will be used to calculate deposition as long as BC > 1.49mL. If the BC < 1.5 mL, the precipitation amount will be set to 0 and the sample type set to “D” (dry). If the BC is between 1.5 and 10.0 mL, the sample type will be set to “T” (trace) and the BC used to calculate deposition. These samples are also coded with an “i” in the Notes field and downgraded to a “B” Quality Rating to indicate uncertainty due to low volume. If the BC

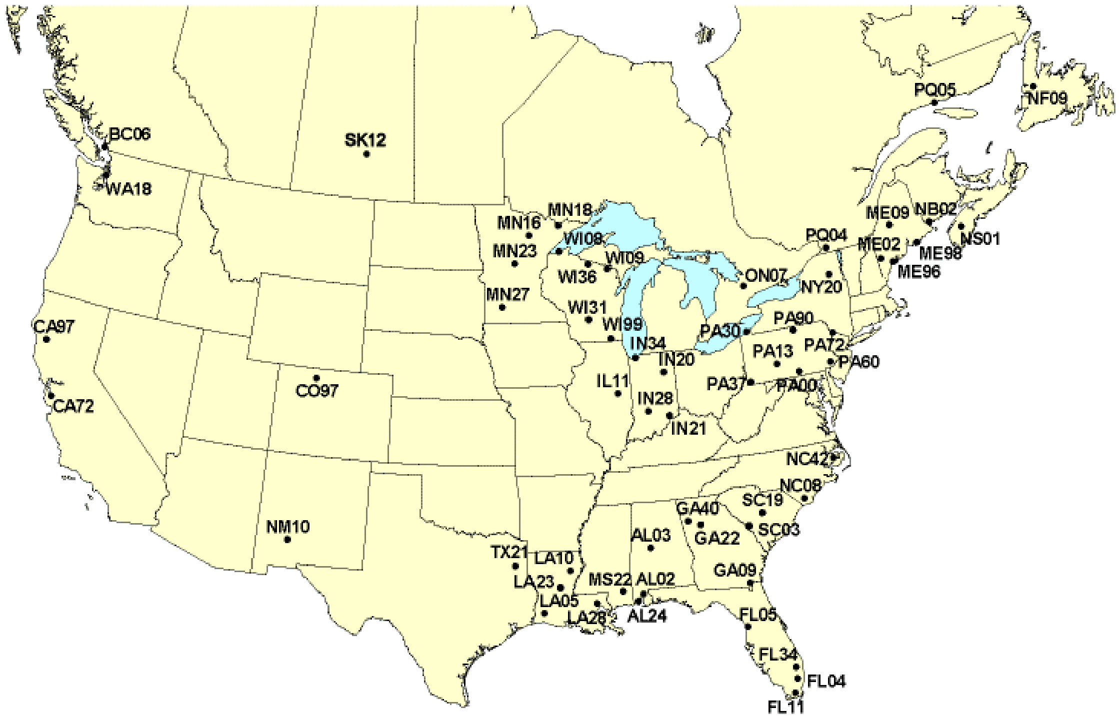
is > 10 mL, the sample type will be set to “W” (wet) and the BC will be used to calculate deposition.

3. If the RG indicates sampler openings, but the precipitation amount can’t be determined accurately from the RG chart (RG < 0.03 inches) the sample type will be coded “T” (trace) and the BC will be used to calculate deposition as long as the BC is >= 1.5mL. If the BC is < 10mL, samples will be coded for low volume as in 2. If the BC is < 1.5mL, no concentration will be reported and the ppt, subppt, and deposition will be set to 0.

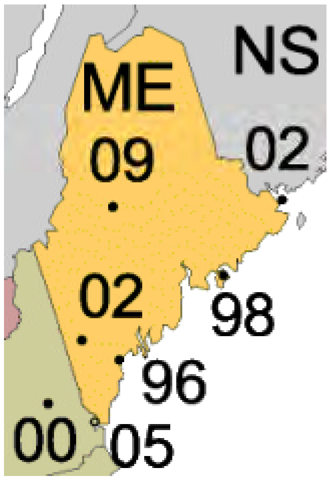
4. In cases where there is a valid precipitation amount from either RG or BC but invalid or missing concentration data, seasonal or annual summary deposition values will be calculated using the site-specific, seasonal, volume-weighted average concentration. This deposition value will not be displayed for individual weeks in the WEB database, but it will be used only for the calculation seasonal and annual average concentrations and deposition amounts on maps and other summary products.

MDN STATIONS

National Atmospheric Deposition Program
Mercury Deposition Network



Mercury Deposition Network   Maine stations



Site ID	Site Name	Start Date	End Date	Elevation (meters)
Active Sites				
ME02	Bridgton	06/04/1997		222
ME09	Greenville Station	09/03/1996		322
ME96	Freeport	01/01/1998		15
ME98	Acadia National Park - McFarland Hill	09/26/1995		129
Inactive Sites				

BRIDGTON ME02

Site	Date On	Date Off	Subppt mm	Pptrec mm	HgConc ng/L	HgDep ng/m²	QR	Sample Type	Notes
ME02	12/26/2000	1/2/2001	0	0	4.5	0	B	W	m
ME02	1/2/2001	1/9/2001	8.6	8.6	1.4	12	B	W	m
ME02	1/9/2001	1/16/2001	5.8	5.8	e3.8	22	C	W	mhf
ME02	1/16/2001	1/23/2001	1.8	1.8	6.1	10.9	B	W	mi
ME02	1/23/2001	1/30/2001	0	0	--	0	A	D	
ME02	1/30/2001	2/6/2001	39.7	39.7	2.1	82.2	B	W	mh
ME02	2/6/2001	2/13/2001	8.3	8.3	8.3	68.7	B	W	m
ME02	2/13/2001	2/20/2001	2.2	2.2	11.4	24.7	B	W	dmz
ME02	2/20/2001	2/27/2001	21	21	6.2	130.1	B	W	dm
ME02	2/27/2001	3/6/2001	17.5	17.5	e4.6	80.5	C	W	dmhf
ME02	3/6/2001	3/13/2001	15.2	15.2	3	45	B	W	dmz
ME02	3/13/2001	3/20/2001	2.5	2.5	3.8	9.8	B	W	d
ME02	3/20/2001	3/27/2001	45.5	45.5	0.9	41.5	B	W	dmz
ME02	3/27/2001	4/3/2001	29.5	29.5	3.1	91.1	B	W	mh
ME02	4/3/2001	4/10/2001	7.5	7.5	10.7	80.1	B	W	m
ME02	4/10/2001	4/17/2001	20.6	20.6	6.9	142.5	B	W	dm
ME02	4/17/2001	4/24/2001	0.9	0.9	17.4	15.4	B	W	dmi
ME02	4/24/2001	5/1/2001	0	0	--	0	B	T	d
ME02	5/1/2001	5/8/2001	1	1	17.6	16.8	B	W	di
ME02	5/8/2001	5/15/2001	12.2	12.2	25.2	307.3	B	W	d
ME02	5/15/2001	5/22/2001	1	1	11.3	11.5	A	W	
ME02	5/22/2001	5/29/2001	26.7	26.7	14.2	377.5	B	W	d
ME02	5/29/2001	6/5/2001	68.6	68.6	7.2	492.9	B	W	d
ME02	6/5/2001	6/12/2001	6.9	6.9	12.7	87	B	W	d
ME02	6/12/2001	6/19/2001	10.2	10.2	20	202.7	B	W	d
ME02	6/19/2001	6/26/2001	9.1	9.1	8.2	74.2	B	W	d
ME02	6/26/2001	7/3/2001	10.2	10.2	12.9	131.6	B	W	d
ME02	7/3/2001	7/10/2001	22.1	22.1	11.5	254.2	B	W	d
ME02	7/10/2001	7/17/2001	23.1	23.1	9.6	221.8	B	W	d
ME02	7/17/2001	7/24/2001	1	1	e7.0	7	C	W	dv
ME02	7/24/2001	7/31/2001	8.5	8.5	4.3	36.6	B	W	d
ME02	7/31/2001	8/7/2001	2.3	2.3	28	64.4	A	W	
ME02	8/7/2001	8/14/2001	7.1	7.1	12	85.2	B	W	dz
ME02	8/14/2001	8/21/2001	2	2	11	22	B	W	d
ME02	8/21/2001	8/28/2001	0	0	0	0	A	T	
ME02	8/28/2001	9/4/2001	22.9	22.9	9.1	208.4	B	W	d
ME02	9/4/2001	9/11/2001	8	8	8.6	68.8	B	W	d
ME02	9/11/2001	9/18/2001	0	0	0	0	A	T	
ME02	9/18/2001	9/25/2001	20.6	20.6	10.2	210.1	A	W	
ME02	9/25/2001	10/2/2001	32	32	5	160	B	W	dh
ME02	10/2/2001	10/9/2001	2.2	2.2	6	13.2	A	W	
ME02	10/9/2001	########	12.4	12.4	6.1	75.6	B	W	d
ME02	10/16/2001	########	16.4	16.4	7.9	129.6	B	W	dh
ME02	10/23/2001	########	11.9	11.9	10.7	127.3	B	W	d
ME02	10/30/2001	11/6/2001	43.9	43.9	1.6	70.2	B	W	d
ME02	11/6/2001	########	2	2	17.1	34.2	B	W	d
ME02	11/13/2001	########	2.3	2.3	10.1	23.2	B	W	d
ME02	11/20/2001	########	13.5	13.5	4.7	63.4	B	W	d
ME02	11/27/2001	12/4/2001	28.4	28.4	4.5	127.8	A	W	
ME02	12/4/2001	########	4.7	4.7	9.7	45.6	B	W	d
ME02	12/11/2001	########	28.8	28.8	2.1	60.5	B	W	d
ME02	12/18/2001	########	10.3	10.3	2.1	21.6	B	W	d

GREENVILLE MEO9

Site	Date On	Date Off	Subppt mm	Pptrec mm	HgConc ng/L	HgDep ng/m²	QR	Sample Type	Notes
ME09	12/26/2000	1/2/2001	19.3	19.3	2.1	41	A	W	
ME09	1/2/2001	1/9/2001	2.8	2.8	4.7	13.1	A	W	
ME09	1/9/2001	1/16/2001	3	3	4	12.1	B	W	zi
ME09	1/16/2001	1/23/2001	1.8	1.8	4.5	8	A	W	
ME09	1/23/2001	1/30/2001	0	0	--	0	A	T	
ME09	1/30/2001	2/6/2001	47	47	2.7	125.8	B	W	dzh
ME09	2/6/2001	2/13/2001	8.3	8.3	7	57.8	B	W	zh
ME09	2/13/2001	2/20/2001	4.6	4.6	4.6	21.1	B	W	dz
ME09	2/20/2001	2/27/2001	10.7	10.7	25.6	272.9	B	W	d
ME09	2/27/2001	3/6/2001	0	0	--	0	A	D	
ME09	3/6/2001	3/13/2001	2.8	--	4	11.2	B	W	m
ME09	3/13/2001	3/20/2001	14.5	14.5	2.1	30.2	B	W	dz
ME09	3/20/2001	3/27/2001	23.7	23.7	1.7	39.5	B	W	d
ME09	3/27/2001	4/3/2001	22	22	8.4	184.8	B	W	d
ME09	4/3/2001	4/10/2001	0.5	0.5	--	0	A	T	
ME09	4/10/2001	4/17/2001	6.1	6.1	9.1	55.2	B	W	d
ME09	4/17/2001	4/24/2001	0	0	--	0	B	T	z
ME09	4/24/2001	5/1/2001	4.2	--	11.5	48.3	B	W	dmp
ME09	5/1/2001	5/8/2001	2.7	2.7	13.3	35.6	B	W	dm
ME09	5/8/2001	5/15/2001	7.7	7.7	12.1	93.5	B	W	dmz
ME09	5/15/2001	5/22/2001	8.9	8.9	7.5	66.9	B	W	dm
ME09	5/22/2001	5/29/2001	19.1	19.1	4.2	80.8	B	W	dmh
ME09	5/29/2001	6/5/2001	38.1	38.1	8.5	324.6	B	W	dh
ME09	6/5/2001	6/12/2001	0.4	--	27.3	10.1	B	T	i
ME09	6/12/2001	6/19/2001	25	25	3.8	94.1	B	W	dzh
ME09	6/19/2001	6/26/2001	25.3	25.3	2.1	51.9	B	W	dh
ME09	6/26/2001	7/3/2001	10.3	10.3	16.4	168.9	B	W	d
ME09	7/3/2001	7/10/2001	37.1	37.1	6.3	233.7	B	W	dh
ME09	7/10/2001	7/17/2001	19.3	19.3	8.6	166	B	W	d
ME09	7/17/2001	7/24/2001	3.9	3.9	11.6	45.2	B	W	d
ME09	7/24/2001	7/31/2001	1.3	1.3	18.2	23.7	B	W	d
ME09	8/7/2001	8/14/2001	0	0	0	0	B	T	d
ME09	8/14/2001	8/21/2001	9.4	9.4	9.8	92.1	B	W	d
ME09	8/21/2001	8/28/2001	21.6	21.6	6.7	144.7	B	W	dh
ME09	8/28/2001	9/4/2001	20.8	20.8	10.7	222.6	B	W	d
ME09	9/4/2001	9/11/2001	29	29	3.9	113.1	B	W	dz
ME09	9/18/2001	9/25/2001	33	33	6	198	B	W	d
ME09	9/25/2001	10/2/2001	19.6	19.6	7.2	141.1	B	W	dh
ME09	10/2/2001	10/9/2001	6.6	6.6	3.8	25.1	B	W	dh
ME09	10/9/2001	10/16/2001	2.8	2.8	3.1	8.7	B	W	d
ME09	10/16/2001	10/23/2001	21.1	21.1	7.2	151.9	B	W	d
ME09	10/23/2001	10/30/2001	15.7	15.7	10.5	164.8	B	W	d
ME09	10/30/2001	11/6/2001	2.8	2.8	2.5	7	B	W	dz
ME09	11/6/2001	11/13/2001	10.2	10.2	e4.5	45.9	C	W	dzl
ME09	11/13/2001	11/20/2001	2.3	2.3	6.5	15	B	W	dh
ME09	11/20/2001	11/27/2001	12.2	12.2	2.9	35.4	B	W	dzh
ME09	11/27/2001	12/4/2001	19.6	19.6	3.9	76.4	B	W	dzh
ME09	12/4/2001	12/11/2001	5.5	5.5	10.4	57.2	B	W	dz
ME09	12/11/2001	12/18/2001	20.3	20.3	2.4	48.7	B	W	d
ME09	12/18/2001	12/24/2001	20.4	20.4	e2.4	48.7	C	W	dv

FREEPORT ME96

Site	Date On	Date Off	Subppt mm	Pptrec mm	HgConc ng/L	HgDep ng/m²	QR	Sample Type	Notes
ME96	12/26/2000	1/2/2001	16	16	3.1	49.4	B	W	d
ME96	1/2/2001	1/9/2001	6.1	6.1	4	24.4	A	W	
ME96	1/9/2001	1/16/2001	1.8	1.8	6.5	11.5	A	W	
ME96	1/16/2001	1/23/2001	5.3	5.3	7.5	40.2	A	W	
ME96	1/23/2001	1/30/2001	0	0	--	0	B	D	h
ME96	1/30/2001	2/6/2001	31	31	4.5	138.1	B	W	d
ME96	2/6/2001	2/13/2001	7.4	7.4	4.4	32.7	B	W	d
ME96	2/13/2001	2/20/2001	5.8	5.8	4.1	23.8	B	W	d
ME96	2/20/2001	2/27/2001	24.6	24.6	4.2	104.1	B	W	d
ME96	2/27/2001	3/7/2001	16.5	16.5	4.7	77.2	A	W	
ME96	3/7/2001	3/13/2001	6.4	6.4	3.7	23.6	B	W	dz
ME96	3/13/2001	3/20/2001	7.4	--	5.6	41	B	W	m
ME96	3/20/2001	3/27/2001	112.2	112.2	1.8	201.2	B	W	d
ME96	3/27/2001	4/3/2001	36.7	36.7	1.6	58	B	W	d
ME96	4/3/2001	4/10/2001	5.1	5.1	e3.7	18.9	C	W	dzvf
ME96	4/10/2001	4/17/2001	33	33	5.8	190.1	B	W	d
ME96	4/17/2001	4/24/2001	1	1	26.3	26.7	B	W	di
ME96	4/24/2001	5/1/2001	0.8	0.8	54.1	41.2	B	W	zi
ME96	5/1/2001	5/8/2001	5.1	5.1	13.1	66.6	B	W	dh
ME96	5/8/2001	5/15/2001	1.3	1.3	19.8	25.2	B	W	di
ME96	6/5/2001	6/12/2001	36.6	36.6	12.2	446.7	B	W	d
ME96	6/12/2001	6/19/2001	21.6	21.6	28.6	617.5	B	W	dh
ME96	6/19/2001	6/26/2001	0.8	0.8	16.3	12.4	B	W	d
ME96	6/26/2001	7/3/2001	19.3	19.3	19.8	382.1	B	W	h
ME96	7/3/2001	7/10/2001	3	3	19.7	59.1	B	W	d
ME96	7/10/2001	7/17/2001	22.4	22.4	11.8	264.3	A	W	
ME96	7/17/2001	7/24/2001	0.9	0.9	11.8	10.6	B	W	i
ME96	7/24/2001	7/31/2001	8.4	8.4	5.3	44.5	B	W	d
ME96	7/31/2001	8/7/2001	0	0.5	0	0	B	T	d
ME96	8/7/2001	8/14/2001	0.3	0	162.2	48.7	B	T	mi
ME96	8/14/2001	8/21/2001	3.3	3.3	14.2	46.9	A	W	
ME96	8/21/2001	8/28/2001	0	0	0	0	B	D	d
ME96	8/28/2001	9/4/2001	19.3	19.3	8	154.4	B	W	d
ME96	9/4/2001	9/11/2001	6.1	6.1	12.2	74.4	B	W	d
ME96	9/11/2001	9/18/2001	0.3	--	14	4.2	B	T	dmi
ME96	9/18/2001	9/25/2001	40.1	40.1	6.8	272.7	B	W	d
ME96	9/25/2001	10/2/2001	31.5	31.5	7.6	239.4	B	W	d
ME96	10/2/2001	10/9/2001	3.8	3.8	5.3	20.1	B	W	dz
ME96	10/9/2001	10/16/2001	10.9	10.9	4.6	50.1	B	W	d
ME96	10/16/2001	10/23/2001	20.3	20.3	8	162.4	B	W	dz
ME96	10/23/2001	10/30/2001	3.8	3.8	10.8	41	B	W	dzh
ME96	10/30/2001	11/6/2001	35.8	35.8	4.6	164.7	B	W	dh
ME96	11/6/2001	11/13/2001	3.8	3.8	14.3	54.3	B	W	dh
ME96	11/13/2001	11/20/2001	1.3	1.3	10.9	14.2	B	W	di
ME96	11/20/2001	11/27/2001	13.6	13.6	4.7	63.9	B	W	d
ME96	11/27/2001	12/4/2001	18.5	18.5	8.7	161	B	W	d
ME96	12/4/2001	12/11/2001	4.8	4.8	5.7	27.4	B	W	dh
ME96	12/11/2001	12/18/2001	25.1	25.1	3.6	90.4	B	W	d
ME96	12/18/2001	12/26/2001	26.7	26.7	4.3	114.8	B	W	d

ACADIA NATIONAL PARK ME98

Site	Date On	Date Off	Subppt mm	Pptrec mm	HgConc ng/L	HgDep ng/m²	QR	Sample Type	Notes
ME98	12/26/2000	1/2/2001	21.3	21.3	2.3	49.4	B	W	mh
ME98	1/2/2001	1/9/2001	9.7	9.7	e3.0	29.1	C	W	hf
ME98	1/9/2001	1/16/2001	3.3	3.3	e3.0	9.9	C	W	vf
ME98	1/16/2001	1/23/2001	6.1	6.1	e3.0	18.3	C	W	hvf
ME98	1/23/2001	1/30/2001	1.3	1.3	e3.0	3.9	C	W	hvf
ME98	1/30/2001	2/7/2001	27.2	27.2	3.7	99.9	B	W	dh
ME98	2/7/2001	2/13/2001	8.9	8.9	e3.6	32	C	W	f
ME98	2/13/2001	2/20/2001	24.1	24.1	3.5	83.8	A	W	
ME98	2/20/2001	2/27/2001	14.2	14.2	15.7	223.3	B	W	dh
ME98	2/27/2001	3/7/2001	3	3	e9.6	28.8	C	W	v
ME98	3/7/2001	3/13/2001	10.9	10.9	3.5	37.7	B	W	d
ME98	3/13/2001	3/20/2001	12.7	12.7	5.3	67.1	B	W	dz
ME98	3/20/2001	3/27/2001	36.3	36.3	4.1	149.8	B	W	dzh
ME98	3/27/2001	4/3/2001	23.4	23.4	e6.9	161.5	C	W	hf
ME98	4/3/2001	4/10/2001	3.2	3.2	9.7	30.8	A	W	
ME98	4/10/2001	4/17/2001	25.4	25.4	6.7	171	B	W	dh
ME98	4/17/2001	4/24/2001	16	16	3.8	61.1	B	W	d
ME98	4/24/2001	5/1/2001	0.5	--	32.8	15.4	B	T	i
ME98	5/1/2001	5/8/2001	3.4	3.4	13.3	45.7	A	W	
ME98	5/8/2001	5/15/2001	2.8	2.8	16.1	45	A	W	
ME98	5/15/2001	5/22/2001	20.8	20.8	7.6	158.3	A	W	
ME98	5/22/2001	5/29/2001	18.8	18.8	6.5	122.7	B	W	dh
ME98	5/29/2001	6/5/2001	47.8	47.8	11.1	529.3	B	W	h
ME98	6/5/2001	6/12/2001	10.7	10.7	22.3	237.4	B	W	d
ME98	6/12/2001	6/19/2001	27.9	27.9	8.9	248.1	B	W	dh
ME98	6/19/2001	6/26/2001	10.9	10.9	7.6	83.2	B	W	d
ME98	6/26/2001	7/3/2001	2.8	2.8	102.4	286.7	B	W	dmi
ME98	7/3/2001	7/10/2001	7.6	7.6	11.7	88.9	B	W	h
ME98	7/10/2001	7/17/2001	2.5	2.5	14.8	37	B	W	d
ME98	7/17/2001	7/24/2001	1.8	1.8	11.2	20.2	B	W	d
ME98	7/24/2001	7/31/2001	5	5	11.5	57.5	B	W	dh
ME98	7/31/2001	8/7/2001	0	0	0	0	A	T	
ME98	8/7/2001	8/14/2001	14.2	14.2	14.5	205.9	B	W	dh
ME98	8/14/2001	8/21/2001	3.8	3.8	16.5	62.7	B	W	d
ME98	8/21/2001	8/28/2001	0	0	0	0	B	T	d
ME98	8/28/2001	9/4/2001	11.7	11.7	10.5	122.8	B	W	dh
ME98	9/4/2001	9/11/2001	2	2	14	28	B	W	d
ME98	9/18/2001	9/25/2001	12.2	12.2	12.2	148.8	B	W	dh
ME98	9/25/2001	10/2/2001	34	34	8.7	295.8	B	W	d
ME98	10/2/2001	10/9/2001	2.5	2.5	7.2	18	B	W	d
ME98	10/9/2001	10/16/2001	4.4	4.4	4.9	21.6	B	W	dh
ME98	10/16/2001	10/23/2001	31.6	31.6	4.5	142.2	B	W	dh
ME98	10/23/2001	10/30/2001	5.3	5.3	10.7	56.7	B	W	dh
ME98	10/30/2001	11/6/2001	23.6	23.6	2.2	51.9	B	W	d
ME98	11/6/2001	11/13/2001	6.6	6.6	11.9	78.5	B	W	dh
ME98	11/13/2001	11/20/2001	0	0	0	0	A	T	
ME98	11/20/2001	11/27/2001	12.7	12.7	6.4	81.3	B	W	dzh
ME98	11/27/2001	12/4/2001	15.2	15.2	5.3	80.6	B	W	d
ME98	12/4/2001	12/11/2001	4.2	4.2	2.7	11.3	B	W	dh
ME98	12/11/2001	12/18/2001	24.3	24.3	2.9	70.5	B	W	d
ME98	12/18/2001	12/26/2001	46	46	5	230	B	W	d

2.2

FISH CONSUMPTION ADVISORIES

SALMONIDS

NORTHERN PIKE

CHAIN PICKEREL

DDT

FISH CONSUMPTION ADVISORIES

General Statewide -Lakes -DEP

We had hoped we could identify an indicator fish species and avoid the need to test multiple species. However, our review of the data from the 'Indicator Species Study' does not appear to support this approach. The mercury levels for the species sampled does not seem consistent enough to identify a reliable predictor fish species, though this conclusion is somewhat compromised by the small number of lakes sampled.

Therefore, we are back to looking at obtaining data at the individual species level. Collapsing data into cold water versus warm water fish species is problematic because lake trout and brown trout have mercury levels more similar to warm water fish species than other cold water species, such as brook trout or landlocked salmon. Another important determinant of data needs is our desire to estimate a high percentile lake average fish-mercury concentration rather than the statewide mean. Anglers do not necessarily fish lakes randomly or fish a large number of water bodies (if they did, the mean would be the appropriate statistic). Rather, they may have one or just a few lakes or ponds they primarily fish (especially for those people living on a lake). Consequently, we believe we need to evaluate the likelihood that individuals may routinely consume fish from a high-end lake. To do this, we need sufficient data to estimate the statewide distribution for fish species routinely consumed and to estimate high percentile lakes (e.g., 75^{th} to 95^{th} percentile lake). This means data from the same distribution from at least 30 lakes for each of several species.

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Cold-water fish

In 2000 we focused on lake trout to augment the REMAP data. The Maine Department of Inland Fisheries and Wildlife collected samples from 11 lakes for mercury analysis, but the data exhibited a different distribution than did the REMAP data. Therefore, more data were needed for lake trout as well as brown trout, landlocked salmon, splake, cusk, and whitefish. We asked DIFW to collect a sample of at least 5 fish of any of these species encountered as part of their regular investigations of lakes and ponds this summer. DIFW was able to collect 23 samples from 18 lakes and ponds (Table 2.2.1). All but one sample of brook trout and one sample of splake exceeded the Maine Bureau of Health's Fish Tissue Action Level for mercury (FTAL=0.20 ppm). Although there was considerable variation in concentrations among lakes, concentrations appeared to be highest in lake trout, followed by splake, brown trout and landlocked salmon, and brook trout in decreasing amounts, but no statistical comparisons were made. More samples of each species are needed for the Bureau of Health assessment.

Northern Pike. Northern pike are highly piscivorous fish and would be expected to have higher mercury concentrations than even pickerel,which are smaller. In 2000 we were able to capture pike from only Great Pond in Belgrade and Sabattus Pond in Sabattus. Concentrations were greatly different, being much higher in Great Pond and surprisingly low in Sabattus, even though those fish were smaller. Collection of pike from Sabattus Pond was repeated in 2001. The concentration of mercury was slightly higher than in 2000 (0.06 ppm) which may be the result of larger fish in 2001 (Table 2.2.1).. Once again concentrations were lower than those from Great Pond in 2001 (0.45 ppm) which were larger than these pike from Sabattus Pond.

Table 2.2.1. MERCURY CONCENTRATIONS IN FISH FROM MAINE LAKES 2001

SUMMARY

WATER	MIDAS NO.	TOWN	SPECIES CODE	HG mg/l	N
Big Indian P	2866	T07 R12 WELS	BKT	0.27	5
Sandy River Pond	3566	Sandy River Plt	BKT	0.36	5
Tufts Pond	0028	Kingfield	BKT	0.09	5
Webster Lake	2718	T06 R10 WELS	BKT	0.21	5
Upper Shin Pond	2202	Mt Chase	BKT	0.21	1
MEAN				**0.22**	
Alford Lake	4798	Hope	BNT	0.40	5
Biscay Pond	5710	Damariscotta	BNT	0.28	5
MEAN				**0.34**	
Big Indian Pond	2866	T07 R12 WELS	LKT	0.45	5
Chamberlain Lake	2882	T07 R13 WELS	LKT	0.86	5
Cliff Lake	2780	T09 R12 WELS	LKT	0.32	5
First Roach Pond	0436	Frenchtown twp	LKT	0.40	5
Millinocket Lake	2020	T01 R08 WELS	LKT	0.56	5
Monson Pond	0380	Monson	LKT	0.22	5
Webster Lake	2718	T06 R10 WELS	LKT	0.64	5
MEAN				**0.49**	
Cross Lake	1674	T17 R05 WELS	LLS	0.22	5
Moosehead Lake	0390	Greenville	LLS	0.27	5
Upper Shin Pond	2202	Mt Chase	LLS	0.52	2
MEAN				**0.34**	
Biscay Pond	5710	Damariscotta	SPK	0.39	5
Bradbury Pond	9763	New Limerick	SPK	0.52	1
Cochrane Pond	1744	New Limerick	SPK	0.14	4
Minnehonk Lake	5812	Mt Vernon	SPK	0.27	5
Spectacle Pond	5410	Vassalboro	SPK	0.40	5
Tufts Pond	0028	Kingfield	SPK	0.44	5
MEAN				**0.36**	
Sabattus Pond	3796	Sabattus	PKE	**0.14**	5
Androscoggin Lake	3836	Wayne	PKL	0.71	5
Branch Pond	5754	China	PKL	0.39	5
China Lake	5448	China	PKL	0.62	5
Givens Pond	5450	Whitefield	PKL	0.34	5
MEAN				**0.52**	

raw data

WATER	DATE	LENGTH	WEIGHT	HG mg/l
Big Indian Pond				
#2866-BKT-1	8/22/2001	420	890	0.21
#2866-BKT-2	8/22/2001	415	840	0.31
#2866-BKT-3	8/22/2001	368	540	0.24
#2866-BKT-4	8/22/2001	378	640	0.20
#2866-BKT-5	8/22/2001	375	520	0.34
#2866-BKT-6	8/22/2001	378	700	0.32
Sandy River Pond				
#3566-BKT-1	7/10/2001	362	630	0.40
#3566-BKT-2	7/10/2001	346	490	0.42
#3566-BKT-3	7/10/2001	309	305	0.36
#3566-BKT-4	7/10/2001	318	415	0.24
#3566-BKT-5	7/10/2001	293	275	0.39
Tufts Pond				
#28-BKT-1	6/28/2001	300	250	0.05
#28-BKT-2	6/28/2001	279	220	0.08
#28-BKT-3	6/28/2001	292	245	0.18
#28-BKT-4	6/28/2001	300	275	0.07
#28-BKT-5	6/28/2001	290	285	0.10
Webster Lake				
LK2718-BKT-1	6/22/2001	405	700	0.34
LK2718-BKT-2	6/22/2001	367	470	0.28
LK2718-BKT-3	6/22/2001	225	130	0.08
LK2718-BKT-4	6/22/2001	235	145	0.24
LK2718-BKT-5	6/22/2001	337	380	0.12
Upper Shin Pond				
USP-BKT-1	7/11/2001	296	320	0.21
Alford Lake				
#4798-BNT-1	8/3/2001	445	830	0.50
#4798-BNT-2	8/3/2001	421	610	0.18
#4798-BNT-3	8/3/2001	449	860	0.36
#4798-BNT-4	8/3/2001	411	650	0.32
#4798-BNT-5	8/3/2001	460	1050	0.66

WATER	DATE	LENGTH	WEIGHT	HG mg/l
Biscay Pond				
#5710-BNT-1	7/27/2001	361	475	0.09
#5710-BNT-2	7/27/2001	435	775	0.26
#5710-BNT-3	7/27/2001	396	575	0.29
#5710-BNT-4	7/27/2001	436	950	0.26
#5710-BNT-5	7/27/2001	476	1125	0.50
Big Indian Pond				
#2866-LKT-1	8/22/2001	470	1060	0.29
#2866-LKT-2	8/22/2001	610	2500	0.45
#2866-LKT-3	8/22/2001	525	1480	0.26
#2866-LKT-4	8/22/2001	618	2550	0.54
#2866-LKT-5	8/22/2001	705	3700	0.71
Chamberlain Lake				
#2882-LKT-1	10/10/2001	600	1980	1.50
#2882-LKT-2	10/11/2001	607	1830	1.04
#2882-LKT-3	10/12/2001	528	1380	0.50
#2882-LKT-4	10/12/2001	589	720	0.69
#2882-LKT-5	10/12/2001	552	1520	0.55
Cliff Lake				
#2780-LKT-1	FALL 2001	508	1240	0.31
#2780-LKT-2	FALL 2001	545	1410	0.42
#2780-LKT-3	FALL 2001	559	1850	0.35
#2780-LKT-4	FALL 2001	400	540	0.20
First Roach Pond				
#0436-LKT-1	07/17/01	432	630	0.39
#0436-LKT-2	07/17/01	427	620	0.41
#0436-LKT-3	07/17/01	449	570	0.30
#0436-LKT-4	07/17/01	472	740	0.45
#0436-LKT-5	07/17/01	475	830	0.47
Millinocket Lake				
LK2020-LKT-1	7/12/2001	380	500	0.40
LK2020-LKT-2	7/12/2001	589	2100	0.90
LK2020-LKT-3	7/12/2001	405	600	0.45
LK2020-LKT-4	7/12/2001	456	1000	0.58
LK2020-LKT-5	7/12/2001	476	1050	0.47

WATER	DATE	LENGTH	WEIGHT	HG mg/l
Monson Pond				
MPM-LKT-1	7/5/2001	486	840	0.55
MPM-LKT-2	7/5/2001	480	830	0.25
MPM-LKT-3	7/5/2001	415	590	0.11
MPM-LKT-4	7/5/2001	399	460	0.09
MPM-LKT-5	7/5/2001	443	670	0.09
Webster Lake				
LK2718-LKT-1	6/22/2001	477	930	0.51
LK2718-LKT-2	6/22/2001	565	1580	0.66
LK2718-LKT-3	6/22/2001	508	1160	0.61
LK2718-LKT-4	6/22/2001	552	1200	0.78
LK2718-LKT-5	6/22/2001	550	1420	0.63
Cross Lake				
CRL-LLS-1	6/26/2001	470	1040	0.22
CRL-LLS-2	6/26/2001	430	735	0.24
CRL-LLS-3	6/26/2001	387	495	0.13
CRL-LLS-4	6/26/2001	447	710	0.21
CRL-LLS-5	6/26/2001	512	1070	0.29
Moosehead Lake				
LK0390-LLS-1	7/20/2001	377	440	0.28
LK0390-LLS-2	7/20/2001	363	450	0.12
LK0390-LLS-3	7/20/2001	435	820	0.30
LK0390-LLS-4	7/20/2001	430	720	0.32
LK0390-LLS-5	7/20/2001	386	520	0.33
Upper Shin Pond				
USP-LLS-1	7/11/2001	470	1110	0.75
USP-LLS-2	7/11/2001	393	540	0.30
Biscay Pond				
#5710-SPK-1	7/27/2001	325	275	0.46
#5710-SPK-2	7/27/2001	400	475	0.41
#5710-SPK-3	7/27/2001	336	350	0.33
#5710-SPK-4	7/27/2001	441	760	0.46
#5710-SPK-5	7/27/2001	315	200	0.28

WATER	DATE	LENGTH	WEIGHT	HG mg/l
Bradbury Pond				
BPN-SPK-1	6/26/2001	343	495	0.52
Cochran Pond				
CPN-SPK-1	7/10/2001	350	470	0.14
CPN-SPK-2	7/10/2001	382	600	0.16
CPN-SPK-3	7/10/2001	380	600	0.14
CPN-SPK-4	7/10/2001	381	605	0.14
Minnehonk Lake				
#5812-SPK-1	8/1/2001	335	350	0.31
#5812-SPK-2	8/1/2001	332	325	0.23
#5812-SPK-3	8/1/2001	340	350	0.24
#5812-SPK-4	8/1/2001	320	275	0.25
#5812-SPK-5	8/1/2001	353	350	0.30
Spectacle Pond				
#5410-SPK-1	8/7/2001	468	1120	0.31
#5410-SPK-2	8/7/2001	459	1120	0.43
#5410-SPK-3	8/7/2001	434	1120	0.19
#5410-SPK-4	8/7/2001	500	1580	0.58
#5410-SPK-5	8/7/2001	502	1490	0.49
Tufts Pond				
#28-SPK-1	6/28/2001	385	415	0.39
#28-SPK-2	6/28/2001	411	580	0.48
#28-SPK-3	6/28/2001	370	425	0.38
#28-SPK-4	6/28/2001	385	535	0.50
#28-SPK-5	6/28/2001	372	430	0.45
Sabattus Pond				
SPS-PKE-1	8/21/2001	558	1060	0.15
SPS-PKE-2	8/21/2001	505	730	0.09
SPS-PKE-3	8/21/2001	580	930	0.16
SPS-PKE-4	8/21/2001	525	830	0.11
SPS-PKE-5	8/21/2001	555	900	0.17

WATER	DATE	LENGTH	WEIGHT	HG mg/l
Androscoggin Lake				
#3336-PKL-1	2/7/2002	588	1380	0.64
#3336-PKL-2	2/7/2002	540	1050	1.04
#3336-PKL-3	2/7/2002	420	520	0.37
#3336-PKL-4	2/7/2002	552	1000	0.81
#3336-PKL-5	2/7/2002	500	840	0.68
Branch Pond				
#5754-PKL-1	2/6/2002	370	340	0.39
#5754-PKL-2	2/6/2002	350	290	0.27
#5754-PKL-3	2/6/2002	380	320	0.66
#5754-PKL-4	2/6/2002	335	230	0.26
#5754-PKL-5	2/6/2002	400	400	0.36
China Lake				
#5448-PKL-1	2/1/2002	552	880	0.73
#5448-PKL-2	2/1/2002	462	500	0.14
#5448-PKL-3	2/1/2002	565	1000	0.73
#5448-PKL-4	2/1/2002	550	1000	0.60
#5448-PKL-5	2/1/2002	580	1220	0.90
Givens Pond				
#5450-PKL-1	1/30/2002	330	210	0.39
#5450-PKL-2	1/30/2002	330	210	0.40
#5450-PKL-3	1/30/2002	327	230	0.23
#5450-PKL-4	1/30/2002	326	225	0.22
#5450-PKL-5	1/30/2002	380	340	0.46

Chain Pickerel. There are mercury data from only 8 lakes sampled for chain pickerel , which appear to be high in mercury, though standard deviations are low. More data are needed to get a better sense of the underlying distribution, but it is unclear whether new data would have much of an effect on the advisory. Chain pickerel were collected from 4 lakes during the winter ice fishing season 2002. Although there was considerable variation in concentrations among lakes, the mean concentration was the highest of all species sampled in 2001 (Table 2.2.1). Nevertheless, the mean concentration was lower than that for the 8 lakes sampled previously (0.92 ppm). Mercury concentrations appeared to be correlated with length for both these data and the historical data.

Confirming REMAP DDT analysis. From the 1993-94 REMAP study of Maine lakes, 15 lake/species samples were identified as having fish with elevated total DDT that exceeded Bureau of Health fish tissue action level (FTAL=64 ppb) in edible filets. Most of the REMAP data were flagged for some sort of quality assurance exceedance, so the data were questionable. To confirm the REMAP data, the lakes were resampled in 2000 and 2001. In 2000, a total of seven samples of fish were captured from a total of five lakes. In 2001, a total of six samples of fish were collected from a total of five lakes. Although we were unable to collect the same species as in the REMAP study in all lakes, we did capture related species, i.e. salmonids, from most lakes in 2000 and 2001. Total DDT concentrations from both 2000 and 2001 were much lower than those from the REMAP project (Table 2.2.2). None of the 2000 samples exceeded the FTAL.

Table 2.2.2. Total DDT in fish from some Maine lakes

SUMMARY

LAKE	MIDAS	LAKE CODE	SPECIES	N	DDX ppb
2000					
Eagle Lake	1634	LK1634	LKT	5	2.9
Eagle Lake					
Little Ossipee Pond	5024	LOW	LLS	5	3.0
Waterboro					
Lovewell Pond	3254	LPF	BNT	5	15.9
Fryeburg					
Lower Range Pond	3760	RPL	SMB	5	6.8
Poland		RPL	WHS	2	61.9
Round Pond	3818	LRP	BNT	5	4.1
Livermore		LRP	WHS	5	27.6
2001					
Cross L	1674	CRL	LLS	5	19.5
T17 R05 WELS					
Bradbury L	9763	BPN	SPK	1	11.7
New Limerick					
Cochrane L	1744	CPN	CPN	4	5.7
New Limerick					
Monson P	1821	MPM	LKT	5	3.3
Monson					
Upper Shin P	2202	USP	LLS	2	22.9
Mt Chase	2202	USP	BKT	1	25.0

RAW DATA

DEP ID#	DL	MPM-LKT-01	MPM-LKT-02	MPM-LKT-03	MPM-LKT-04	MPM-LKT-05
WRI ID #	ppb	01-316	01-317	01-318	01-319	01-320
EXT ID #	wet	1565	1566	1567	1568	1569
Compound						
2,4-DDE	1.0	<DL	<DL	<DL	<DL	<DL
4,4-DDE	1.0	5.87	1.24	0.52	0.96	1.55
2,4-DDD	1.0	<DL	<DL	<DL	<DL	<DL
4,4-DDD	1.0	0.40	<DL	<DL	0.40	0.44
2,4-DDT	1.0	1.28	0.84	1.00	1.04	0.88
4,4-DDT	1.0	<DL	<DL	<DL	<DL	<DL
Total DDX		7.55	2.08	1.52	2.40	2.87
TCMX (% rec.)	65-125	69.5	84.5	87.0	81.2	78.2
Sample weight (g)		25.04	25.01	25.00	24.98	25.13

DEP ID#	DL	BPN-SPK-01	CPN-SPK-02	CPN-SPK-03	CPN-SPK-04	CPN-SPK-05
WRI ID #	ppb	01-321	01-322	01-323	01-324	01-325
EXT ID #	wet	1570	1571	1572	1573	1574
Compound						
2,4-DDE	1.0	<DL	<DL	<DL	<DL	<DL
4,4-DDE	1.0	8.51	6.95	1.24	3.87	1.32
2,4-DDD	1.0	<DL	<DL	<DL	<DL	<DL
4,4-DDD	1.0	1.64	0.92	<DL	0.56	<DL
2,4-DDT	1.0	1.56	1.12	1.00	1.08	1.12
4,4-DDT	1.0	<DL	1.84	<DL	<DL	1.76
Total DDX		11.71	10.82	2.23	5.51	4.20
TCMX (% rec.)	65-125	71.0	115	90.0	113	96.5
Sample weight (g)		25.03	25.04	25.10	25.06	25.01

RAW DATA

DEP ID#	DL	CRL-LLS-01	CRL-LLS-02	CRL-LLS-03	CRL-LLS-04	CRL-LLS-05
WRI ID #	ppb	01-410	01-411	01-412	01-413	01-414
EXT ID #	wet	1575	1576	1577	1578	1580
Compound						
2,4-DDE	1.0	<DL	<DL	<DL	<DL	<DL
4,4-DDE	1.0	4.35	10.3	26.6	16.1	9.54
2,4-DDD	1.0	<DL	<DL	<DL	<DL	<DL
4,4-DDD	1.0	2.44	1.52	3.00	2.00	3.59
2,4-DDT	1.0	1.56	1.48	1.56	1.28	3.63
4,4-DDT	1.0	2.32	<DL	2.84	<DL	3.35
Total DDX		10.67	13.34	33.96	19.38	20.11
TCMX (% rec.	65-125	98.8	85.7	94.0	105	125
Sample weight (g)		25.03	25.04	25.03	25.02	25.06

DEP ID#	DL	USP-LLS-01	USP-LLS-02	USP-BKT-01
WRI ID #	ppb	01-420	01-421	01-422
EXT ID #	wet	1675	1584	1585
Compound				
2,4-DDE	1.0	<DL	13.25	<DL
4,4-DDE	1.0	6.79	7.15	1.56
2,4-DDD	1.0	<DL	<DL	<DL
4,4-DDD	1.0	3.47	2.24	<DL
2,4-DDT	1.0	1.24	3.59	0.88
4,4-DDT	1.0	3.35	4.67	<DL
Total DDX		14.86	30.90	2.44
TCMX (% rec.	65-125	103	82.6	75.8
Sample weight (g)		25.04	25.05	24.98

2.3

LOON EFFECTS STUDY

Assessing the impacts of methylmercury on piscivorous wildlife using a wildlife criterion value based on the Common Loon

(Report BRI2002-08)

2001 Final Report

Submitted to:

Maine Department of Environmental Protection
Surface Water Ambient Toxic Monitoring Program
State House Station 17
Augusta, Maine 04333

Submitted by:

David C. Evers, Oksana P. Lane, Chris De Sorbo, and Lucas Savoy
BioDiversity Research Institute[1]

19 April 2002

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Executive Summary:

Anthropogenic inputs of mercury (Hg) into the environment have significantly increased in the past few decades. In conjunction, the current availability of methylmercury (MeHg) in aquatic systems has increased to levels posing risks to human and ecological health. Risk levels vary considerably in response to MeHg availability, which is affected by lake hydrology, biogeochemistry, habitat, topography, and proximity to airborne sources. We selected the Common Loon as the most suitable bioindicator of aquatic Hg toxicity, based on ecological, logistical, and other criteria, including public valuations of natural resources. Opportunistic and probability-based sampling efforts from 1994-2001 indicate New England's breeding loon population is at unacceptable levels of risk to Hg contamination, particularly in Maine. Based on risk categories developed from the literature and *in situ* studies by BioDiversity Research Institute and their collaborators, at least 26% of the breeding loon population in Maine is estimated to be at risk, while at least 19% of the eggs laid are potentially impacted.

Because results from national sampling indicated loons were at most risk from Hg in New England (particularly Maine), we identified several individual- and population-level parameters to better understand the extent of mercury toxicity across Maine. Between 1994-01 we collected 199 abandoned eggs (60 in 2001) as well as blood and feather samples from 303 adult (50 in 2001) and 103 juvenile loons captured in Maine. The Hg concentrations in these samples were used to relate sublethal impacts on behavior, developmental stability, immunosuppression, individual survival, egg development, and overall reproductive success. In the Rangeley Lakes Study Area, a total of 181 loon territories were monitored on 44 lakes during 1998-01. Current monitoring efforts and historical data comprise 674 territory-years measured. Behavioral observations were conducted for over 1,500 hours on 16 lakes with 38 loon territories from 1998 to 2000.

Several reproductive measures significantly declined for loon pairs at high risk to prey MeHg availability, thereby corroborating studies in high-risk sites in Nova Scotia and Wisconsin that show Hg impacts reproductive success. Based on 219 loon territories representing 946 territory-years surveyed we found that pairs above the lowest observed adverse effect level (i.e., >3.0 ppm in the blood) fledged 40% fewer young than pairs below our no observed adverse effect level (i.e., <1.0 ppm in the blood). We also found similar significant patterns of lower productivity for other reproductive measures. We view the implication of long-term declines in these reproductive measures as serious and contend they would not be detected by traditional survey techniques.

Insight into why loons are facing Hg-based population declines can be viewed through our hazard assessment process that is based on a weight-of-evidence approach. Physiological impacts of Hg are measured through two key biomarkers: corticosterone stress hormone levels and flight feather asymmetry. Circulating corticosterone hormone levels are strongly linked with increasing blood Hg levels and are not related to capture and handling stress. Corticosterone hormone levels increase on an average of 14.6% for every one ppm of increase in blood Hg levels (n=239). This indicates that loons with high blood Hg levels have higher rates of chronic stress and may therefore have compromised immune systems. Asymmetry measurements provide insights into developmental stability and potentially reproductive fitness. Three years of flight feather measurements have shown agreement among years that loon breeding populations with greater exposure to Hg have significantly greater asymmetry than populations at low risk

(n=227). Greater asymmetry may indicate disruptions from stressors on their embryonic development and current physiological status as well as a potential decline in reproductive fitness.

Many behavioral impacts that appear to be related to the neurotoxic effects of MeHg can rarely be observed in the field. We found adult loons in high risk situations left eggs unattended 14% of the time, compared to 1% in controls. Several cases of direct field observations indicate that adult loons with high MeHg body burdens avoid incubating their eggs and display atypical behaviors such as patrolling in front of, or sitting next to the nest. We documented a significant negative relationship between adult blood Hg and foraging behavior, and a significant positive relationship between adult blood Hg and brooding behavior. Recategorizing our data according to energy demands revealed a significant inverse relationship between blood Hg and time spent in high energy behaviors. Our findings are consistent with other studies linking Hg and lethargy, reduced motivation to hunt prey, and compromised foraging abilities.

Current levels of Hg in Maine’s lacustrine ecosystems also appear to be impacting individual survival of adult and juvenile loons. Recaptured adult loons exhibit a significant annual increase of Hg (9% in males, 5.6% in females) that we predict will significantly reduce lifetime individual performance. A model of this impact indicates a decline of 13 to 8 young produced over a loon’s lifetime. Further, juveniles from high-risk territories have increasing blood Hg levels of 3% per day during the summer, potentially reaching dangerous levels after the final feather molt at 11 weeks of age.

Characterization of the risk imposed by MeHg bioavailability in aquatic systems to high trophic level obligate piscivores such as the Common Loon indicates negative population level impacts in Maine. Although the impacts of Hg on loons are varied, complex, and not yet fully understood, the combination of high exposure to a significant part of the breeding population and the “bottom-line” impact of reducing overall reproductive success to 40%, is creating an aquatic landscape that is not sustainable for the Common Loon in Maine.

Current models indicate a negative population growth rate. Because of the loon’s life history strategy (i.e., long lived, slow maturing, and low fecundity) the annual and continual impacts of this type of stressor causes an erosion of the non-breeding or buffer population that serves as a natural cushion to catastrophic events. Once this buffer population is exhausted, the occupancy of established territories will shrink and it will be more obvious that loon populations are declining. However, the realization of shrinking loon populations at that stage will require drastic and potentially expensive efforts to reverse the decline. Models based on a 25-year, statewide comprehensive monitoring effort in New Hampshire show approximately half of Maine’s buffer population has been exhausted. Certain areas in Maine, such as the Allagash area that may be particularly impacted from Hg, may already exhibit exhaustion of the buffer population and a shrinking number of territorial pairs.

Continued refinement of model parameters and either a probability-based sampling scheme or new sampling efforts in northern Maine will provide higher confidence in our estimates that will therefore assist in state-based policy efforts as well as national regulations that reflect the ecological injury Hg is currently having on the freshwater landscape.

Our approach to a high resolution risk characterization for the Common Loon provides the necessary information for developing a Maine-based wildlife criterion value (WCV). Recent efforts by the USEPA have established a generic WCV with several major limitations that we are improving with this study. A WCV estimates wildlife population viability through measurement of contaminant stressors such as surface water Hg concentrations.

First-year measurements of exposure parameters indicate a bioaccumulation factor (BAF) of 75,000 for trophic level 3 and 120,000 for trophic level 4 based on the relationship of total Hg in unfiltered water with total Hg in yellow perch. We are not able to calculate a Maine-based reference dose because of several outstanding uncertainties. Further work will correct this limitation and a Maine-based WCV that is protective of aquatic piscivorous wildlife will be obtainable.

The full report is available as a separate file with the 2001 SWAT report at http://www.state.me.us/dep/blwq/monitoring.htm

2.4

PREDICTING MERCURY LEVELS IN FISH

PREDICTION OF THE CONCENTRATION OF MERCURY IN FRESHWATER FISH IN MAINE

Aria Amirbahman, Assistant Professor of Civil and Environmental Engineering, University of Maine, Orono, ME 04469.

Introduction:

The objective of this research is to predict the concentration of mercury (Hg) in freshwater fish from Maine lakes based on the background aqueous phase chemistry. A methylmercury (MeHg) chemical speciation model developed by us previously will be used to correlate the fish Hg concentration to the speciation of MeHg with respect to chloride and the dissolved organic carbon (DOC).

Considerable effort was spent in August 2002 on designing sampling schemes and selecting lakes that would best serve the study objectives. The following 5 lakes were selected based on the existing fish Hg data provided by the Maine DEP.

Lake	Fish Hg concentration (ppb)	
East Musquash	0.63	Topsfiled area
Matagamon	0.53	Piscataquis County
Great Pond	0.38	Belgrade area
Auburn	0.15	Poland area
Sabbatus Pond	0.06	Lewiston area

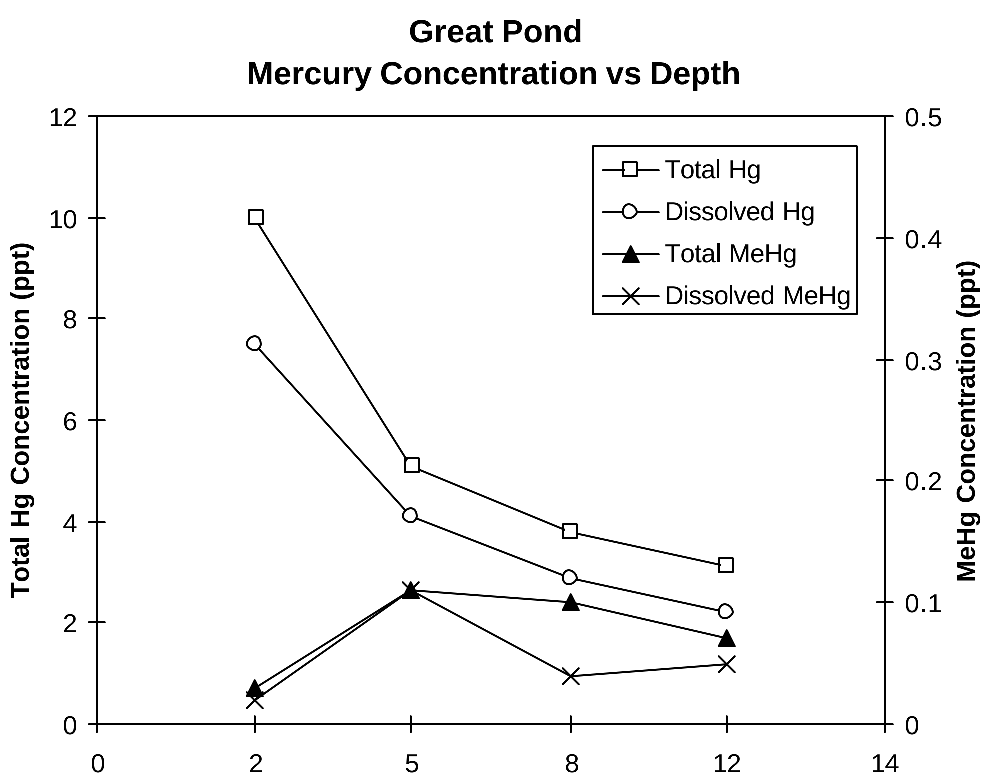
Preliminary Results:

Water samples were taken at Great Pond on 5 October 2001 and analyzed for Hg and MeHg. A Teflon kemmerer was used to collect water samples. Samples were kept in the dark in a cooler until they were transferred to the lab where they were refrigerated prior to the analysis. Sample analysis was performed according to the EPA method 1631. Hg and MeHg were analyzed in both filtered (dissolved defined as passing through 0.45 μm filter) and unfiltered (dissolved + particulate) samples. The results are shown below in the attached figure.

The results in the attached figure show higher total and dissolved Hg concentrations at higher depths, perhaps indicating atmospheric deposition as the main source of Hg input in Great Pond. The results for MeHg are not conclusive, as they do not show a clear trend in MeHg distribution with respect to the depth.

Sampling of all five lakes were planned starting in mid May 2002, after the spring turnover and just before the onset of summer stratification. The plan consisted of sampling the deepest part of the lakes 4 times during the summer and fall. The sampling would span the period just before the early summer stratification, and just after the fall turnover.

We began sampling the 2002 sampling campaign on 16 May 2002 at East Musquash Lake. Unfortunately, during the sampling, the Teflon kemmerer was lost due to a snapped cable. On June 5th, Mr. Dan Placzek, a professional diver, conducted an eight hour search of the lakebed, but was unable to find the kemmerer. We then ordered a kemmerer through Wildco Products, and received one toward the end of August. It was decided at that stage to postpone sampling until the 2003 season, in order to collect a complete set of Hg and MeHg data before and after the summer stratification. Sampling will resume in mid May 2003 and finish by the end of September 2003.



2.5

LEA MERCURY STUDY

The Lakes Environmental Association (LEA) is a private, non-profit organization founded in Naples, Maine in 1970 to protect the water quality and watersheds of the Sebago-Long Lake Region. The Association serves the towns of Bridgton, Denmark, Harrison, Naples, Sweden, and Waterford as well as Sebago Lake. LEA wished to monitor mercury in fish from lakes within these towns and collected 23 samples of fish from 4 area lakes and ponds. DEP is interested in partnering with groups that can assist monitoring of a number of lakes and ponds. DEP agreed to share costs equally for those samples that met DEP protocols. A total of 4 samples of at least 4 fish each from a total of two lakes met DEP's requirements. The results show that concentrations of mercury in samples of brown trout, largemouth bass and smallmouth bass from Highland lake exceeded the Maine Bureau of Health's Fish Tissue Action Level (FTAL=0.2 mg/kg) but concentrations in white perch did not (Table 2.4.1). Concentrations of mercury in largemouth bass from Keoka Lake also exceeded the FTAL. These concentrations are somewhat lower than the statewide averages for these species. Concentrations in fish from Long Lake and Moose Pond also exceeded the FTAL, but sample sizes are too small to make these data definitive.

Table 2.4.1. Mercury concentrations in LEA lakes, 2001

SUMMARY

WATER	MIDAS NO.	TOWN	SPECIES CODE	HG mg/l	N
HIGHLAND L	3454	Bridgton	BNT	0.24	4
			LMB	0.23	5
			SMB	0.35	4
			WHP	0.10	5
LONG L	5780	Bridgton	SMB	0.35	1
MOOSE P	3134	Bridgton	SMB	0.27	1
			WHP	0.57	2
KEOKA L	3416.0000	Waterford	LMB	0.40	5

LEA Fish/Mercury data:

Lake/ Midas	Date	Species	Sample ID	Length mm	Result (mg/kg)
Highland 3454	8/14/2001	Brown Trout A	BTHI A	330	0.0325
Highland 3454	8/15/2001	Brown Trout B	BTHI B	356	0.1691
Highland 3454	8/15/2001	Brown Trout C	BTHI C	381	0.3306
Highland 3454	8/14/2001	Brown Trout D	BTHI D	406	0.4190
Highland 3454	8/10/2001	Small Mouth A	SMHI A	229	0.1414
Highland 3454	8/14/2001	Small Mouth B	SMHI B	330	0.4079
Highland 3454	8/19/2001	Small Mouth C	SMHI C	356	0.4085
Highland 3454	8/19/2001	Small Mouth D	SMHI D	381	0.4564
		Small Mouth D dup.	SMHI D dup		0.4610
		W. P. Composite	WPHI		0.1003
		W. P. Composite dup.	WPHI dup		0.0984
Highland 3454	8/10/2001	White Perch A	WPHI A		
Highland 3454	8/10/2001	White Perch B	WPHI B		
Highland 3454	8/10/2001	White Perch C	WPHI C		
Highland 3454	8/10/2001	White Perch D	WPHI D		
Highland 3454	8/10/2001	White Perch E	WPHI E		
Long 5780	8/18/2001	Small Mouth	SMLL	305	0.3517
Moose 3134	8/19/2001	Small Mouth	SMMO	254	0.2678
Keoka 3416	8/3/2001	Large Mouth A	LMKO A	305	0.1584
Keoka 3416	7/28/2001	Large Mouth B	LMKO B	305	0.2436
Keoka 3416	8/3/2001	Large Mouth C	LMKO C	330	0.3380
Keoka 3416	7/26/2001	Large Mouth D	LMKO D	381	0.4900
Keoka 3416	8/3/2001	Large Mouth E	LMKO E	381	0.7598
Highland 3454	8/10/2001	Large Mouth A	LMHI A	254	0.1951
Highland 3454	8/10/2001	Large Mouth B	LMHI B	279	0.2356
Highland 3454	8/10/2001	Large Mouth C	LMHI C	292	0.1784
Highland 3454	8/10/2001	Large Mouth D	LMHI D	305	0.2706
Highland 3454	8/10/2001	Large Mouth E	LMHI E	318	0.2806
Moose 3134	8/7/2001	White Perch A	WMPO A	279	0.4299
		White Perch A dup.	WMPO A dup		0.4159
Moose 3134	8/7/2001	White Perch B	WMPO B	305	0.7236
SRM was dogfish m		**% recovery**	**SRM**		
		104	DORM A		
		102	DORM B		**LEA**
		102	DORM C	**Fish Species**	**Average for Group**
				Brown Trout HI	0.23
		% difference	**Duplicates**	Small Mouth HI	0.35
		1.00	SMHI D	White Perch HI	0.1
		1.90	WPHI	mall Mouth Lor	0.35
		3.20	WMPO A	Small Mouth MC	0.27
				Large Mouth KC	0.4
		% recovery	**Spikes**	Large Mouth HI	0.23
		86	SMHI D	White Perch MC	0.58
		85	WPHI		
		92	WMPO A		

MODULE 3 RIVERS AND STREAMS

3.1.1

COPLANAR PCB IN FISH

Coplanar PCB in Fish

In 2001 the SWAT program was again integrated with the Dioxin Monitoring Program (DMP) that has been in effect since 1988. Fish samples collected at 21 DMP stations for dioxin analyses were also analyzed for coplanar PCBs in the SWAT program. All non-detects were calculated at half the detection limit. Dioxin toxic equivalents (DTEh) and coplanar PCB toxic equivalents (CTEh) were calculated using World Health Organization (1998) toxicity equivalency factors (TEFs). For comparison with the Bureau of Health (BOH) Fish Tissue Action Levels (FTAL) for protection of human consumers, the 95^{th} upper confidence limits (95% UCL) were used. The 95%UCL DTEh are compared to the cancer action level, FTALc=1.5 ppt, and the 95%UCL TTEh (sum of both CTEh and DTEh) are compared to the reproductive and developmental action level, FTALr=1.8 ppt. For suckers from Veazie, Windham, and Westbrook, that were analyzed as whole fish, concentrations in filets were estimated for comparison with the Fish Tissue Action Levels. This was accomplished by dividing whole body concentrations by a factor of 3.5, determined from Androscoggin River suckers in the mid 1980's

The results show that DTEh in trout from the Androscoggin River at Gilead and the Kennebec River at Fairfield, eels from the commercial fishery in the Penobscot River at Orrington and suckers from the Androscoggin River at Rumford, Riley and Livermore Falls exceeded the FTALc (Figures 3.1.1, 3.1.2, 3.1.3). CTEh exceeded the FTALc in several samples. TTEh exceeded the FTALr in all fish sampled from the Androscoggin River and fish from many other stations as well documenting significant CTEh concentrations at many stations. CTEh concentrations were similar to those from 2000 at most stations. Mean coplanar PCB toxic equivalents (CTEh) varied in magnitude in relation to mean dioxin toxic equivalents (DTEh) as a percentage of total toxic equivalents (TTEh) (Table 3.1.1). DTEh were lowest at the reference stations at Norridgewock on the Kennebec River, Woodville on the Penobscot River, and in Androscoggin Lake and higher below known point sources. CTEh were not necessarily the lowest at the reference stations indicating some source in addition to or other than point sources, most likely atmospheric deposition at many stations.

SPECIES CODES

BNT	brown trout
EEL	eel
LMB	largemouth bass
RBT	rainbow trout
SMB	smallmouth bass
WHP	white perch
WHS	white sucker

STATION CODES

AGL	Androscoggin R at Gilead
ARP	Androscoggin R at Rumford Point
ARF	Androscoggin R at Rumford
ARY	Androscoggin R at Riley
AGI	Androscoggin R at GIP, Auburn
ALV	Androscoggin R at Livermore Falls
ALS	Androscoggin R at Lisbon Falls
ALW	Androscoggin Lake at Wayne
KRM	Kennebec R at Madison
KNW	Kennebec R at Norridgewock
KFF	Kennebec R at Shawmut, Fairfield
KRS	Kennebec R at Sidney
PBW	Penobscot R at Woodville
PBM	Penobscot R at Winn
PBL	Penobscot R at S Lincoln
PBV	Penobscot R at Veazie
PBO	Penobscot R at Orrington
PWD	Presumpscot R at Windham
PWB	Presumpscot R at Westbrook
SFS	Salmon Falls R at S. Berwick
SEN	E Br Sebasticook at Newport
SED	E Br Sebasticook at Detroit
SWP	W Br Sebasticook at Palmyra

Figure 3.1.1.1 Coplanar PCB (CTEh) and dioxins (DTEh) in 2001 bass samples

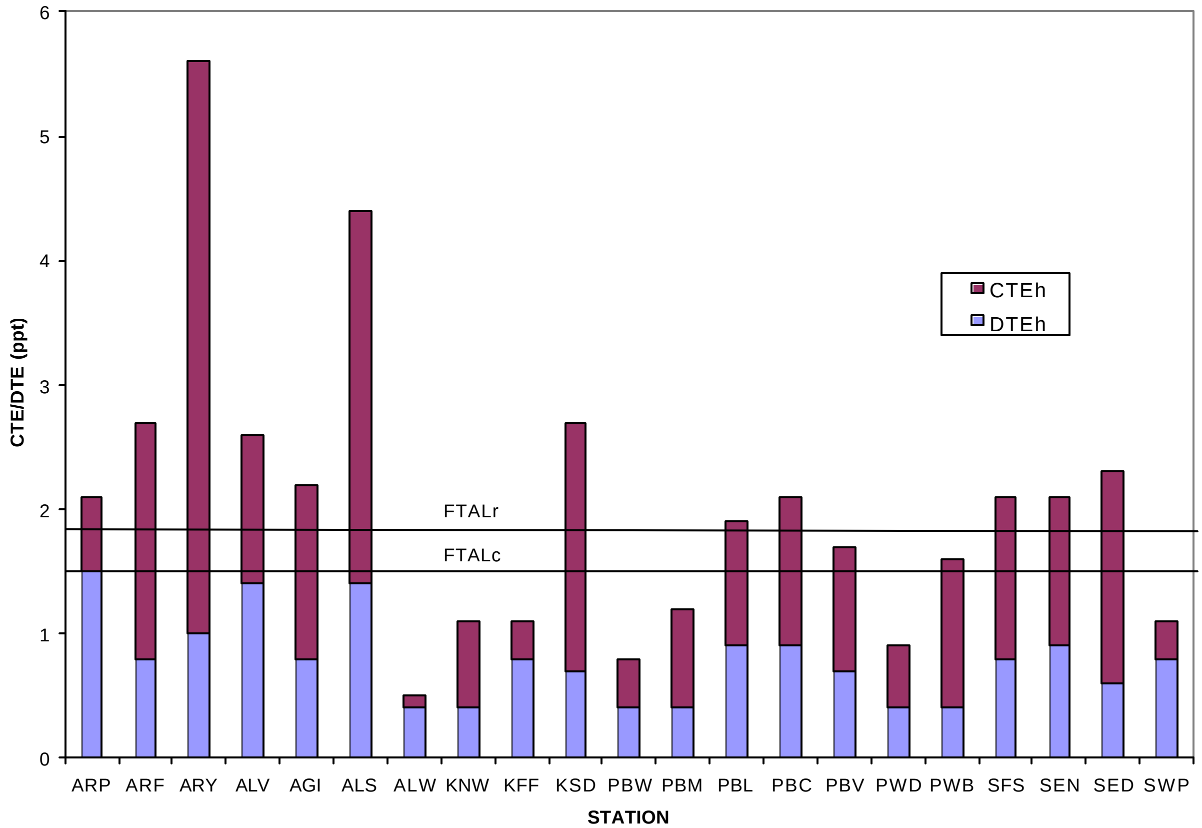


Figure 3.1.1.2 Coplanar PCB (CTEh) and dioxins (DTEh) in 2001 white sucker samples

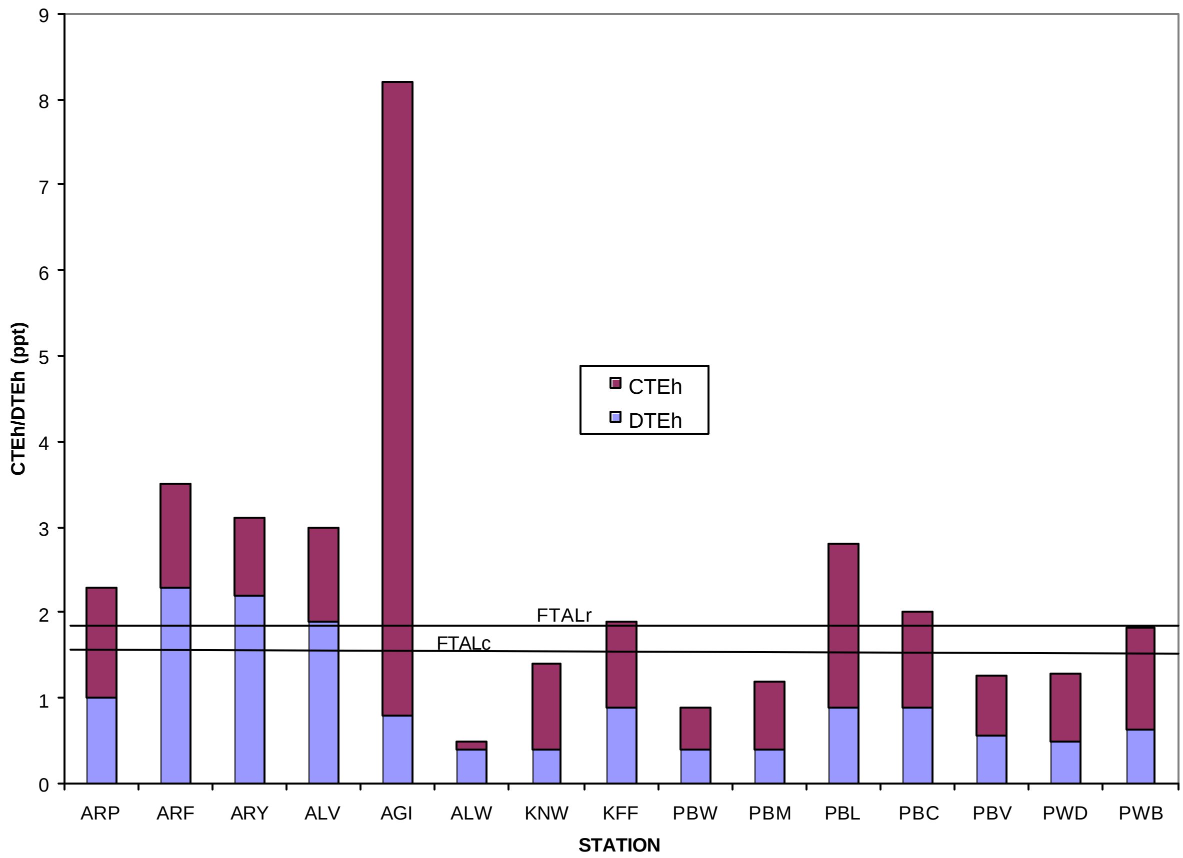
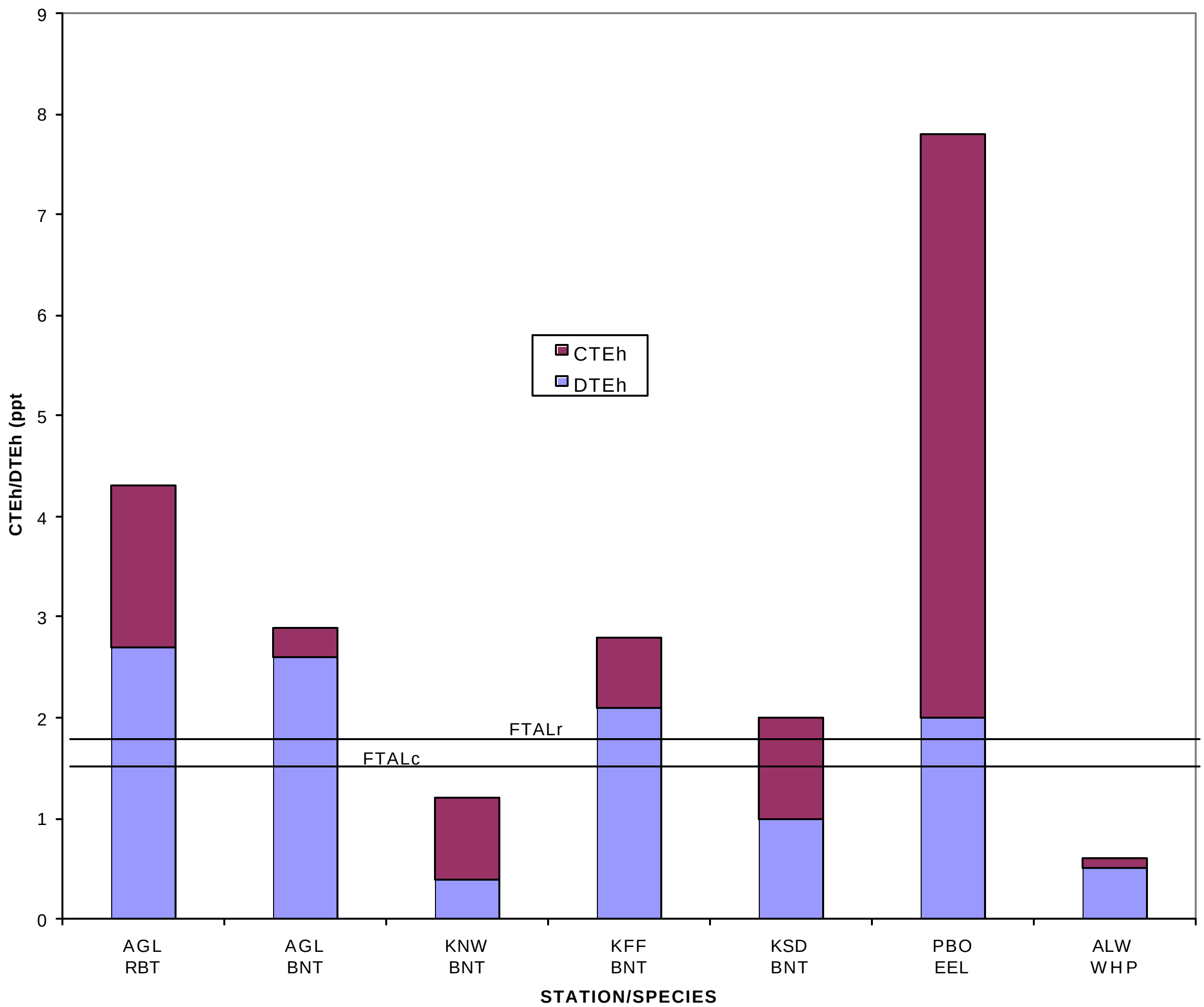


Figure 3.1.1.3 Coplanar PCB (CTEh) and dioxins (DTEh) in 2001 fish samples



DEP ID Congener	IUPAC #	DL ng/kg	AGL-RBT-01	AGL-RBT-02	AGL-RBT-03	AGL-RBT-04	AGL-BNT-01
3,3',4,4'-TCB	77	0.5	30.5	51.2	45.6	35.8	26.9
2',3,4,4',5-PeCB	123	0.5	26.8	48.9	41.2	37.7	3.66
2,3',4,4',5-PeCB	118	0.5	66.8	103	121	75.3	51.8
2,3,4,4',5-PeCB	114	0.5	24.6	41.6	38.5	28.7	21.5
2,3,3',4,4'-PeCB	105	0.5	18.4	31.4	29.7	22.2	4.58
3,3',4,4',5-PeCB	126	0.5	11.3	15.8	12.2	10.8	3.06
2,3',4,4',5,5'-HxCB	167	1.0	4.55	5.69	4.81	5.09	1.58
2,3,3',4,4',5-HxCB	156	1.0	102	198	169	88.5	33.6
2,3,3',4,4',5'-HxCB	157	1.0	2.26	2.69	2.47	2.55	0.55
3,3',4,4',5,5'-HxCB	169	1.0	1.03	2.25	1.87	1.48	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	21.7	40.2	35.9	30.6	7.01
CTEo			1.221	1.751	1.371	1.175	0.343
CTEd			1.221	1.751	1.371	1.175	0.353
% Lipids			1.96	3.61	3.06	2.19	10.22
Sample weight (g)			50.1	50.0	50.1	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	ARP-SMB-01	ARP-SMB-02	ARP-SMB-03	ARP-SMB-04	ARP-SMB-05
3,3',4,4'-TCB	77	0.5	8.07	22.3	25.9	30.8	7.89
2',3,4,4',5-PeCB	123	0.5	15.7	30.4	48.7	61.2	11.7
2,3',4,4',5-PeCB	118	0.5	105	269	288	324	95.6
2,3,4,4',5-PeCB	114	0.5	2.55	4.41	5.36	7.14	2.07
2,3,3',4,4'-PeCB	105	0.5	31.8	75.8	81.7	85.6	26.9
3,3',4,4',5-PeCB	126	0.5	1.78	2.69	3.91	4.58	1.33
2,3',4,4',5,5'-HxCB	167	1.0	2.56	5.88	7.01	7.25	2.04
2,3,3',4,4',5-HxCB	156	1.0	59.7	124	159	166	56.9
2,3,3',4,4',5'-HxCB	157	1.0	1.89	4.36	4.67	5.26	1.58
3,3',4,4',5,5'-HxCB	169	1.0	<DL	2.28	2.89	3.65	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	7.81	15.7	17.9	20.8	6.65
CTEo			0.227	0.400	0.551	0.636	0.178
CTEd			0.237	0.400	0.551	0.636	0.188
% Lipids			0.69	1.40	1.83	2.32	0.58
Sample weight (g)			50.1	50.1	50.1	50.0	50.1

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ARP-WHS-C1	ARP-WHS-C2		ARF-WHS-C1	ARF-WHS-C2
3,3',4,4'-TCB	77	0.5	31.4	26.9		18.7	15.9
2',3,4,4',5-PeCB	123	0.5	22.6	31.5		88.3	74.2
2,3',4,4',5-PeCB	118	0.5	124	133		441	399
2,3,4,4',5-PeCB	114	0.5	6.61	5.21		9.1	10.2
2,3,3',4,4'-PeCB	105	0.5	21.4	15.3		256	288
3,3',4,4',5-PeCB	126	0.5	11.2	8.51		10.1	8.15
2,3',4,4',5,5'-HxCB	167	1.0	5.47	4.26		35.8	29.8
2,3,3',4,4',5-HxCB	156	1.0	74.5	59.6		66.2	68.9
2,3,3',4,4',5'-HxCB	157	1.0	5.14	4.31		5.09	6.25
3,3',4,4',5,5'-HxCB	169	1.0	0.66	<DL		1.01	1.24
2,3,3',4,4',5,5'-HpCB	189	1.0	15.4	13.4		8.57	9.57
CTEo			1.191	0.908		1.142	0.949
CTEd			1.191	0.918		1.142	0.949
% Lipids			2.49	1.85		12.88	12.42
Sample weight (g)			50.0	50.1		50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	ARF-SMB-01	ARF-SMB-02	ARF-SMB-03	ARF-SMB-04	ARF-SMB-05
3,3',4,4'-TCB	77	0.5	21.2	12.0	15.6	18.9	26.5
2',3,4,4',5-PeCB	123	0.5	30.6	12.7	18.4	22.5	40.2
2,3',4,4',5-PeCB	118	0.5	387	266	321	294	421
2,3,4,4',5-PeCB	114	0.5	6.98	4.14	5.84	5.57	7.16
2,3,3',4,4'-PeCB	105	0.5	38.2	21.5	26.9	31.6	45.2
3,3',4,4',5-PeCB	126	0.5	15.9	9.98	10.5	14.2	18.9
2,3',4,4',5,5'-HxCB	167	1.0	12.6	6.58	11.7	9.85	14.7
2,3,3',4,4',5-HxCB	156	1.0	147	75.2	124	94.7	155
2,3,3',4,4',5'-HxCB	157	1.0	12.9	7.01	8.47	10.3	11.2
3,3',4,4',5,5'-HxCB	169	1.0	3.02	1.55	1.89	2.26	3.99
2,3,3',4,4',5,5'-HpCB	189	1.0	17.4	9.58	13.3	15.1	20.1
CTEo			1.753	1.089	1.178	1.536	2.072
CTEd			1.753	1.089	1.178	1.536	2.072
% Lipids			1.23	0.70	1.12	1.19	1.62
Sample weight (g)			50.0	50.1	50.0	50.1	50.0

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ARY SMB-01	ARY SMB-02	ARY SMB-03	ARY SMB-04	ARY SMB-05
3,3',4,4'-TCB	77	0.5	52.6	15.6	39.2	41.2	35.8
2',3,4,4',5-PeCB	123	0.5	48.7	22.6	41.8	61.5	54.7
2,3',4,4',5-PeCB	118	0.5	326	198	321	412	355
2,3,4,4',5-PeCB	114	0.5	15.8	13.2	19.4	29.6	25.7
2,3,3',4,4'-PeCB	105	0.5	98.7	55.2	114	147	121
3,3',4,4',5-PeCB	126	0.5	48.6	21.7	40.2	53.8	42.3
2,3',4,4',5,5'-HxCB	167	1.0	31.0	16.9	28.7	45.7	36.9
2,3,3',4,4',5-HxCB	156	1.0	187	112	179	268	224
2,3,3',4,4',5'-HxCB	157	1.0	42.5	18.4	31.6	51.7	45.7
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	1.05	0.85
2,3,3',4,4',5,5'-HpCB	189	1.0	20.2	11.0	15.8	29.8	26.2
CTEo			5.038	2.272	4.188	5.635	4.446
CTEd			5.048	2.282	4.198	5.635	4.446
% Lipids			1.23	0.61	1.09	1.73	1.57
Sample weight (g)			50.1	50.1	50.1	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	ARY SMB-06	ARY SMB-07	ARY SMB-08	ARY SMB-09	ARY SMB-10
3,3',4,4'-TCB	77	0.5	30.1	25.8	32.6	19.4	37.6
2',3,4,4',5-PeCB	123	0.5	27.3	31.0	26.4	25.8	38.9
2,3',4,4',5-PeCB	118	0.5	256	188	221	274	301
2,3,4,4',5-PeCB	114	0.5	10.8	12.1	16.3	14.7	21.6
2,3,3',4,4'-PeCB	105	0.5	62.8	84.1	78.5	88.3	102
3,3',4,4',5-PeCB	126	0.5	35.6	28.9	31.4	35.8	39.7
2,3',4,4',5,5'-HxCB	167	1.0	20.2	16.6	23.8	29.7	33.6
2,3,3',4,4',5-HxCB	156	1.0	158	142	130	167	139
2,3,3',4,4',5'-HxCB	157	1.0	26.9	20.4	26.8	33.7	23.4
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	12.6	16.7	20.3	14.7	21.2
CTEo			3.697	3.012	3.265	3.730	4.112
CTEd			3.707	3.022	3.275	3.740	4.122
% Lipids			0.76	0.73	0.87	0.77	0.90
Sample weight (g)			50.0	50.0	50.1	50.0	50.0

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ARY-SSMB-01 **	ARY-SSMB-02	ARY-SSMB-03 **	ARY-SSMB-04 **	ARY-SSMB-05
3,3',4,4'-TCB	77	0.5	15.9	21.5	5.04	13.6	26.3
2',3,4,4',5-PeCB	123	0.5	14.3	26.9	18.1	12.5	24.6
2,3',4,4',5-PeCB	118	0.5	135	257	208	144	288
2,3,4,4',5-PeCB	114	0.5	5.98	12.6	3.66	6.09	11.6
2,3,3',4,4'-PeCB	105	0.5	29.6	48.2	30.4	22.5	57.8
3,3',4,4',5-PeCB	126	0.5	18.4	31.6	10.5	15.7	36.2
2,3',4,4',5,5'-HxCB	167	1.0	13.6	25.9	21.6	16.5	22.1
2,3,3',4,4',5-HxCB	156	1.0	102	155	51.5	131	185
2,3,3',4,4',5'-HxCB	157	1.0	11.6	21.4	6.02	5.24	26.4
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	8.22	12.7	6.62	11.9	16.2
CTEo			1.920	3.291	1.108	1.662	3.773
CTEd			1.940	3.301	1.138	1.692	3.783
% Lipids			1.84	2.69	0.49	1.71	4.01
Sample weight (g)			22.3	46.8	14.4	16.7	50.0

DEP ID Congener	IUPAC #	DL ng/kg	ARY-SSMB-06 **	ARY-SSMB-07 **	ARY-SSMB-08 **	ARY-SSMB-09 **	ARY-SSMB-10 **
3,3',4,4'-TCB	77	0.5	16.8	9.88	14.2	9.47	8.12
2',3,4,4',5-PeCB	123	0.5	12.6	9.17	15.8	8.56	7.54
2,3',4,4',5-PeCB	118	0.5	127	114	157	125	96.7
2,3,4,4',5-PeCB	114	0.5	8.69	5.75	5.41	7.26	4.47
2,3,3',4,4'-PeCB	105	0.5	52.3	32.7	23.9	41.4	28.9
3,3',4,4',5-PeCB	126	0.5	26.8	22.3	20.4	22.5	18.9
2,3',4,4',5,5'-HxCB	167	1.0	10.1	8.15	15.9	20.1	13.8
2,3,3',4,4',5-HxCB	156	1.0	87.6	75.2	89.6	63.9	72.5
2,3,3',4,4',5'-HxCB	157	1.0	15.4	7.61	10.2	8.85	6.24
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	9.23	6.89	5.17	5.36	4.08
CTEo			2.758	2.292	2.114	2.309	1.946
CTEd			2.778	2.312	2.134	2.339	1.976
% Lipids			2.64	2.25	4.09	3.91	4.06
Sample weight (g)			21.9	19.8	22.2	17.8	15.9

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ARY-WHS-C1	ARY-WHS-C2	ARY-WHS-C3	ARY-WHS-C4	ARY-WHS-C5
3,3',4,4'-TCB	77	0.5	24.6	30.8	12.5	14.5	16.9
2',3,4,4',5-PeCB	123	0.5	87.9	148	78.4	92.4	88.6
2,3',4,4',5-PeCB	118	0.5	222	326	121	159	141
2,3,4,4',5-PeCB	114	0.5	3.89	10.8	2.69	4.41	3.69
2,3,3',4,4'-PeCB	105	0.5	55.4	75.9	31.5	41.5	33.6
3,3',4,4',5-PeCB	126	0.5	5.23	8.59	4.01	5.58	7.21
2,3',4,4',5,5'-HxCB	167	1.0	16.8	23.6	12.7	15.8	11.5
2,3,3',4,4',5-HxCB	156	1.0	158	201	88.5	101	97.3
2,3,3',4,4',5'-HxCB	157	1.0	13.1	15.7	6.39	7.16	12.4
3,3',4,4',5,5'-HxCB	169	1.0	6.46	8.15	3.35	2.08	6.19
2,3,3',4,4',5,5'-HpCB	189	1.0	12.8	15.6	8.14	7.35	9.94
CTEo			0.716	1.114	0.509	0.667	0.869
CTEd			0.716	1.114	0.509	0.667	0.869
% Lipids			3.69	5.12	2.40	2.85	2.84
Sample weight (g)			50.1	50.1	50.1	50.1	50

DEP ID Congener	IUPAC #	DL ng/kg	ARY-WHS-C6	ARY-WHS-C7	ARY-WHS-C8	ARY-WHS-C9	ARY-WHS-C10
3,3',4,4'-TCB	77	0.5	28.6	26.9	15.9	18.7	23.7
2',3,4,4',5-PeCB	123	0.5	157	125	104	127	143
2,3',4,4',5-PeCB	118	0.5	301	299	175	203	287
2,3,4,4',5-PeCB	114	0.5	8.85	8.51	2.91	3.87	11.6
2,3,3',4,4'-PeCB	105	0.5	64.5	57.8	38.9	47.2	69.4
3,3',4,4',5-PeCB	126	0.5	8.06	6.98	4.84	5.56	7.26
2,3',4,4',5,5'-HxCB	167	1.0	22.1	18.9	8.85	22.3	25.5
2,3,3',4,4',5-HxCB	156	1.0	189	169	152	187	194
2,3,3',4,4',5'-HxCB	157	1.0	17.5	11.5	10.6	14.8	15.1
3,3',4,4',5,5'-HxCB	169	1.0	7.57	4.25	7.75	8.02	7.26
2,3,3',4,4',5,5'-HpCB	189	1.0	12.9	5.10	8.85	13.5	16.0
CTEo			1.046	0.887	0.679	0.780	0.963
CTEd			1.046	0.887	0.679	0.780	0.963
% Lipids			4.20	4.99	3.40	3.37	4.20
Sample weight (g)			50.0	50.1	50.0	50.1	50.1

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ALV-SMB-01	ALV-SMB-02	ALV-SMB-03	ALV-SMB-04	ALV-SMB-05
3,3',4,4'-TCB	77	0.5	7.32	31.8	9.95	13.8	7.75
2',3,4,4',5-PeCB	123	0.5	75.9	72.5	42.8	88.6	69.4
2,3',4,4',5-PeCB	118	0.5	560	298	188	392	287
2,3,4,4',5-PeCB	114	0.5	19.7	15.8	12.3	30.3	24.7
2,3,3',4,4'-PeCB	105	0.5	105	40.3	61.2	77.6	61.8
3,3',4,4',5-PeCB	126	0.5	4.25	8.58	6.59	14.2	12.2
2,3',4,4',5,5'-HxCB	167	1.0	6.94	12.7	8.75	16.9	13.4
2,3,3',4,4',5-HxCB	156	1.0	20.7	84.6	51.2	62.4	55.9
2,3,3',4,4',5'-HxCB	157	1.0	2.50	7.75	2.81	4.09	3.65
3,3',4,4',5,5'-HxCB	169	1.0	<DL	0.96	<DL	1.25	1.02
2,3,3',4,4',5,5'-HpCB	189	1.0	8.25	6.21	6.07	9.58	7.37
CTEo			0.522	0.967	0.723	1.539	1.316
CTEd			0.532	0.967	0.733	1.539	1.316
% Lipids			0.43	0.45	0.46	0.86	0.76
Sample weight (g)			50.1	50.0	50.0	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	ALV-SMB-06	ALV-SMB-07	ALV-SMB-08	ALV-SMB-09	ALV-SMB-10
3,3',4,4'-TCB	77	0.5	6.91	8.07	11.7	4.06	4.97
2',3,4,4',5-PeCB	123	0.5	52.8	45.5	91.4	39.8	35.2
2,3',4,4',5-PeCB	118	0.5	241	167	377	134	161
2,3,4,4',5-PeCB	114	0.5	20.6	14.7	26.9	7.04	8.69
2,3,3',4,4'-PeCB	105	0.5	50.0	21.1	84.7	23.6	29.7
3,3',4,4',5-PeCB	126	0.5	9.51	6.02	12.7	3.25	3.69
2,3',4,4',5,5'-HxCB	167	1.0	10.8	6.37	15.8	5.14	4.88
2,3,3',4,4',5-HxCB	156	1.0	47.5	17.9	35.9	9.14	10.3
2,3,3',4,4',5'-HxCB	157	1.0	2.97	1.85	3.36	1.16	1.25
3,3',4,4',5,5'-HxCB	169	1.0	0.88	<DL	1.14	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	7.02	5.14	8.41	4.25	5.09
CTEo			1.031	0.644	1.372	0.354	0.403
CTEd			1.031	0.654	1.372	0.364	0.413
% Lipids			0.61	0.44	0.78	0.19	0.25
Sample weight (g)			50.1	50.0	50.0	50.0	50.0

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ALV-SSMB-01 **	ALV-SSMB-02 **	ALV-SSMB-03 **	ALV-SSMB-04 **	ALV-SSMB-05 **
3,3',4,4'-TCB	77	0.5	2.66	2.15	2.97	3.97	4.02
2',3,4,4',5-PeCB	123	0.5	14.5	10.2	16.8	16.4	20.1
2,3',4,4',5-PeCB	118	0.5	234	175	198	122	147
2,3,4,4',5-PeCB	114	0.5	22.5	24.8	15.9	24.4	20.1
2,3,3',4,4'-PeCB	105	0.5	47.9	226.9	31.7	25.2	28.9
3,3',4,4',5-PeCB	126	0.5	5.81	5.17	4.25	<DL	3.05
2,3',4,4',5,5'-HxCB	167	1.0	20.6	16.8	22.2	11.2	12.8
2,3,3',4,4',5-HxCB	156	1.0	51.8	52.4	61.6	34.5	42.1
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	6.91	7.75	8.24	5.46	7.89
CTEo			0.649	0.598	0.490	0.047	0.357
CTEd			0.680	0.629	0.521	0.228	0.389
% Lipids			3.41	3.25	3.27	5.53	1.98
Sample weight (g)			16.8	14.2	15.7	13.2	13.4

DEP ID Congener	IUPAC #	DL ng/kg	ALV-SSMB-06 **	ALV-SSMB-07 **	ALV-SSMB-08 **	ALV-SSMB-09 **	ALV-SSMB-10 **
3,3',4,4'-TCB	77	0.5	3.22	4.98	5.19	4.21	3.55
2',3,4,4',5-PeCB	123	0.5	27.5	42.9	26.8	17.4	15.9
2,3',4,4',5-PeCB	118	0.5	189	201	106	124	155
2,3,4,4',5-PeCB	114	0.5	21.8	18.6	26.9	15.9	20.5
2,3,3',4,4'-PeCB	105	0.5	33.8	42.2	15.7	21.6	<DL
3,3',4,4',5-PeCB	126	0.5	<DL	2.99	<DL	<DL	<DL
2,3',4,4',5,5'-HxCB	167	1.0	15.2	9.01	8.14	10.2	<DL
2,3,3',4,4',5-HxCB	156	1.0	68.4	45.7	26.9	34.7	23.5
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	6.16	6.71	5.84	5.25	<DL
CTEo			0.071	0.361	0.043	0.043	0.039
CTEd			0.313	0.393	0.285	0.285	0.282
% Lipids			5.12	4.33	3.61	4.49	3.65
Sample weight (g)			10.5	12.4	9.5	9.0	6.9

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC \#	DL ng/kg	ALV-WHS-C1	ALV-WHS-C2	ALV-WHS-C3	ALV-WHS-C4	ALV-WHS-C5
3,3',4,4'-TCB	77	0.5	31.2	36.9	33.7	41.2	27.4
2',3,4,4',5-PeCB	123	0.5	95.6	121	158	196	136
2,3',4,4',5-PeCB	118	0.5	268	298	326	425	275
2,3,4,4',5-PeCB	114	0.5	8.01	8.67	11.5	12.1	9.45
2,3,3',4,4'-PeCB	105	0.5	36.9	42.9	86.7	213	102
3,3',4,4',5-PeCB	126	0.5	5.02	6.65	7.91	13.7	6.33
2,3',4,4',5,5'-HxCB	167	1.0	3.66	4.81	15.4	20.6	12.5
2,3,3',4,4',5-HxCB	156	1.0	49.9	56.9	88.4	106	52.9
2,3,3',4,4',5'-HxCB	157	1.0	7.24	8.31	9.87	15.7	5.51
3,3',4,4',5,5'-HxCB	169	1.0	<DL	1.02	<DL	2.26	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	11.3	13.6	8.51	4.78	6.69
CTEo			0.579	0.763	0.907	1.548	0.722
CTEd			0.589	0.763	0.917	1.548	0.732
% Lipids			3.49	3.74	3.35	5.30	3.27
Sample weight (g)			50.1	50.0	50.0	50.1	50.1

DEP ID Congener	IUPAC \#	DL ng/kg	ALV-WHS-C6	ALV-WHS-C7	ALV-WHS-C8	ALV-WHS-C9	ALV-WHS-C10
3,3',4,4'-TCB	77	0.5	38.1	26.7	28.9	35.7	48.9
2',3,4,4',5-PeCB	123	0.5	88.2	175	106	163	155
2,3',4,4',5-PeCB	118	0.5	231	306	281	315	361
2,3,4,4',5-PeCB	114	0.5	7.88	8.51	7.24	10.6	13.7
2,3,3',4,4'-PeCB	105	0.5	131	75.6	51.6	126	188
3,3',4,4',5-PeCB	126	0.5	5.81	5.24	4.26	12.6	11.7
2,3',4,4',5,5'-HxCB	167	1.0	6.23	10.8	5.91	9.51	18.9
2,3,3',4,4',5-HxCB	156	1.0	47.7	92.4	31.5	61.3	87.5
2,3,3',4,4',5'-HxCB	157	1.0	12.7	10.4	6.03	15.2	16.2
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	1.52
2,3,3',4,4',5,5'-HpCB	189	1.0	7.35	9.47	6.91	10.5	4.21
CTEo			0.665	0.639	0.496	1.369	1.320
CTEd			0.675	0.649	0.506	1.379	1.320
% Lipids			2.85	3.61	2.28	3.36	4.28
Sample weight (g)			50.1	50.0	50.0	50.1	50.1

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	AGI-SMB-01	AGI-SMB-02	AGI-SMB-03	AGI-SMB-04	AGI-SMB-05
3,3',4,4'-TCB	77	0.5	8.99	16.9	15.4	3.88	6.35
2',3,4,4',5-PeCB	123	0.5	65.7	120	124	26.3	55.2
2,3',4,4',5-PeCB	118	0.5	188	251	274	59.8	91.5
2,3,4,4',5-PeCB	114	0.5	39.7	64.7	59.8	12.4	20.4
2,3,3',4,4'-PeCB	105	0.5	26.9	55.2	49.3	11.7	19.8
3,3',4,4',5-PeCB	126	0.5	8.41	13.5	12.4	2.06	4.47
2,3',4,4',5,5'-HxCB	167	1.0	16.4	26.9	23.6	4.21	7.36
2,3,3',4,4',5-HxCB	156	1.0	88.5	166	174	33.6	62.5
2,3,3',4,4',5'-HxCB	157	1.0	25.3	51.2	40.2	8.97	15.4
3,3',4,4',5,5'-HxCB	169	1.0	1.85	3.06	2.65	<DL	1.12
2,3,3',4,4',5,5'-HpCB	189	1.0	6.69	8.51	7.26	7.57	10.3
CTEo			0.966	1.567	1.451	0.244	0.526
CTEd			0.966	1.567	1.451	0.254	0.526
% Lipids			0.55	0.89	0.71	0.21	0.32
Sample weight (g)			50.0	50.1	50.1	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	AGI-WHS-C1	AGI-WHS-C2	ALW-SMB-C1	ALW-SMB-C2
3,3',4,4'-TCB	77	0.5	9.16	10.2	6.89	7.45
2',3,4,4',5-PeCB	123	0.5	85.2	95.2	8.15	10.2
2,3',4,4',5-PeCB	118	0.5	142	133	41.8	56.9
2,3,4,4',5-PeCB	114	0.5	74.6	64.7	0.69	1.02
2,3,3',4,4'-PeCB	105	0.5	25.5	21.4	9.57	10.6
3,3',4,4',5-PeCB	126	0.5	53.1	66.2	<DL	<DL
2,3',4,4',5,5'-HxCB	167	1.0	23.4	31.6	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	105	124	15.5	18.7
2,3,3',4,4',5'-HxCB	157	1.0	54.2	63.8	6.24	7.75
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	5.58	6.35	4.41	6.25
CTEo			5.454	6.773	0.018	0.023
CTEd			5.464	6.783	0.078	0.083
% Lipids			1.03	1.11	1.07	1.15
Sample weight (g)			50.0	50.1	50.1	50.0

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	ALW-WHP-C1	ALW-WHP-C2	ALW-WHS-C1	ALW-WHS-C2
3,3',4,4'-TCB	77	0.5	2.02	1.55	4.22	6.52
2',3,4,4',5-PeCB	123	0.5	15.6	9.67	35.7	58.9
2,3',4,4',5-PeCB	118	0.5	41.8	38.2	31.2	78.4
2,3,4,4',5-PeCB	114	0.5	2.69	2.05	1.06	2.21
2,3,3',4,4'-PeCB	105	0.5	8.85	7.35	4.59	13.5
3,3',4,4',5-PeCB	126	0.5	0.55	<DL	<DL	<DL
2,3',4,4',5,5'-HxCB	167	1.0	2.25	1.36	5.59	10.2
2,3,3',4,4',5-HxCB	156	1.0	46.9	29.9	49.7	104
2,3,3',4,4',5'-HxCB	157	1.0	6.07	3.47	3.06	5.21
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	2.03	1.48	1.01	2.33
CTEo			0.090	0.024	0.035	0.072
CTEd			0.100	0.084	0.095	0.132
% Lipids			1.11	0.54	0.32	0.84
Sample weight (g)			50.0	50.0	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	ALS-SMB-01	ALS-SMB-02	ALS-SMB-03	ALS-SMB-04	ALS-SMB-05
3,3',4,4'-TCB	77	0.5	10.4	12.8	26.9	21.4	25.8
2',3,4,4',5-PeCB	123	0.5	28.7	31.8	84.2	61.3	66.9
2,3',4,4',5-PeCB	118	0.5	121	137	299	224	245
2,3,4,4',5-PeCB	114	0.5	13.8	11.9	26.8	18.7	21.4
2,3,3',4,4'-PeCB	105	0.5	26.9	38.7	84.7	61.3	75.3
3,3',4,4',5-PeCB	126	0.5	14.7	15.4	30.2	21.7	25.8
2,3',4,4',5,5'-HxCB	167	1.0	30.2	22.6	61.6	52.8	49.7
2,3,3',4,4',5-HxCB	156	1.0	147	114	287	203	253
2,3,3',4,4',5'-HxCB	157	1.0	12.6	8.96	24.1	15.6	20.1
3,3',4,4',5,5'-HxCB	169	1.0	1.14	1.14	2.54	1.74	2.26
2,3,3',4,4',5,5'-HpCB	189	1.0	18.7	26.5	36.9	21.1	26.9
CTEo			1.589	1.644	3.268	2.345	2.794
CTEd			1.589	1.644	3.268	2.345	2.794
% Lipids			0.35	0.32	0.89	0.65	0.70
Sample weight (g)			50.1	50.0	50.0	50.1	50.1

Values less than the established MDLs are to be considered estimated values.

** For sample weights below 40 grams the detection limits must be adjusted accordingly.
TEQ s were calculated with estimated detection limits for these samples.

DEP ID Congener	IUPAC #	DL ng/kg	KMD-BNT-1	KMD-BNT-2	KMD-BNT-3	KMD-BNT-4	KMD-BNT-5
3,3',4,4'-TCB	77	0.5	3.58	5.22	4.89	2.47	2.63
2',3,4,4',5-PeCB	123	0.5	3.55	3.36	2.88	3.06	1.59
2,3',4,4',5-PeCB	118	0.5	37.9	81.7	61.7	42.4	40.2
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	3.47	6.06	5.87	3.21	3.66
3,3',4,4',5-PeCB	126	0.5	5.7	7.22	6.39	4.35	3.88
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	88.3	141	102	72.6	55.3
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	2.06	3.61	2.23	2.87	1.55
2,3,3',4,4',5,5'-HpCB	189	1.0	9.24	20.2	17.4	12.6	8.57
CTEo			0.642	0.840	0.722	0.506	0.437
CTEd			0.642	0.841	0.722	0.507	0.438
% Lipids			2.89	4.27	3.38	2.69	2.17
Sample weight (g)			50.1	50.0	50.0	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg
3,3',4,4'-TCB	77	0.5
2',3,4,4',5-PeCB	123	0.5
2,3',4,4',5-PeCB	118	0.5
2,3,4,4',5-PeCB	114	0.5
2,3,3',4,4'-PeCB	105	0.5
3,3',4,4',5-PeCB	126	0.5
2,3',4,4',5,5'-HxCB	167	1.0
2,3,3',4,4',5-HxCB	156	1.0
2,3,3',4,4',5'-HxCB	157	1.0
3,3',4,4',5,5'-HxCB	169	1.0
2,3,3',4,4',5,5'-HpCB	189	1.0
CTEo		
CTEd		
% Lipids		
Sample weight (g)		

DEP ID Congener	IUPAC #	DL ng/kg	KNW-SMB-1	KNW-SMB-2	KNW-SMB-3	KNW-SMB-4	KNW-SMB-5
3,3',4,4'-TCB	77	0.5	1.98	2.27	3.55	2.06	5.91
2',3,4,4',5-PeCB	123	0.5	2.88	4.45	5.02	4.21	8.22
2,3',4,4',5-PeCB	118	0.5	16.9	26.7	38.9	21.5	46.5
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	1.87	2.08	3.67	2.66	5.69
3,3',4,4',5-PeCB	126	0.5	2.04	2.68	3.06	2.87	4.88
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	41.6	66.3	75.2	62.3	124
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	4.26	5.24	6.61	4.89	8.66
CTEo			0.228	0.305	0.349	0.322	0.557
CTEd			0.238	0.316	0.360	0.332	0.568
% Lipids			0.26	0.53	0.67	0.50	1.05
Sample weight (g)			50.0	50.0	50.1	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	KNW-SMB-6	KNW-SMB-7	KNW-SMB-8	KNW-SMB-9	KNW-SMB-10
3,3',4,4'-TCB	77	0.5	4.55	3.26	6.14	6.07	5.29
2',3,4,4',5-PeCB	123	0.5	9.47	4.74	11.3	9.36	8.27
2,3',4,4',5-PeCB	118	0.5	61.3	31.6	68.6	71.6	59.6
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	7.58	3.26	7.45	8.06	7.22
3,3',4,4',5-PeCB	126	0.5	6.21	2.87	6.98	7.25	7.36
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	108	68.9	132	141	117
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	9.85	7.25	11.9	10.6	9.38
CTEo			0.684	0.326	0.775	0.806	0.803
CTEd			0.695	0.337	0.785	0.817	0.814
% Lipids			1.06	0.63	1.11	0.88	0.84
Sample weight (g)			50.1	50.1	50.0	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	KNW-WHS-1	KNW-WHS-2	KNW-WHS-3	KNW-WHS-4	KNW-WHS-5
3,3',4,4'-TCB	77	0.5	5.98	9.45	15.4	10.1	13.6
2',3,4,4',5-PeCB	123	0.5	6.87	9.87	16.8	12.5	12.8
2,3',4,4',5-PeCB	118	0.5	69.8	94.7	155	121	134
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	4.25	8.73	13.5	8.35	11.6
3,3',4,4',5-PeCB	126	0.5	3.09	8.05	6.66	6.01	8.02
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	47.8	89.6	110	102	131
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	3.55	12.1	15.2	7.35	12.7
2,3,3',4,4',5,5'-HpCB	189	1.0	4.21	7.75	11.3	8.47	11.3
CTEo			0.378	0.984	0.894	0.742	1.013
CTEd			0.378	0.985	0.895	0.742	1.014
% Lipids			0.97	1.72	2.47	1.84	2.09
Sample weight (g)			50.1	50.1	50.1	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	KNW-WHS-6	KNW-WHS-7	KNW-WHS-8	KNW-WHS-9	KNW-WHS-10
3,3',4,4'-TCB	77	0.5	7.58	16.3	14.7	6.97	15.7
2',3,4,4',5-PeCB	123	0.5	11.2	17.2	16.1	7.84	13.2
2,3',4,4',5-PeCB	118	0.5	107	188	131	88.5	154
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	6.91	13.6	12.4	5.69	12.7
3,3',4,4',5-PeCB	126	0.5	4.27	8.38	7.39	3.33	9.57
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	75.6	121	118	66.7	125
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	5.24	13.7	14.3	7.01	15.2
2,3,3',4,4',5,5'-HpCB	189	1.0	6.17	12.5	12.0	7.12	11.0
CTEo			0.531	1.060	0.960	0.448	1.192
CTEd			0.532	1.061	0.960	0.449	1.193
% Lipids			1.65	2.92	2.54	1.45	2.10
Sample weight (g)			50.0	50.0	50.1	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	KFF-BNT-1	KFF-BNT-2	KFF-BNT-3	KFF-BNT-4	KFF-BNT-5
3,3',4,4'-TCB	77	0.5	3.24	3.98	2.04	1.87	1.91
2',3,4,4',5-PeCB	123	0.5	7.04	4.55	3.02	2.75	3.31
2,3',4,4',5-PeCB	118	0.5	94.2	81.4	52.7	41.2	75.6
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	5.24	2.71	3.36	2.48	3.06
3,3',4,4',5-PeCB	126	0.5	5.91	4.26	5.21	2.88	3.91
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	184	168	105	97.3	75.5
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	8.11	7.02	4.21	4.06	3.88
2,3,3',4,4',5,5'-HpCB	189	1.0	25.3	21.8	10.2	15.8	13.5
CTEo			0.778	0.592	0.623	0.384	0.477
CTEd			0.778	0.592	0.623	0.384	0.478
% Lipids			3.37	3.29	1.33	1.06	1.08
Sample weight (g)			50.0	50.0	50.1	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg
3,3',4,4'-TCB	77	0.5
2',3,4,4',5-PeCB	123	0.5
2,3',4,4',5-PeCB	118	0.5
2,3,4,4',5-PeCB	114	0.5
2,3,3',4,4'-PeCB	105	0.5
3,3',4,4',5-PeCB	126	0.5
2,3',4,4',5,5'-HxCB	167	1.0
2,3,3',4,4',5-HxCB	156	1.0
2,3,3',4,4',5'-HxCB	157	1.0
3,3',4,4',5,5'-HxCB	169	1.0
2,3,3',4,4',5,5'-HpCB	189	1.0
CTEo		
CTEd		
% Lipids		
Sample weight (g)		

DEP ID Congener	IUPAC #	DL ng/kg	KFF-SMB-1	KFF-SMB-2	KFF-SMB-3	KFF-SMB-4	KFF-SMB-5
3,3',4,4'-TCB	77	0.5	3.06	4.21	3.35	3.60	4.45
2',3,4,4',5-PeCB	123	0.5	7.14	8.59	8.87	9.58	11.6
2,3',4,4',5-PeCB	118	0.5	38.6	47.6	56.7	45.2	51.2
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	3.98	5.36	4.12	4.78	5.06
3,3',4,4',5-PeCB	126	0.5	2.69	2.87	1.99	2.06	3.39
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	48.3	61.4	51.3	54.9	68.7
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	1.57	1.99	2.06	1.66	2.32
2,3,3',4,4',5,5'-HpCB	189	1.0	6.67	8.31	7.92	7.21	9.06
CTEo			0.315	0.345	0.253	0.257	0.405
CTEd			0.316	0.346	0.254	0.258	0.405
% Lipids			0.57	0.60	0.58	0.62	0.67
Sample weight (g)			50.0	50.1	50.0	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	KFF-SMB-6	KFF-SMB-7	KFF-SMB-8	KFF-SMB-9	KFF-SMB-10
3,3',4,4'-TCB	77	0.5	4.06	2.37	3.81	2.54	3.58
2',3,4,4',5-PeCB	123	0.5	8.15	10.3	9.54	8.63	9.97
2,3',4,4',5-PeCB	118	0.5	51.2	31.6	45.5	38.7	48.2
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	5.06	2.25	3.87	3.62	4.47
3,3',4,4',5-PeCB	126	0.5	3.55	1.29	2.58	1.87	2.28
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	50.7	31.8	40.4	36.9	41.2
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	2.58	1.63	1.97	1.14	2.25
2,3,3',4,4',5,5'-HpCB	189	1.0	11.0	9.45	6.29	8.31	10.3
CTEo			0.414	0.167	0.305	0.223	0.279
CTEd			0.415	0.168	0.306	0.224	0.280
% Lipids			0.47	0.47	0.56	0.37	0.57
Sample weight (g)			50.0	50.0	50.0	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	KFF-WHS-1	KFF-WHS-2	KFF-WHS-3	KFF-WHS-4	KFF-WHS-5
3,3',4,4'-TCB	77	0.5	10.8	9.38	8.39	7.75	8.59
2',3,4,4',5-PeCB	123	0.5	9.59	8.47	7.44	6.03	7.58
2,3',4,4',5-PeCB	118	0.5	131	139	109	88.6	126
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	11.8	12.7	9.28	8.31	7.98
3,3',4,4',5-PeCB	126	0.5	9.41	8.58	7.31	6.92	8.26
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	114	118	102	81.4	121
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	8.57	9.02	7.38	7.91	9.47
2,3,3',4,4',5,5'-HpCB	189	1.0	13.6	14.1	10.6	8.23	12.6
CTEo			1.101	1.026	0.870	0.824	0.997
CTEd			1.102	1.026	0.871	0.824	0.998
% Lipids			2.92	2.79	2.61	1.99	2.48
Sample weight (g)			50.0	50.1	50.1	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	KFF-WHS-6	KFF-WHS-7	KFF-WHS-8	KFF-WHS-9	KFF-WHS-10
3,3',4,4'-TCB	77	0.5	8.02	7.26	6.99	8.11	11.8
2',3,4,4',5-PeCB	123	0.5	7.14	6.69	5.28	7.24	10.2
2,3',4,4',5-PeCB	118	0.5	91.3	72.3	69.7	101	124
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	7.21	6.09	5.58	7.23	10.6
3,3',4,4',5-PeCB	126	0.5	6.95	5.87	4.75	7.65	8.98
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	88.3	61.3	74.2	87.2	134
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	3.08	4.28	5.39	9.05	10.5
2,3,3',4,4',5,5'-HpCB	189	1.0	5.19	6.06	7.14	8.31	14.7
CTEo			0.782	0.670	0.575	0.912	1.087
CTEd			0.783	0.671	0.576	0.913	1.088
% Lipids			1.84	1.80	1.74	1.82	3.39
Sample weight (g)			50.1	50.0	50.0	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	KWL-BNT-1	KWL-BNT-2	KWL-BNT-3	KWL-BNT-4	KWL-BNT-5
3,3',4,4'-TCB	77	0.5	3.97	3.22	8.15	5.88	5.21
2',3,4,4',5-PeCB	123	0.5	2.58	2.09	17.3	4.28	10.2
2,3',4,4',5-PeCB	118	0.5	31.6	21.5	155	66.3	71.3
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	2.06	2.55	8.41	5.17	4.26
3,3',4,4',5-PeCB	126	0.5	3.15	1.69	10.2	4.69	5.04
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	35.6	31.6	175	81.2	71.3
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	3.15	2.35	13.6	6.33	6.69
2,3,3',4,4',5,5'-HpCB	189	1.0	8.84	7.35	18.4	15.9	9.05
CTEo			0.369	0.212	1.264	0.583	0.617
CTEd			0.370	0.213	1.265	0.583	0.617
% Lipids			1.00	0.45	1.89	2.87	1.25
Sample weight (g)			50.1	50.0	50.0	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	KSD-SMB-1	KSD-SMB-2	KSD-SMB-3	KSD-SMB-4	KSD-SMB-5
3,3',4,4'-TCB	77	0.5	7.69	8.95	10.5	13.4	12.6
2',3,4,4',5-PeCB	123	0.5	14.8	22.9	19.6	23.7	22.8
2,3',4,4',5-PeCB	118	0.5	195	222	267	302	268
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	7.25	10.9	11.8	12.8	11.5
3,3',4,4',5-PeCB	126	0.5	10.9	14.6	18.4	15.9	13.8
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	154	224	184	259	201
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	10.8	11.5	14.2	16.9	15.9
2,3,3',4,4',5,5'-HpCB	189	1.0	15.8	18.3	25.6	21.4	23.8
CTEo			1.299	1.715	2.107	1.926	1.673
CTEd			1.300	1.716	2.108	1.927	1.674
% Lipids			0.41	0.60	0.60	0.51	0.70
Sample weight (g)			50.0	50.0	50.0	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBW-SMB-1	PBW-SMB-2	PBW-SMB-3	PBW-SMB-4	PBW-SMB-8
3,3',4,4'-TCB	77	0.5	4.11	3.67	4.61	3.09	3.87
2',3,4,4',5-PeCB	123	0.5	6.29	4.58	5.91	5.22	4.71
2,3',4,4',5-PeCB	118	0.5	188	320	265	224	212
2,3,4,4',5-PeCB	114	0.5	1.27	<DL	0.88	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	5.68	6.93	4.89	3.72	3.06
3,3',4,4',5-PeCB	126	0.5	1.35	0.75	0.95	1.06	0.88
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	98.4	41.2	82.5	77.3	61.9
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	3.56	0.66	2.24	1.85	2.06
2,3,3',4,4',5,5'-HpCB	189	1.0	5.27	1.24	4.58	4.03	3.67
CTEo			0.241	0.136	0.188	0.187	0.162
CTEd			0.242	0.137	0.188	0.188	0.163
% Lipids			0.67	0.21	0.52	0.44	0.44
Sample weight (g)			50.1	50.0	50.1	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBW-SMB-11	PBW-SMB-12	PBW-SMB-13	PBW-SMB-14	PBW-SMB-15
3,3',4,4'-TCB	77	0.5	4.95	4.69	2.85	5.06	3.97
2',3,4,4',5-PeCB	123	0.5	5.67	4.93	3.06	8.97	5.92
2,3',4,4',5-PeCB	118	0.5	141	239	96.2	225	268
2,3,4,4',5-PeCB	114	0.5	1.98	<DL	<DL	1.54	0.75
2,3,3',4,4'-PeCB	105	0.5	4.35	4.02	2.69	7.26	6.26
3,3',4,4',5-PeCB	126	0.5	5.84	0.97	0.51	3.68	2.87
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	124	91.9	53.9	151	76.4
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	3.84	1.47	0.84	4.25	3.08
2,3,3',4,4',5,5'-HpCB	189	1.0	6.02	4.91	1.02	5.49	5.06
CTEo			0.702	0.183	0.097	0.512	0.385
CTEd			0.702	0.184	0.098	0.512	0.386
% Lipids			0.82	0.49	0.18	0.82	0.58
Sample weight (g)			50.1	50.1	50.1	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBW-WHS-3	PBW-WHS-4	PBW-WHS-7	PBW-WHS-14	PBW-WHS-15
3,3',4,4'-TCB	77	0.5	7.66	13.5	8.47	6.94	3.26
2',3,4,4',5-PeCB	123	0.5	4.32	20.1	6.28	8.55	1.21
2,3',4,4',5-PeCB	118	0.5	127	159	139	167	101
2,3,4,4',5-PeCB	114	0.5	<DL	5.80	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	3.69	30.9	4.28	5.29	3.38
3,3',4,4',5-PeCB	126	0.5	1.15	1.75	1.33	4.01	1.06
2,3',4,4',5,5'-HxCB	167	1.0	<DL	6.44	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	58.9	42.4	88.5	126	35.6
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	4.61	11.5	5.87	8.55	4.26
2,3,3',4,4',5,5'-HpCB	189	1.0	3.35	4.19	3.98	6.32	2.85
CTEo			0.205	0.337	0.252	0.569	0.178
CTEd			0.206	0.337	0.253	0.570	0.178
% Lipids			1.43	1.92	1.62	2.84	1.31
Sample weight (g)			50.0	50.0	50.1	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBW-WHS-18	PBW-WHS-19	PBW-WHS-24	PBW-WHS-27	PBW-WHS-28
3,3',4,4'-TCB	77	0.5	4.75	5.02	7.39	9.51	7.47
2',3,4,4',5-PeCB	123	0.5	5.29	5.88	7.36	10.5	8.71
2,3',4,4',5-PeCB	118	0.5	154	187	220	297	154
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	1.47	3.19	<DL
2,3,3',4,4'-PeCB	105	0.5	15.2	4.79	6.02	8.59	4.44
3,3',4,4',5-PeCB	126	0.5	2.21	2.65	3.91	4.75	2.27
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	1.06	2.24	<DL
2,3,3',4,4',5-HxCB	156	1.0	71.5	90.3	145	188	101
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	5.78	6.22	7.48	11.6	4.89
2,3,3',4,4',5,5'-HpCB	189	1.0	3.47	2.87	5.61	9.06	3.57
CTEo			0.333	0.393	0.564	0.720	0.344
CTEd			0.334	0.394	0.564	0.721	0.345
% Lipids			1.66	1.70	2.40	3.41	1.77
Sample weight (g)			50.1	50.0	50.1	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBM-SMB-1	PBM-SMB-2	PBM-SMB-3	PBM-SMB-4	PBM-SMB-5
3,3',4,4'-TCB	77	0.5	70.2	53.9	85.1	71.5	81.3
2',3,4,4',5-PeCB	123	0.5	58.3	35.7	40.4	51.2	30.6
2,3',4,4',5-PeCB	118	0.5	134	93.1	268	206	158
2,3,4,4',5-PeCB	114	0.5	12.3	7.55	11.2	9.78	3.75
2,3,3',4,4'-PeCB	105	0.5	48.1	41.2	66.8	55.6	39.8
3,3',4,4',5-PeCB	126	0.5	9.97	5.97	6.63	7.21	5.26
2,3',4,4',5,5'-HxCB	167	1.0	5.64	3.51	2.25	4.97	3.99
2,3,3',4,4',5-HxCB	156	1.0	136	74.2	87.4	106	91.2
2,3,3',4,4',5'-HxCB	157	1.0	16.4	9.59	11.7	9.51	8.54
3,3',4,4',5,5'-HxCB	169	1.0	8.52	5.22	6.02	4.36	5.01
2,3,3',4,4',5,5'-HpCB	189	1.0	33.10	25.6	27.3	21.1	18.7
CTEo			1.199	0.720	0.827	0.868	0.661
CTEd			1.199	0.720	0.827	0.868	0.661
% Lipids			0.42	0.34	0.81	0.60	0.55
Sample weight (g)			50.1	50.0	50.0	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PBM-SMB-6	PBM-SMB-7	PBM-SMB-8	PBM-SMB-9	PBM-SMB-10
3,3',4,4'-TCB	77	0.5	94.2	48.7	41.2	53.8	46.7
2',3,4,4',5-PeCB	123	0.5	37.8	28.5	21.4	31.7	27.7
2,3',4,4',5-PeCB	118	0.5	187	88.5	75.2	91.7	78.3
2,3,4,4',5-PeCB	114	0.5	4.69	2.87	<DL	1.55	3.21
2,3,3',4,4'-PeCB	105	0.5	65.5	46.8	35.2	41.7	39.4
3,3',4,4',5-PeCB	126	0.5	6.25	4.21	3.14	4.57	2.95
2,3',4,4',5,5'-HxCB	167	1.0	2.64	1.25	<DL	1.97	0.98
2,3,3',4,4',5-HxCB	156	1.0	98.6	45.8	21.4	29.8	32.5
2,3,3',4,4',5'-HxCB	157	1.0	4.58	3.66	<DL	5.10	2.25
3,3',4,4',5,5'-HxCB	169	1.0	3.68	4.29	2.58	5.61	4.78
2,3,3',4,4',5,5'-HpCB	189	1.0	11.3	8.51	6.39	7.27	6.69
CTEo			0.755	0.512	0.368	0.554	0.382
CTEd			0.755	0.512	0.369	0.554	0.382
% Lipids			0.65	0.37	0.24	0.35	0.32
Sample weight (g)			50.1	50.1	50.1	50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PBM-WHS-1	PBM-WHS-5	PBM-WHS-10	PBM-WHS-11	PBM-WHS-14
3,3',4,4'-TCB	77	0.5	5.29	11.1	6.80	7.21	10.2
2',3,4,4',5-PeCB	123	0.5	4.59	12.8	6.97	6.96	7.32
2,3',4,4',5-PeCB	118	0.5	88.5	118	52.5	121	141
2,3,4,4',5-PeCB	114	0.5	<DL	4.34	2.08	<DL	1.59
2,3,3',4,4'-PeCB	105	0.5	11.3	25.2	12.8	14.3	25.8
3,3',4,4',5-PeCB	126	0.5	3.34	6.19	4.26	5.84	6.65
2,3',4,4',5,5'-HxCB	167	1.0	<DL	3.19	3.82	<DL	1.54
2,3,3',4,4',5-HxCB	156	1.0	88.5	185	93.6	124	138
2,3,3',4,4',5'-HxCB	157	1.0	<DL	1.15	<DL	<DL	2.06
3,3',4,4',5,5'-HxCB	169	1.0	3.59	4.53	2.22	3.44	5.89
2,3,3',4,4',5,5'-HpCB	189	1.0	4.59	6.69	3.45	6.21	7.57
CTEo			0.426	0.777	0.504	0.696	0.814
CTEd			0.426	0.777	0.505	0.697	0.814
% Lipids			1.16	2.36	1.37	1.83	2.73
Sample weight (g)			50.1	50.1	50.0	50.0	50.0

DEP ID Congener	IUPAC #	DL ng/kg
3,3',4,4'-TCB	77	0.5
2',3,4,4',5-PeCB	123	0.5
2,3',4,4',5-PeCB	118	0.5
2,3,4,4',5-PeCB	114	0.5
2,3,3',4,4'-PeCB	105	0.5
3,3',4,4',5-PeCB	126	0.5
2,3',4,4',5,5'-HxCB	167	1.0
2,3,3',4,4',5-HxCB	156	1.0
2,3,3',4,4',5'-HxCB	157	1.0
3,3',4,4',5,5'-HxCB	169	1.0
2,3,3',4,4',5,5'-HpCB	189	1.0
CTEo		
CTEd		
% Lipids		
Sample weight (g)		

DEP ID Congener	IUPAC #	DL ng/kg	PBL-SMB-1	PBL-SMB-7	PBL-SMB-8	PBL-SMB-12	PBL-SMB-13
3,3',4,4'-TCB	77	0.5	15.4	31.9	28.4	18.7	12.3
2',3,4,4',5-PeCB	123	0.5	11.3	23.8	21.1	16.9	10.2
2,3',4,4',5-PeCB	118	0.5	157	162	189	124	223
2,3,4,4',5-PeCB	114	0.5	<DL	7.51	2.47	<DL	1.58
2,3,3',4,4'-PeCB	105	0.5	10.3	38.3	18.7	15.3	21.3
3,3',4,4',5-PeCB	126	0.5	7.61	9.51	8.97	8.21	7.69
2,3',4,4',5,5'-HxCB	167	1.0	<DL	5.45	1.29	<DL	0.85
2,3,3',4,4',5-HxCB	156	1.0	141	102	201	195	173
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	5.58	7.47	9.47	8.57	9.06
2,3,3',4,4',5,5'-HpCB	189	1.0	4.98	4.50	7.65	6.69	8.02
CTEo			0.907	1.107	1.120	1.022	0.974
CTEd			0.908	1.107	1.120	1.023	0.975
% Lipids			0.76	1.02	1.05	0.96	1.03
Sample weight (g)			50.1	50.1	50.0	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBL-SMB-14	PBL-SMB-15	PBL-SMB-16	PBL-SMB-18	PBL-SMB-19
3,3',4,4'-TCB	77	0.5	8.55	5.22	6.31	7.59	11.6
2',3,4,4',5-PeCB	123	0.5	9.61	4.31	8.45	6.84	13.3
2,3',4,4',5-PeCB	118	0.5	137	98.5	141	112	159
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	0.75
2,3,3',4,4'-PeCB	105	0.5	11.9	5.15	6.95	7.36	8.68
3,3',4,4',5-PeCB	126	0.5	7.99	5.23	6.78	6.94	8.06
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	<DL	1.02
2,3,3',4,4',5-HxCB	156	1.0	144	85.6	157	131	163
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	8.14	5.21	10.3	7.75	8.51
2,3,3',4,4',5,5'-HpCB	189	1.0	5.92	4.02	8.57	4.75	7.98
CTEo			0.970	0.630	0.877	0.851	0.993
CTEd			0.970	0.630	0.877	0.852	0.994
% Lipids			0.87	0.38	0.73	0.58	0.91
Sample weight (g)			50.0	50.1	50.0	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PBL-WHS-3	PBL-WHS-10	PBL-WHS-12	PBL-WHS-13	PBL-WHS-14
3,3',4,4'-TCB	77	0.5	8.86	4.91	7.49	4.22	6.31
2',3,4,4',5-PeCB	123	0.5	9.19	5.69	9.47	6.31	8.24
2,3',4,4',5-PeCB	118	0.5	66.8	75.9	114	85.6	138
2,3,4,4',5-PeCB	114	0.5	3.48	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	16.5	7.31	13.4	3.87	9.61
3,3',4,4',5-PeCB	126	0.5	20.9	11.6	18.9	9.47	13.8
2,3',4,4',5,5'-HxCB	167	1.0	3.32	<DL	2.07	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	61.1	74.2	158	104	135
2,3,3',4,4',5'-HxCB	157	1.0	1.34	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	8.57	5.79	12.7	6.39	8.14
2,3,3',4,4',5,5'-HpCB	189	1.0	11.2	8.39	10.5	8.47	10.2
CTEo			2.220	1.265	2.112	1.074	1.546
CTEd			2.220	1.266	2.112	1.075	1.547
% Lipids			3.64	1.94	3.37	1.99	2.90
Sample weight (g)			50.0	50.0	50.1	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBL-WHS-15	PBL-WHS-20	PBL-WHS-21	PBL-WHS-22	PBL-WHS-23
3,3',4,4'-TCB	77	0.5	8.51	4.59	3.48	5.66	9.25
2',3,4,4',5-PeCB	123	0.5	10.2	6.48	4.47	5.01	11.6
2,3',4,4',5-PeCB	118	0.5	131	124	75.2	99.4	159
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	2.51
2,3,3',4,4'-PeCB	105	0.5	12.5	8.46	5.78	9.97	18.9
3,3',4,4',5-PeCB	126	0.5	10.3	10.4	8.85	15.6	21.5
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	<DL	1.14	2.55
2,3,3',4,4',5-HxCB	156	1.0	161	98.7	55.6	124	143
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	13.0	7.45	5.38	8.44	13.9
2,3,3',4,4',5,5'-HpCB	189	1.0	11.7	5.81	4.69	6.23	15.8
CTEo			1.258	1.179	0.976	1.719	2.383
CTEd			1.259	1.180	0.977	1.720	2.384
% Lipids			4.39	2.08	1.52	2.36	4.43
Sample weight (g)			50.0	50.1	50.0	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PBC-SMB-2	PBC-SMB-6	PBC-SMB-7	PBC-SMB-11	PBC-SMB-19
3,3',4,4'-TCB	77	0.5	5.86	6.28	7.14	7.94	8.79
2',3,4,4',5-PeCB	123	0.5	10.9	3.67	5.28	6.05	7.59
2,3',4,4',5-PeCB	118	0.5	78.2	101	124	88.5	224
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	2.89
2,3,3',4,4'-PeCB	105	0.5	18.6	6.95	8.97	11.5	13.2
3,3',4,4',5-PeCB	126	0.5	5.02	7.71	6.39	7.28	11.8
2,3',4,4',5,5'-HxCB	167	1.0	2.5	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	49.3	69.8	102	154	169
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	4.12	5.70	8.54	7.26	8.48
2,3,3',4,4',5,5'-HpCB	189	1.0	16.1	10.20	12.70	13.80	15.3
CTEo			0.581	0.876	0.791	0.890	1.378
CTEd			0.582	0.876	0.792	0.891	1.378
% Lipids			0.49	0.54	0.63	0.65	1.25
Sample weight (g)			50.0	50.1	50.1	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBC-WHS-2	PBC-WHS-5	PBC-WHS-6	PBC-WHS-7	PBC-WHS-13
3,3',4,4'-TCB	77	0.5	3.46	6.97	5.94	1.57	4.22
2',3,4,4',5-PeCB	123	0.5	37.8	4.29	5.29	2.26	8.35
2,3',4,4',5-PeCB	118	0.5	250	211	179	101	154
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	6.42	8.91	12.4	4.59	5.25
3,3',4,4',5-PeCB	126	0.5	9.45	7.61	8.48	4.06	5.88
2,3',4,4',5,5'-HxCB	167	1.0	1.53	<DL	1.89	<DL	1.38
2,3,3',4,4',5-HxCB	156	1.0	45.6	108	123	35.8	88.9
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	11.3	9.95	11.4	6.21	10.4
2,3,3',4,4',5,5'-HpCB	189	1.0	7.41	8.31	15.7	3.18	12.8
CTEo			1.111	0.938	1.045	0.497	0.755
CTEd			1.112	0.939	1.046	0.498	0.756
% Lipids			1.60	2.46	2.91	0.47	1.72
Sample weight (g)			50.0	50.1	50.0	50.1	50.0

DEP ID Congener	IUPAC #	DL ng/kg	PBV-SMB-9	PBV-SMB-12	PBV-SMB-17	PBV-SMB-18	PBV-SMB-19
3,3',4,4'-TCB	77	0.5	19.6	15.7	19.6	10.2	12.6
2',3,4,4',5-PeCB	123	0.5	17.8	16.3	30.8	8.95	11.3
2,3',4,4',5-PeCB	118	0.5	180	175	345	114	201
2,3,4,4',5-PeCB	114	0.5	6.12	<DL	1.23	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	4.02	10.5	7.27	3.68	5.02
3,3',4,4',5-PeCB	126	0.5	5.33	10.2	7.12	4.58	4.62
2,3',4,4',5,5'-HxCB	167	1.0	1.52	<DL	<DL	<DL	<DL
2,3,3',4,4',5-HxCB	156	1.0	39.9	187	82.1	49.7	64.7
2,3,3',4,4',5'-HxCB	157	1.0	1.01	<DL	1.79	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	5.21	8.06	6.39	2.08	4.47
2,3,3',4,4',5,5'-HpCB	189	1.0	33.9	15.3	34.2	10.2	13.6
CTEo			0.634	1.217	0.862	0.518	0.563
CTEd			0.634	1.218	0.862	0.519	0.564
% Lipids			0.46	0.93	0.52	0.25	0.34
Sample weight (g)			50.1	50.1	50.0	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PBV-WHS-C1	PBV-WHS-C2		PBO-EEL-C1	PBO-EEL-C2
3,3',4,4'-TCB	77	0.5	39.7	27.8		16.9	15.2
2',3,4,4',5-PeCB	123	0.5	45.8	38.9		55.2	39.5
2,3',4,4',5-PeCB	118	0.5	524	611		621	501
2,3,4,4',5-PeCB	114	0.5	2.23	<DL		5.24	2.24
2,3,3',4,4'-PeCB	105	0.5	31.5	29.4		33.4	21.6
3,3',4,4',5-PeCB	126	0.5	16.9	13.2		41.2	22.8
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL		2.04	<DL
2,3,3',4,4',5-HxCB	156	1.0	315	498		323	297
2,3,3',4,4',5'-HxCB	157	1.0	3.05	<DL		2.58	<DL
3,3',4,4',5,5'-HxCB	169	1.0	32.9	26.8		41.8	25.4
2,3,3',4,4',5,5'-HpCB	189	1.0	41.5	31.0		62.5	28.9
CTEo			2.247	1.911		4.782	2.744
CTEd			2.247	1.912		4.782	2.745
% Lipids			7.19	6.52		13.56	11.82
Sample weight (g)			50.1	50.1		50.0	50.1

DEP ID **Congener**	**IUPAC** **#**	DL **ng/kg**	PWD-SMB-1	PWD-SMB-2	PWD-SMB-3	PWD-SMB-4	PWD-SMB-5
3,3',4,4'-TCB	77	0.5	20.5	25.8	41.2	29.7	16.3
2',3,4,4',5-PeCB	123	0.5	66.1	88.2	95.2	75.6	48.2
2,3',4,4',5-PeCB	118	0.5	153	129	139	147	95.7
2,3,4,4',5-PeCB	114	0.5	2.01	<DL	4.66	1.55	<DL
2,3,3',4,4'-PeCB	105	0.5	34.1	51.9	65.8	55.7	21.4
3,3',4,4',5-PeCB	126	0.5	1.93	1.48	4.59	3.22	0.55
2,3',4,4',5,5'-HxCB	167	1.0	20.3	13.6	26.8	21.7	15.7
2,3,3',4,4',5-HxCB	156	1.0	37.8	48.8	78.5	61.5	22.6
2,3,3',4,4',5'-HxCB	157	1.0	1.55	3.09	4.25	2.51	<DL
3,3',4,4',5,5'-HxCB	169	1.0	2.33	0.87	1.89	1.09	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	10.8	13.1	18.6	16.2	7.75
Total TEQ (ND=0)			0.266	0.214	0.558	0.398	0.085
Total TEQ (ND=DL)			0.266	0.214	0.558	0.398	0.096
% Lipids			0.299	0.306	0.595	0.426	0.172
Sample weight (g, wet weight)			50.1	50.1	50.0	50.0	50.1

DEP ID **Congener**	**IUPAC** **#**	DL **ng/kg**	PWD-WHS-C1	PWD-WHS-C2
3,3',4,4'-TCB	77	0.5	224	301
2',3,4,4',5-PeCB	123	0.5	267	229
2,3',4,4',5-PeCB	118	0.5	197	188
2,3,4,4',5-PeCB	114	0.5	16.7	17.9
2,3,3',4,4'-PeCB	105	0.5	231	255
3,3',4,4',5-PeCB	126	0.5	18.9	20.3
2,3',4,4',5,5'-HxCB	167	1.0	56.7	35.7
2,3,3',4,4',5-HxCB	156	1.0	177	199
2,3,3',4,4',5'-HxCB	157	1.0	3.69	6.2
3,3',4,4',5,5'-HxCB	169	1.0	66.8	51.7
2,3,3',4,4',5,5'-HpCB	189	1.0	157	166
Total TEQ (ND=0)			2.765	2.773
Total TEQ (ND=DL)			2.765	2.773
% Lipids			10.728	11.776
Sample weight (g, wet weight)			50.1	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PWB-SMB-01	PWB-SMB-02	PWB-SMB-03	PWB-SMB-04	PWB-SMB-05
3,3',4,4'-TCB	77	0.5	8.48	11.3	18.4	5.29	20.8
2',3,4,4',5-PeCB	123	0.5	17.6	8.78	12.8	2.69	16.7
2,3',4,4',5-PeCB	118	0.5	209	168	264	102	301
2,3,4,4',5-PeCB	114	0.5	1.20	<DL	8.93	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	38.6	15.7	25.6	8.79	12.8
3,3',4,4',5-PeCB	126	0.5	10.3	5.28	13.2	4.97	3.99
2,3',4,4',5,5'-HxCB	167	1.0	<DL	<DL	3.02	<DL	1.48
2,3,3',4,4',5-HxCB	156	1.0	75.6	39.0	95.2	45.8	166
2,3,3',4,4',5'-HxCB	157	1.0	1.55	<DL	3.35	<DL	8.95
3,3',4,4',5,5'-HxCB	169	1.0	1.51	1.06	4.27	0.88	1.94
2,3,3',4,4',5,5'-HpCB	189	1.0	4.81	4.21	5.88	2.36	5.56
Total TEQ (ND=0)			1.112	0.579	1.449	0.541	0.542
Total TEQ (ND=DL)			1.112	0.580	1.449	0.542	0.542
% Lipids			0.403	0.255	0.510	0.093	0.644
Sample weight (g, wet weight)			50.0	50.1	50.0	50.0	50.1

DEP ID Congener	IUPAC #	DL ng/kg	PWB-WHS-C1	PWB-WHS-C2
3,3',4,4'-TCB	77	0.5	79.4	101
2',3,4,4',5-PeCB	123	0.5	82.5	88.2
2,3',4,4',5-PeCB	118	0.5	881	794
2,3,4,4',5-PeCB	114	0.5	48.6	38.9
2,3,3',4,4'-PeCB	105	0.5	212	101
3,3',4,4',5-PeCB	126	0.5	34.4	31.4
2,3',4,4',5,5'-HxCB	167	1.0	2.55	1.22
2,3,3',4,4',5-HxCB	156	1.0	357	161
2,3,3',4,4',5'-HxCB	157	1.0	26.3	2.65
3,3',4,4',5,5'-HxCB	169	1.0	21.8	17.3
2,3,3',4,4',5,5'-HpCB	189	1.0	62.9	34.8
Total TEQ (ND=0)			4.006	3.526
Total TEQ (ND=DL)			4.006	3.526
% Lipids			9.283	6.956
Sample weight (g, wet weight)			50.1	50.1

DEP ID Congener	IUPAC \#	DL ng/kg	SWP-SMB-01	SWP-SMB-02	SWP-SMB-03	SWP-SMB-04	SWP-SMB-05
3,3',4,4'-TCB	77	0.5	3.22	6.99	7.21	10.8	5.79
2',3,4,4',5-PeCB	123	0.5	6.97	8.41	10.2	19.9	15.3
2,3',4,4',5-PeCB	118	0.5	52.2	102	147	166	91.6
2,3,4,4',5-PeCB	114	0.5	<DL	4.87	3.09	9.02	1.55
2,3,3',4,4'-PeCB	105	0.5	2.05	9.75	13.8	27.5	11.2
3,3',4,4',5-PeCB	126	0.5	<DL	0.54	1.14	2.44	<DL
2,3',4,4',5,5'-HxCB	167	1.0	3.69	6.31	8.84	10.3	4.69
2,3,3',4,4',5-HxCB	156	1.0	12.7	21.8	33.6	40.2	15.7
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	0.85	1.25	<DL
3,3',4,4',5,5'-HxCB	169	1.0	0.99	5.51	8.71	12.5	2.66
2,3,3',4,4',5,5'-HpCB	189	1.0	11.4	10.6	17.3	21.5	5.29
Total TEQ (ND=0)			0.024	0.136	0.240	0.419	0.048
Total TEQ (ND=DL)			0.075	0.137	0.240	0.419	0.099
% Lipids			0.582	0.657	0.846	0.964	0.582
Sample weight (g, wet weight)			50.0	47.5	50.0	50.0	50.0

DEP ID Congener	IUPAC \#	DL ng/kg	SFS-SMB-01	SFS-SMB-02	SFS-SMB-03	SFS-SMB-04
3,3',4,4'-TCB	77	0.5	12.7	7.75	10.2	5.26
2',3,4,4',5-PeCB	123	0.5	51.4	33.6	42.6	21.7
2,3',4,4',5-PeCB	118	0.5	49.7	34.9	37.1	28.9
2,3,4,4',5-PeCB	114	0.5	1.14	0.55	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	21.6	13.7	16.6	12.7
3,3',4,4',5-PeCB	126	0.5	12.4	6.29	8.84	7.26
2,3',4,4',5,5'-HxCB	167	1.0	16.7	8.87	11.2	5.29
2,3,3',4,4',5-HxCB	156	1.0	22.1	13.1	16.4	9.51
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	9.65	6.27	4.59	3.11
2,3,3',4,4',5,5'-HpCB	189	1.0	14.2	8.85	11.2	5.57
Total TEQ (ND=0)			1.363	0.708	0.950	0.769
Total TEQ (ND=DL)			1.364	0.709	0.951	0.770
% Lipids			0.683	0.358	0.426	0.275
Sample weight (g, wet weight)			50.0	50.0	50.1	50.1

DEP ID **Congener**	**IUPAC** **#**	DL **ng/kg**	SEN-SMB-01	SEN-SMB-02	SEN-SMB-03	SEN-SMB-04	SEN-SMB-05
3,3',4,4'-TCB	77	0.5	3.59	8.22	4.58	6.75	7.59
2',3,4,4',5-PeCB	123	0.5	77.8	69.7	49.7	66.3	84.2
2,3',4,4',5-PeCB	118	0.5	370	213	165	225	197
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	67.5	75.4	61.2	88.2	32.4
3,3',4,4',5-PeCB	126	0.5	7.40	9.68	5.21	8.34	12.6
2,3',4,4',5,5'-HxCB	167	1.0	6.61	18.4	12.0	16.5	21.6
2,3,3',4,4',5-HxCB	156	1.0	103	126	89.7	115	134
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	1.15
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	24.4	31.7	40.1	38.9	35.2
Total TEQ (ND=0)			0.846	1.071	0.598	0.934	1.363
Total TEQ (ND=DL)			0.857	1.082	0.609	0.945	1.374
% Lipids			0.340	0.775	0.613	0.754	1.030
Sample weight (g, wet weight)			50.0	50.0	50.1	50.1	50.1

DEP ID **Congener**	**IUPAC** **#**	DL **ng/kg**	SED-SMB-01	SED-SMB-02	SED-SMB-03	SED-SMB-04	SED-SMB-05
3,3',4,4'-TCB	77	0.5	15.9	6.14	7.55	18.3	14.2
2',3,4,4',5-PeCB	123	0.5	78.2	44.2	48.9	82.3	13.4
2,3',4,4',5-PeCB	118	0.5	124	65.3	71.2	147	107
2,3,4,4',5-PeCB	114	0.5	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4'-PeCB	105	0.5	24.6	13.7	15.9	30.1	21.1
3,3',4,4',5-PeCB	126	0.5	15.2	6.59	8.89	16.8	13.8
2,3',4,4',5,5'-HxCB	167	1.0	38.2	18.7	21.4	42.2	31.9
2,3,3',4,4',5-HxCB	156	1.0	161	99.5	106	147	121
2,3,3',4,4',5'-HxCB	157	1.0	<DL	<DL	<DL	<DL	<DL
3,3',4,4',5,5'-HxCB	169	1.0	<DL	<DL	<DL	<DL	<DL
2,3,3',4,4',5,5'-HpCB	189	1.0	41.8	24.5	28.7	48.7	30.8
Total TEQ (ND=0)			1.629	0.724	0.959	1.787	1.459
Total TEQ (ND=DL)			1.640	0.735	0.970	1.797	1.470
% Lipids			1.778	0.884	0.867	1.964	1.755
Sample weight (g, wet weight)			50.1	50.0	50.0	50.0	50.1

3.1.2

FISH CONSUMPTION ADVISORIES- SPECIFIC RIVERS

FISH CONSUMPTION ADVISORIES – SPECIFIC RIVERS

East Branch of the Sebasticook River

The goal of Maine's Dioxin Monitoring Program is "to determine the nature of dioxin contamination in the waters and fisheries of the State". Charged with administration of the program, the Department of Environmental Protection (DEP) is required to sample fish once a year below bleached pulp mills, municipal wastewater treatment plants, or other known or likely sources of dioxin. Costs of sample collection and analysis are assessed as a fee to the selected facilities.

Fish consumption advisories continue in the East Branch of the Sebasticook River in Newport likely due to past discharges of dioxins from the Eastland Woolen Mill, no longer in business and unable to fund necessary monitoring. In 2001 fish were collected from the County Road Bridge downstream from Corinna at the inlet to Sebasticook lake and downstream of the lake in Detroit for dioxin analysis.

Results may be seen in the 2001 Dioxin Monitoring Program report at **http://www.state.me.us/dep/blwq/docmonitoring/swat/index.htm**

3.1.3

EFFECTS-BASED FISH STUDY

EFFECTS-BASED FISH STUDY

Introduction

To date, most SWAT studies of fish have focused on the effects of persistent, toxic, and bioaccumulative (PBT) contaminants on human consumers, with some consideration of impacts to wildlife consumers as well. Direct effects on fish populations have been measured or estimated by other DEP programs able to detect only relatively severe impacts on survival, growth, and reproduction. Recent studies (Adams et al, 1992; Kavlock et al, 1996; Munkittrick et al, 1998; Rolland et al, 1997) have measured other more subtle effects on development, reproduction, and immune system function not normally found by testing regimes historically used by DEP. These effects may be a result of long term exposure to relatively low levels of contaminants or cumulative effects of exposure to many low-level contaminants. These responses to pollutant challenge are often within the same order of magnitude as natural variation and therefore difficult to measure with the methods that are currently used. Many new techniques, such as cumulative effects-driven assessments of fish populations have been developed to measure some of these effects.

DEP has assisted Environment Canada (EC) with cumulative effects-driven assessments of fish populations on the St John River in 1999 and 2000 that have documented potential impacts to fish populations. In 2000 EC assisted DEP in similar studies of the North Branch of Presque Isle Stream and Prestile Stream, where high concentrations of DDT, a known endocrine disruptor, have been previously found. Lack of suitable reference streams made interpretation of the results difficult. Nevertheless, it appears that there were adverse impacts on reproduction of brook trout, but they may be mitigated by high productivity of the streams.

A 1994 partial cumulative effects-driven assessment of a fish population from the Androscoggin River downstream of 3 bleached kraft pulp and paper mills with secondary treatment, documented some of the effects found in studies elsewhere (McMaster et al, 1996). Female white suckers showed increased mixed function oxidase (MFO) enzymes in the liver, reduced levels of circulating estradiol (E2), reduced gonad size (GSI) , and increased levels of circulating testosterone (T) when compared to a putative reference population in Androscoggin Lake. In-vitro steroid production by ovarian follicles showed no differences in basal and human chorionic gonadotropin (hCG) stimulated E2 between experimental and reference stations, but in-vitro basal levels of T were reduced in the exposed fish in contrast to circulating levels. No other lesions in the pathway were measured unlike previous studies elsewhere. Exposed brown bullhead showed induction of MFO for both sexes. There were no other differences in any measure in females between the populations. Condition factor (K) was lower in exposed males than in unexposed males. There were decreased circulating levels of T and 11 ketotestosterone (11-KT) in exposed males but in vitro levels of both were similar at both sites.

Since 1994, the 3 bleached kraft mills on the Androscoggin River have made significant modifications to their process, primarily to decrease their discharge of dioxin. Modifications include changes in brownstock washing, reduced use of precursors, and increased recovery of chemicals. Most important of all is a switch to elemental chlorine free (ECF) bleaching, using oxygen and chlorine dioxide (CLO2) instead of elemental chlorine, by the end of 1999. These changes have improved the overall quality of the effluent.

The primary objective of this study was to determine if ECF and other changes in effluent quality since 1994 have eliminated impacts on reproductive performance of fish from the Androscoggin River. A second objective was to determine, if impacts have not been eliminated, whether or not impacts could be measured at a population level. The conceptual model is that endocrine disrupting substances in the discharges from the bleached kraft pulp and paper mills and/or municipal treatment plants result in differences in circulating levels of E2, 11-KT, and T between experimental and reference stations, which lead to adverse effects on populations as indicated by GSIs, population estimates and other population characteristics. Another objective was to determine if other biomarkers, such as plasma cortisol (F) levels, liver somatic index (LSI) and MFO activity, are correlated with circulating levels of sex steroids and linked to population level effects.

Materials and Methods

In 2001 we repeated studies originally conducted in 1994 on white suckers from the Androscoggin River and Androscoggin Lake. In addition, in 2001 we expanded the study to sample fish from impoundments above and below each bleached kraft pulp and paper mill and major municipal sewage discharge on the river**.** Stations were 1) Umbagog Lake (AUL), above Fraser Paper Company's pulp and paper mills and municipal wastewater treatment plants in Berlin/Gorham New Hampshire, 2) Rumford Point (ARP), below Berlin and above Mead Paper and the Rumford-Mexico wastewater treatment plant in Rumford and Mexico, 3) Riley (ARY), below Rumford and above International Paper in Jay, 4) Livermore Falls (ALV) below Jay, 5) Gulf Island Pond (AGI), a deep impoundment below the Livermore Falls wastewater treatment plant, and 6) Androscoggin Lake (ALW) (**MAP???)**. We measured biomarkers of fish performance, (E2, 11-KT, T, LSI, and MFO) as well as population characteristics (GSI, mean age and age structure, growth rate and condition factor, fecundity and egg size, gonadal development and/or presence of heterosex). In related studies during the spring, we are trapping, marking, and recapturing suckers on the spring spawning run and in the fall to develop population estimates for Gulf Island Pond and a reference station, Pocasset Lake, to determine any impact on fish populations in the river.

In the field, live white suckers were collected from each site by trapnets or gillnets during fall recrudescence as in 1994. At least 20 males and 20 females were measured for length and weight. Blood samples were collected from live fish from the heart and/or caudal artery or vein via 21 ga syringes into heparinized Vacutainers and placed on ice for transport to the lab the same day. The fish were then killed with a blow to the head. Livers were dissected out, weighed and frozen in liquid nitrogen. Gonads were dissected out, weighed, and a small sample ~1 cm square taken and placed in 10% buffered formalin for storage. The operculum and pectoral fins were taken for aging and stored at –20C until analyzed. Gonad samples remained in formalin for further analyses.

Later the same day in the lab samples were placed in proper storage to await analyses. Plasma was collected from the blood samples after centrifugation in the lab and then frozen at –20C for radioimmunoassay (RIA) analysis for T, 11-KT, E2, following the method of McMaster et al (1992). Liver samples were stored at –80 C for MFO analysis as outlined by Munkittrick et al (1992). Cortisol was not measured in 2001 samples, but will be measured in 2002 samples.

Gonad samples sent to Environment Canada have not yet been analyzed, so no discussion of egg size, gonadal development and presence of heterosex is included in this report. Eggs size will be measured in a subsample of at least 100 eggs per ovary. Histological samples of gonads will be prepared and examined for the presence of testis-ova as outlined in Gray and Metcalf (1997) or analysis of gonadal staging (McMaster, 2001).

Statistical differences between the means of the samples for pairs of stations above and below the major point sources were determined for each variable using the Students t-test if the variances were equal, data were normally distributed, and the p-value was lower than that obtained with the non-parametric Mann-Whitney U test. Otherwise, the Mann-Whitney test was used.

Results and Discussion

There were no stations where all the measurements clearly indicated either an impact or no impact (Table 3.1.3.1). Distinction between significant differences, either positive (+) or negative (-), and no significant difference (0), among stations can be small (i.e. p-value of 0.04 vs. 0.06) however. In addition, previous studies have shown considerable variation in responses from one year to the next (Munkittrick et al, 2000). These differences among stations and years can be influenced by a number of factors including violation of the assumption of equal error of measurement between stations, streamflow, nutrient supply and food abundance, pollutant discharge rates, and weather conditions, any of which may exacerbate or mitigate marginal impacts. Therefore, final conclusions cannot be made on the basis of a single year's data. The study will be repeated in 2002 and additional measurements of these potentially confounding variables will be made.

Nevertheless, a preliminary discussion of the data from each station may elucidate potential impacts. Of all the measurements of biomarkers and population characteristics, there were several significant differences above and below major discharges. There were also differences in responses between males and females at the same stations, but these differences were not the same for all stations.

The most upstream station, AUL, Lake Umbagog, is a National Wildlife Refuge and where the Androscoggin River begins named as the the Androscoggin River. There are no known point source discharges into it or its headwaters. It therefore serves as a reference station for the discharges from the (now) Nexfor –Fraser bleached kraft pulp and paper mills and municipal treatment plants about 30 miles downstream in Berlin and Gorham, New Hampshire and smaller municipal treatment plant in Bethel, Maine.

Although the station ARP, at Rumford Point, is a considerable distance (approximately 50 miles) downstream of the mills and municipal treatment plants in New Hampshire, it serves to document any lingering effects that could confound any of those measured resulting from the discharge from Mead Paper Company's bleached kraft pulp and paper mill and the Rumford-Mexico municipal treatment plant immediately below in Rumford and Mexico repectively. Mean age and mean length of both male and female suckers were no different than at AUL (Figures 3.1.3.1 – 3.1.3.4), but condition factors of both were significantly greater than at AUL(Figures 3.1.3.5 – 3.1.3.6), showing that the fish here were heavier for their length than at Umbagog. These results may indicate increased productivity from the added nutrients from the mills and municipal treatment plants. Curiously, MFOs, an indicator of exposure to pulp and paper mill discharges, were significantly less here than at AUL for females but similar to those at AUL for males (Figures 3.1.3.7 – 3.1.3.8). LSI's, however, were in fact significantly higher than at AUL for both sexes (Figures 3.1.3.9 – 3.1.3.10), as has often been measured downstream of pulp and paper mill discharges (Munkittrick et al, 2000). There were no significant

Table 3.1.3.1 Significant changes in biomarkers and population characteristics compared to station above

station	sex	AGE	LENGTH	K	MFO	LSI	11-KT	T	E2	GSI
		p	p	p	p	p	p	p	p	p
AUL	F									
ARP	F	0	0	+	-	+		0	0	+
ARY	F	0	+	+	0	0		0	+	0
ALV	F	-	-	0	0	0		0	-	+
ALW	F	+	0	-	0	-		0	0	0
AGI	F	-	-	0	0	0		0	0	0
AGI v ALV	F	0	-	-	0	0		+	+	-
AUL	M									
ARP	M	0	0	+	0	+	0	0		+
ARY	M	0	0	+	+	+	+	0		0
ALV	M	-	0	0	0	0	-	0		+
ALW	M	+	-	-	0	-	+	0		-
AGI	M	-	-	-	0	0	+	+		+
AGI v ALV	M	0	-	-	0	-	+	+		-

differences in circulating levels of sex steroids between this station and AUL Figures 3.1.3.11 –3.1.3.14). GSI's, a measure of fecundity, however, were significantly greater here for both males and females than at AUL (Figures 3.1.3.15 – 3.1.3.16), perhaps reflecting increased productivity. Since gonad samples remain to be analyzed, it is not yet known if increase GSI is due to increased egg size or number of eggs.

The station ARY is approximately 20 miles below Mead Paper Company's bleached kraft pulp and paper mill in Rumford and the Rumford-Mexico municipal treatment plant in Mexico. Here age of both males and females and length of males were no different than those at ARP, upstream of Rumford, but length of females was significantly greater than at ARP (Figures 3.1.3.1- 3.1.3.4). Condition factor was significantly greater for both sexes (Figures 3.1.3.5 –3.1.3.6) perhaps again due to increased nutrients and productivity from the industrial and municipal discharges in Rumford. MFOs were similar to those at ARP for females but significantly elevated in males, which were the highest of those from all stations (Figures 3.1.3.7 – 3.1.3.8). LSI's followed MFOs perhaps showing the response to exposure of conditions that induce MFOs (Figures 3.1.3.9 – 3.1.3.10). Among the sex steroids, 11-KT and E2 were significantly higher here than at ARP (Figures 3.1.3.12, 3.1.3.14), but curiously GSIs of males and females was not different than at ARP (Figures 3.1.3.15 – 3.1.3.16).

At ALV, immediately downstream of the International Paper Company's bleached kraft pulp and paper mill in Jay, age of both males and females and length of females were significantly lower than at ARY about 1 mile upstream of the mill (Figures 3.1.3.1 – 3.1.3.4), but condition factors were not different that at ARY (Figures 3.1.3.5 – 3.1.3.6) despite increased nutrient supply from the mill. Neither MFOs (Figures 3.1.3.7 – 3.1.3.8) nor LSIs (Figures 3.1.3.9 – 3.1.3.10) were significantly different than at ARY either. Circulating levels of 11-KT and E2 were significantly lower than those at ARY (Figures 3.1.3.12, 3.1.3.14). However that was due to the high levels at ARY and those here were not significantly different than those at other upstream stations. GSIs were significantly higher here than at ARY, which is incongruent with the steriod data.

Androscoggin Lake, ALW, is a unique lake in Maine, in that it has a reverse delta from centuries of flooding from the Androscoggin River during spring flows and other high water events. Consequently it has received some pollutants from the river, although they have been highly diluted. Nevertheless, mass loading of some pollutants may be significant. In the 1994 study, this station was thought to be unimpacted by point sources and was used as a reference for Gulf Island Pond. In 1996, concentrations of dioxins exceeding any found in fish from any other lake or river station without point sources were measured in fish from Androscoggin Lake, documenting significant exposure to pulp and paper mill discharges to the river. Although since then concentrations of dioxin in fish have declined, questions regarding adverse impacts to fish populations in this lake remain. In 2001mean ages of both male and female suckers was significantly greater that those of fish from ALV, the nearest upstream station (Figure 3.1.3.1 – 3.1.3.2), and in fact were the highest of all the stations. Mean length of females was similar to that at ALV, but mean length of males was significantly lower than at ALV (Figures 3.1.3.3 – 3.1.3.4). Condition factor was significantly lower than at ALV for both sexes (Figures 3.1.3.5 – 3.1.3.6), perhaps reflecting lower productivity. MFOs were no different than at ALV for either sex (Figures 3.1.3.7 – 3.1.3.8), but LSIs were significantly lower for both sexes than at ALV (Figures 3.1.3.9 – 3.1.3.10), perhaps again because of lower productivity. Concentrations of 11-KT were elevated in males (Figure 3.1.3.11), but curiously GSIs were significantly lower compared to ALV (Figure 3.1.3.16).

Gulf Island Pond, AGI, a large (15 miles long) deep (~80 feet) impoundment approximately 15 miles downstream of ALV, was the experimental station of the 1994 study. There is a small municipal treatment plant, which contributes some nutrients, between these two stations,. Unlike other stations, AGI is a net sink for sediments and associated contaminants. In 2001, mean ages were significantly lower for both sexes than those at ALW, which were highest of all stations, but similar to those at ALV (Figures 3.1.3.1 – 3.1.3.2). Mean lengths were significantly lower than at ALW or ALV for both males and females (Figures 3.1.3.3 – 3.1.3.4). Condition factor was significantly different (lower) than that at ALW for males only, but lower than those at ALV for both sexes (Figures 3.1.3.5 – 3.1.3.6). Unlike the 1994 study, MFOs were no different than those at ALW or in fact ALV either (Figures 3.1.3.7 – 3.1.3.8), indicating no difference in exposure to point sources. Like the 1994 study LSIs were no different than those at ALW, but they were significantly lower than those at ALV (Figures 3.1.3.9 – 3.1.3.10). As in 1994, circulating levels of T in males were significantly higher than at ALW, but unlike 1994, levels of 11-KT were also significantly higher and levels of E2 in females were no different than those at ALW (Figures 3.1.3.11 – 3.1.3.14). Levels of all sex steroids were significantly higher at AGI than at ALV, but GSIs were significantly lower for both sexes (Figures 3.1.3.15 – 3.1.3.16). Lower GSIs for females are similar to the results of the 1994 study.

These preliminary results document that some, but not all, of the impacts seen in the 1994 study remain. Lower GSIs in Gulf Island Pond indicate a population level effect. Responses at all stations are not entirely congruent with the conceptual model of effects of the discharges on reproduction mediated via endocrine disruption. The study will be repeated in 2002 to further elucidate any impacts of the discharges.

Figure 3.1.3.1 Mean age of female white suckers sampled from the Androscoggin River 2001

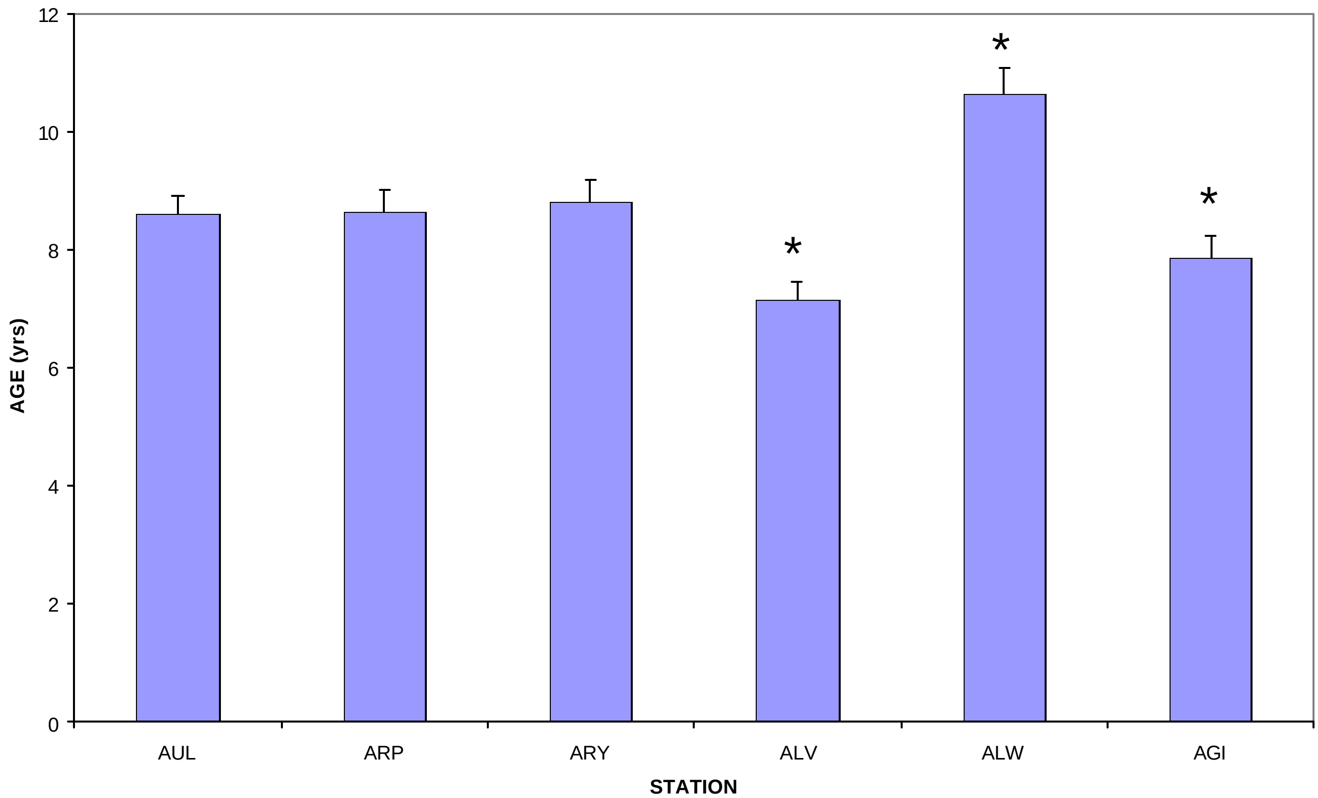


Figure 3.1.3.2 Mean age of male white suckers sampled from the Androscoggin River 2001

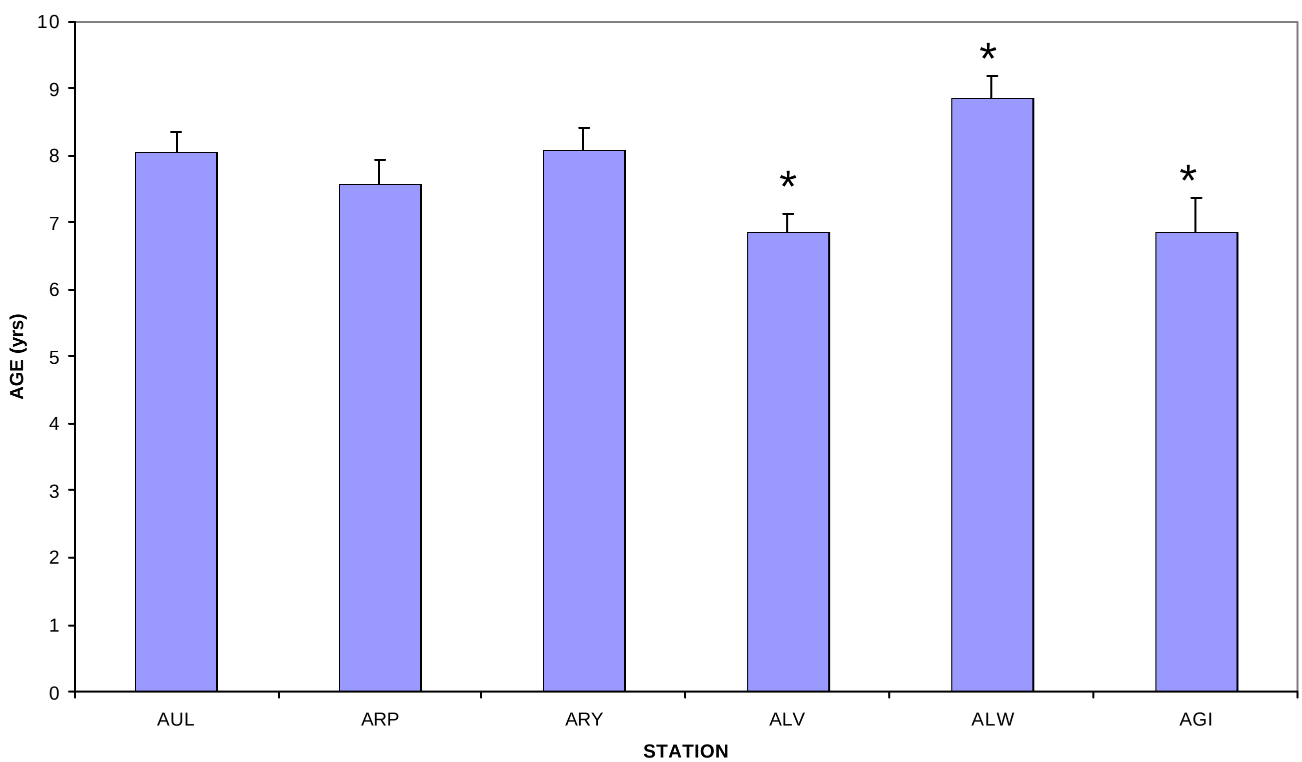


Figure 3.1.3.3 Mean length of female white suckers sampled from the Androscoggin River 2001

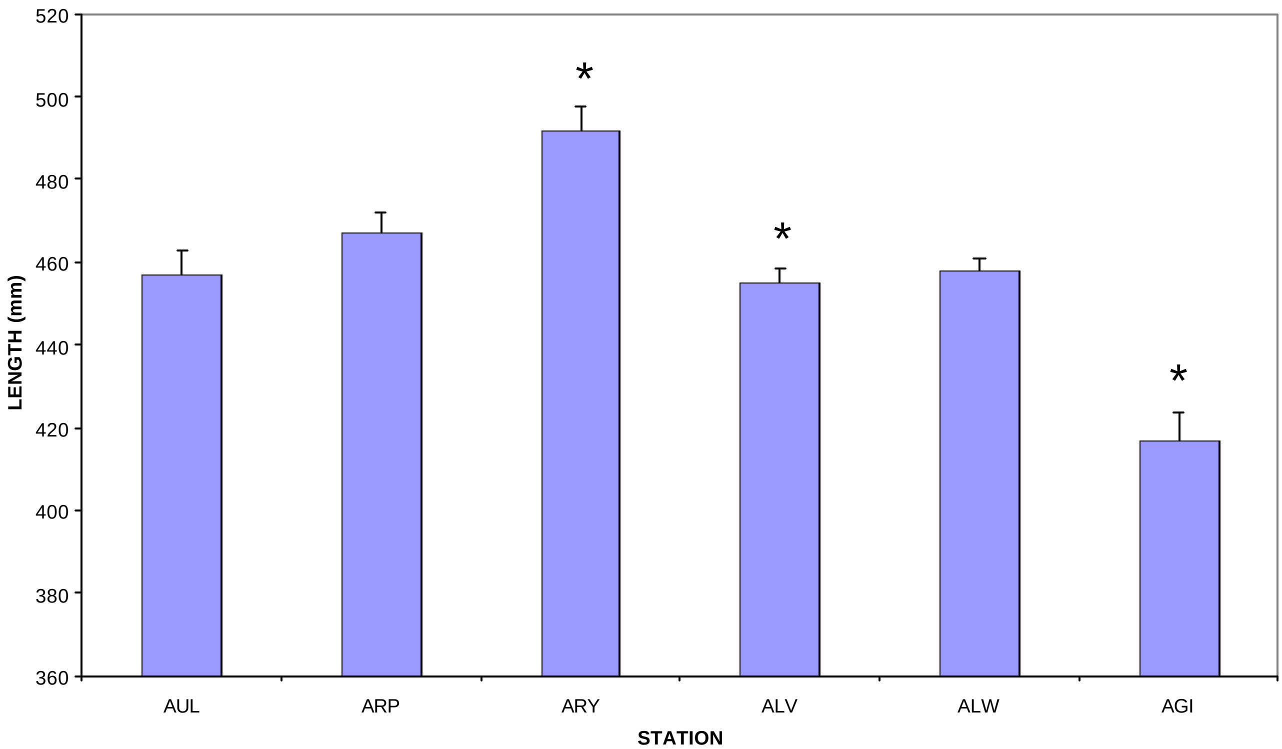


Figure 3.1.3.4 Mean length of male white suckers sampled from the Androscoggin River 2001

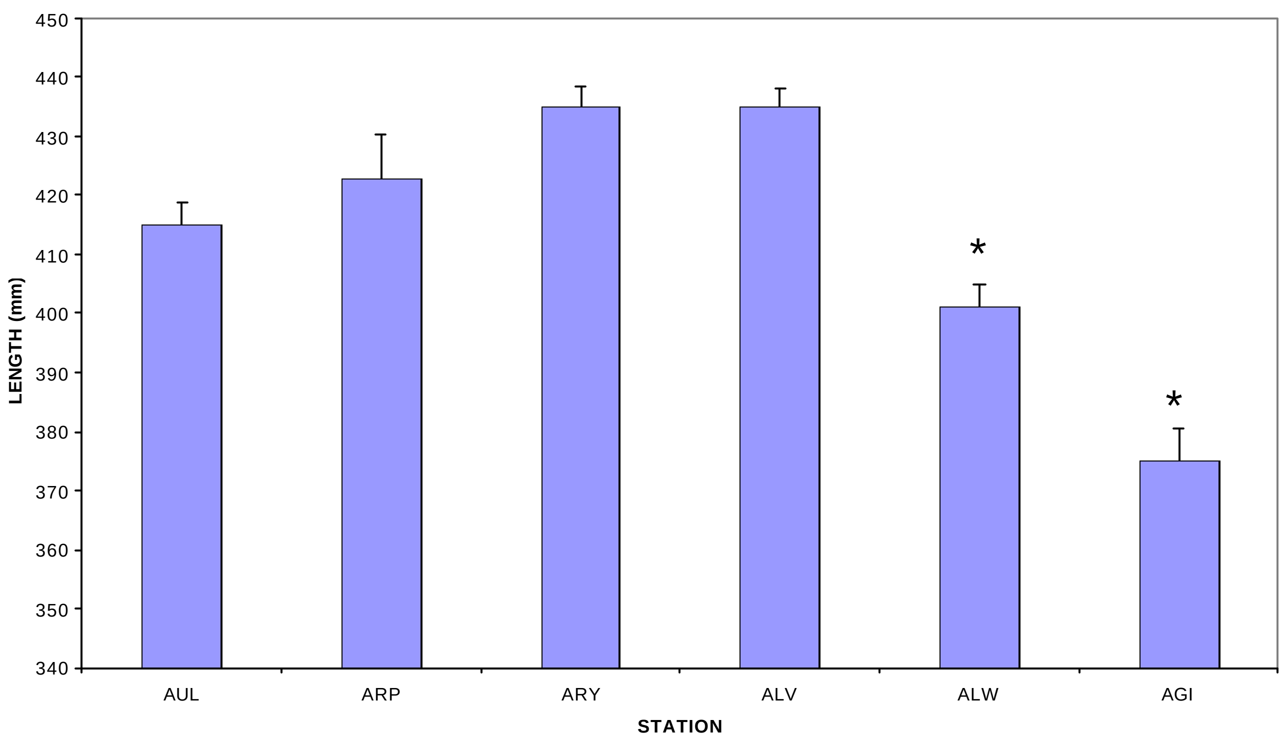


Figure 3.1.3.5 Mean condition factor (K) of female white suckers sampled rom the Androscoggin River 2001

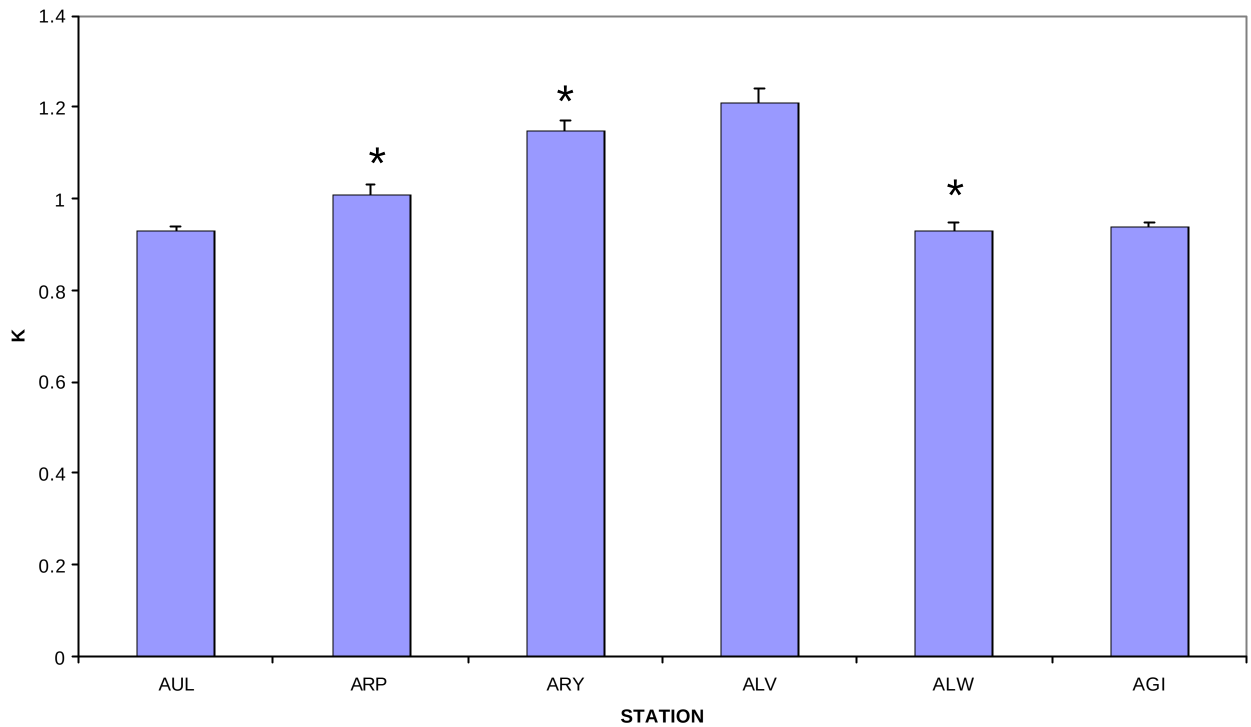


Figure 3.1.3.6 Mean condition factor (K) in male white suckers sampled from the Androscoggin River 2001

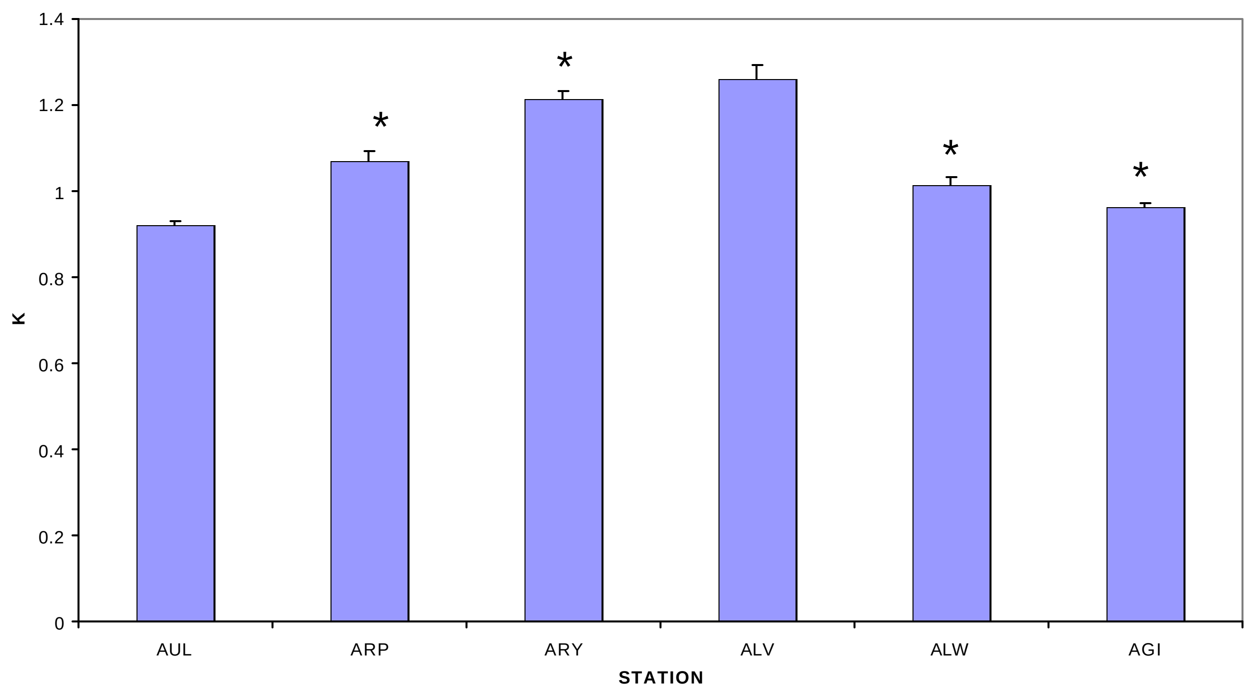


FIGURE 3.1.3.7 Mean MFO in female white suckers sampled from the Androscoggin River 2001

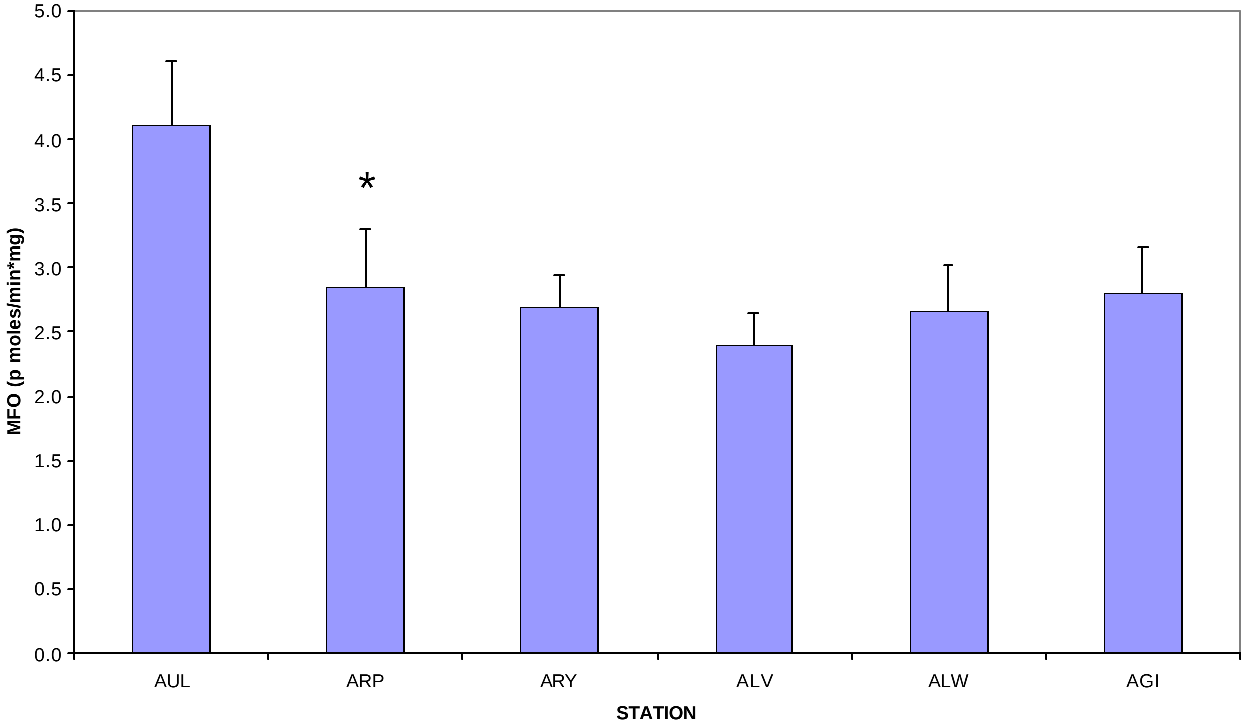


FIGURE 3.1.3.8 Mean MFO in male white suckers sampled from the Androscoggin River 2001

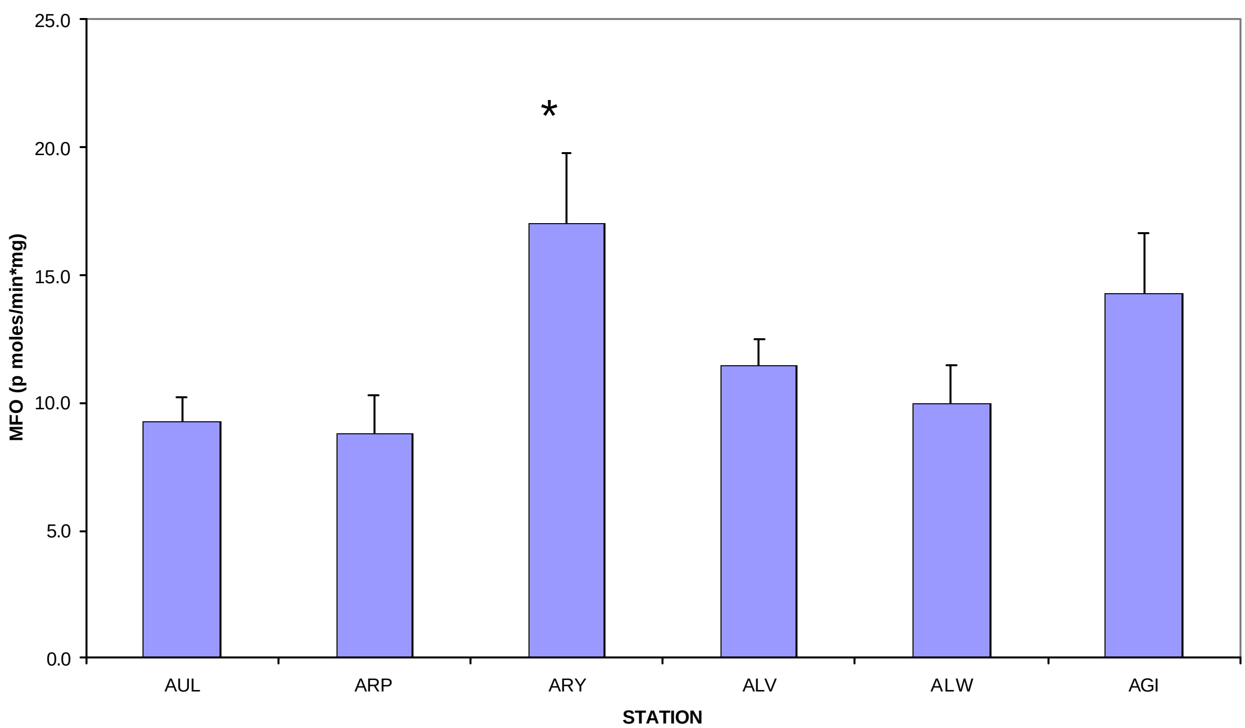


Figure 3.1.3.9 Mean LSI of female white suckers sampled from the Androscoggin River 2001

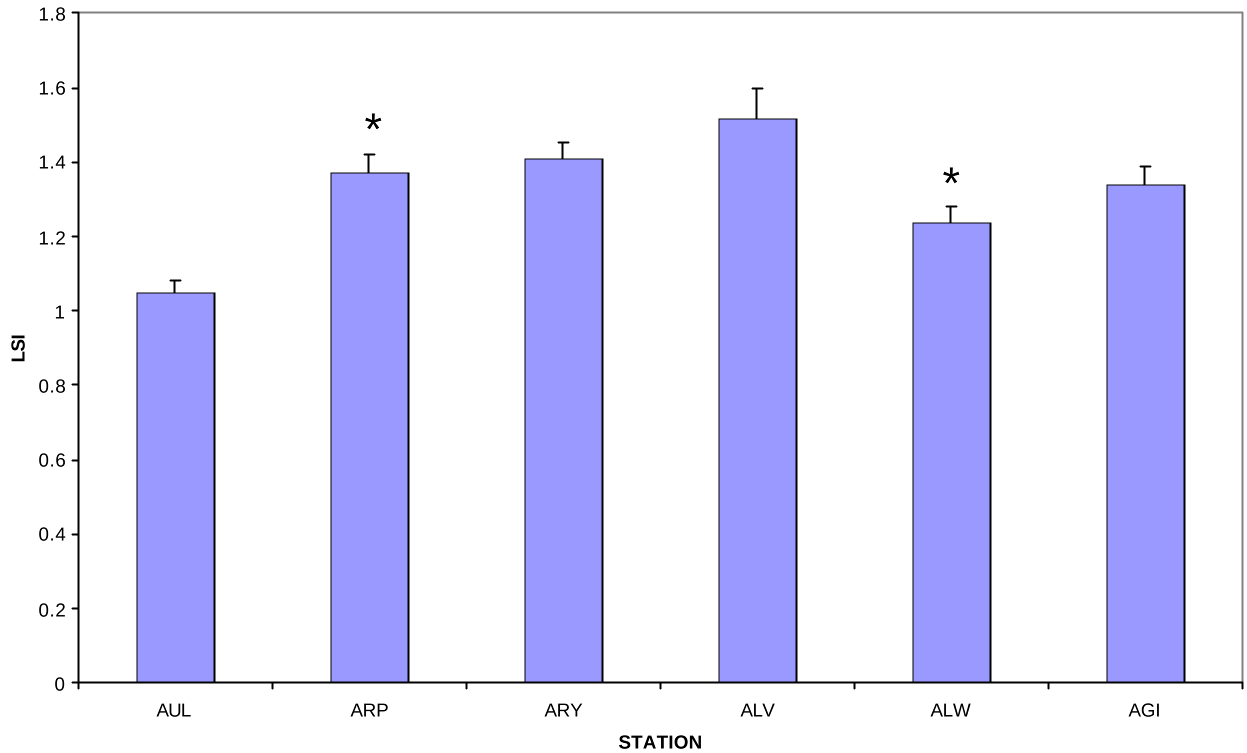


Figure 3.1.3.10 Mean LSI of male white suckers sampled from the Androscoggin River 2001

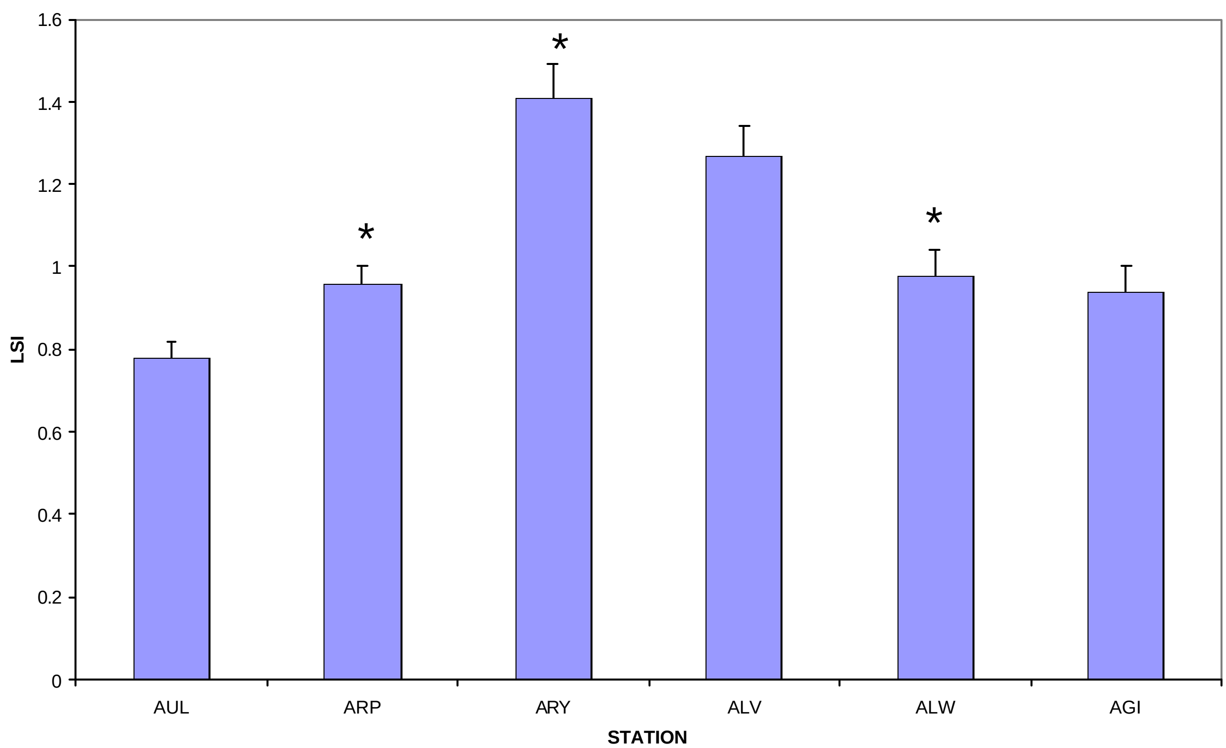


figure 3.1.3.11 Mean testosterone (T) concentrations in male white suckers from the Androscoggin River 2001

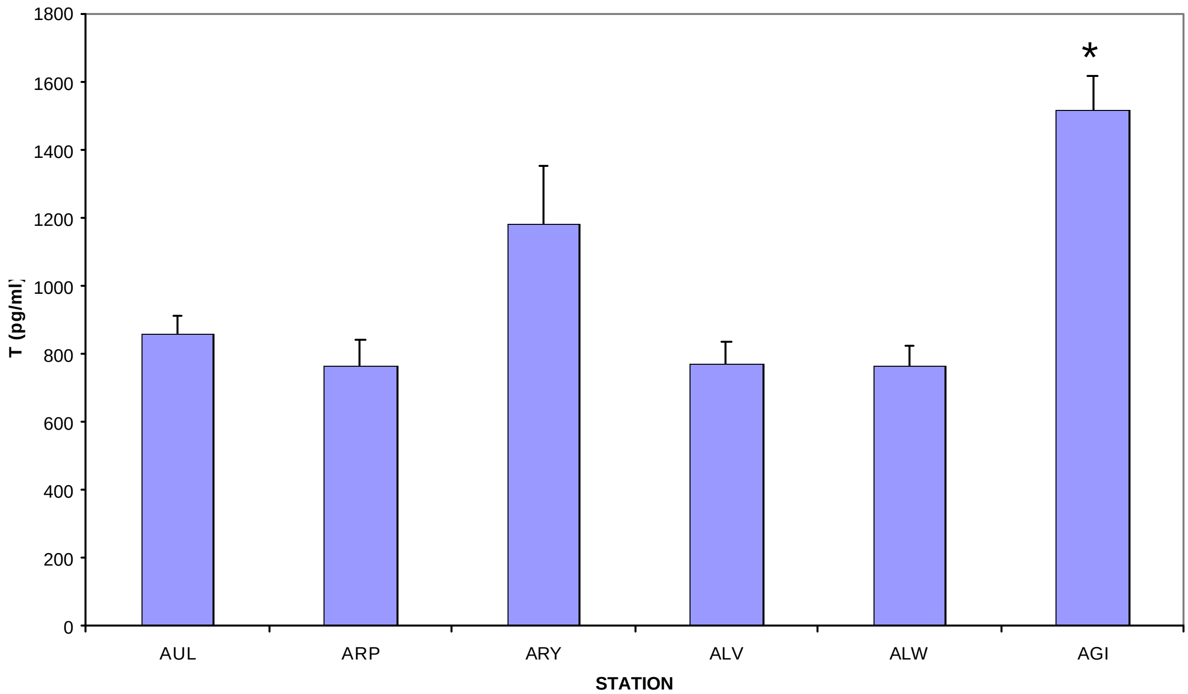


Figure 3.1.3.12 Mean 11-ketotestosterone (11-KT) concentrations in male white suckers from the Androscoggin River 2001

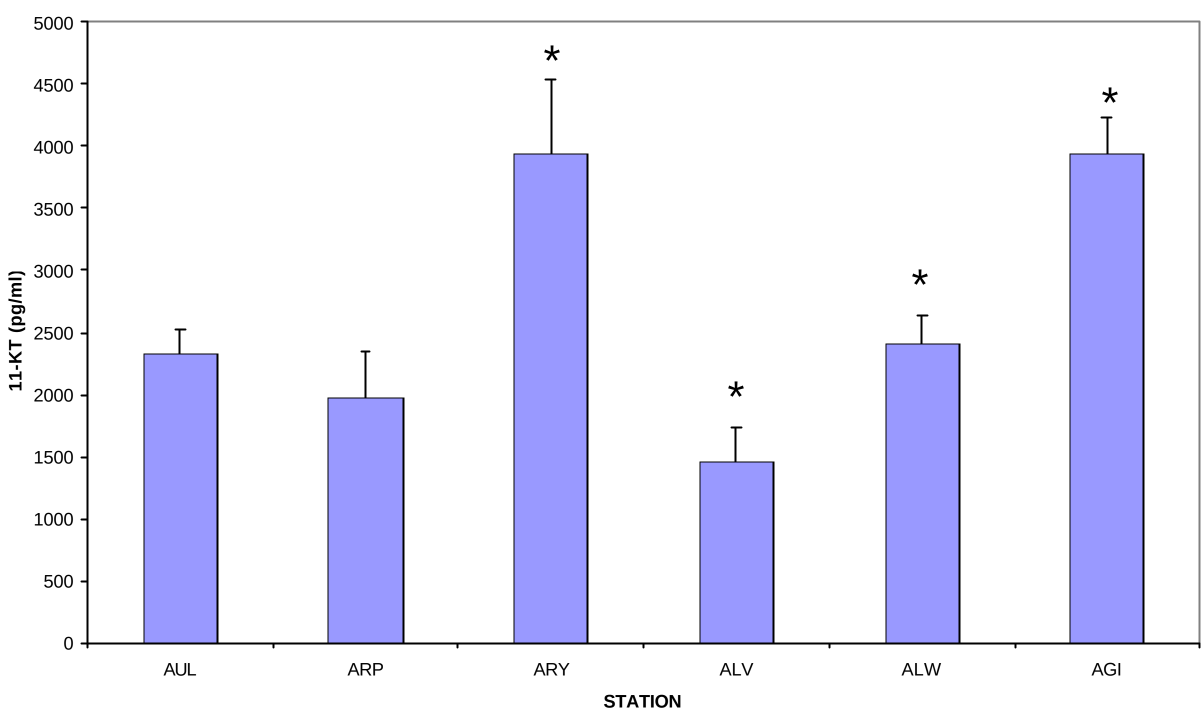


Figure 3.1.3.13 Mean testosterone (T) concentrations in female white suckers from the Androscoggin River 2001

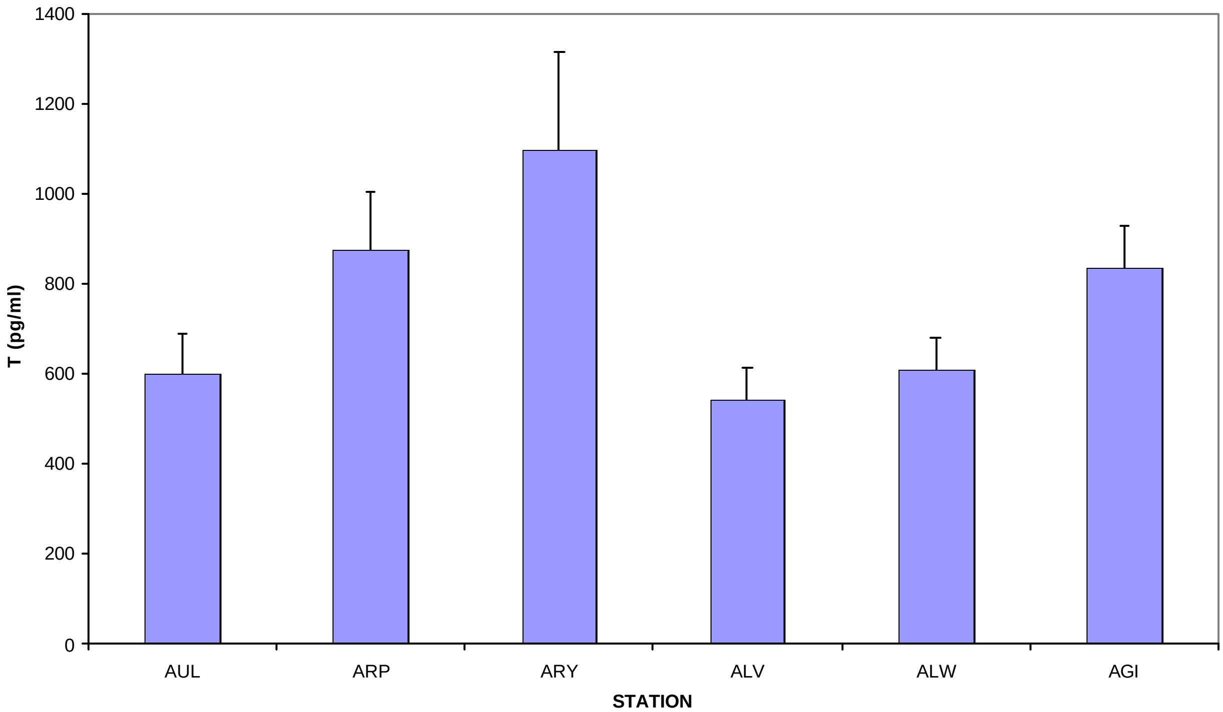


Figure 3.1.3.14 Mean estradiol (E2) concentrations in female white suckers from the Androscoggin River 2001

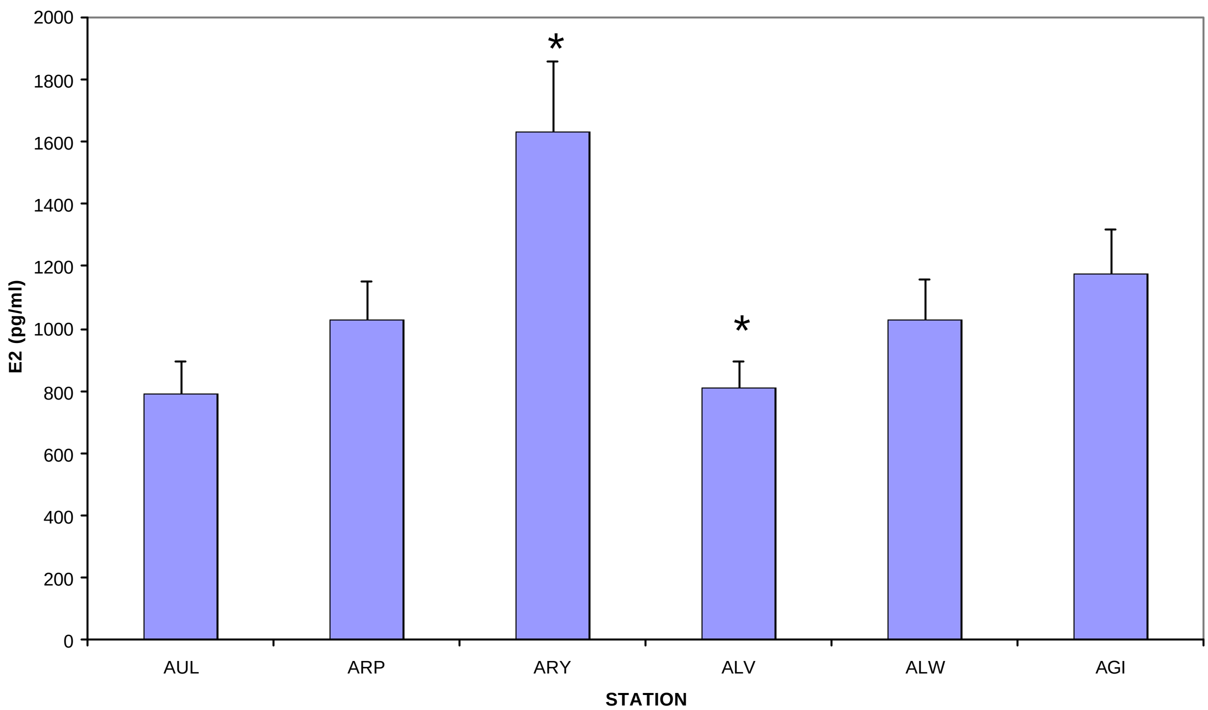


Figure 3.1.3.15 Mean GSI of female white suckers sdampled from the Androscoggin River 2001

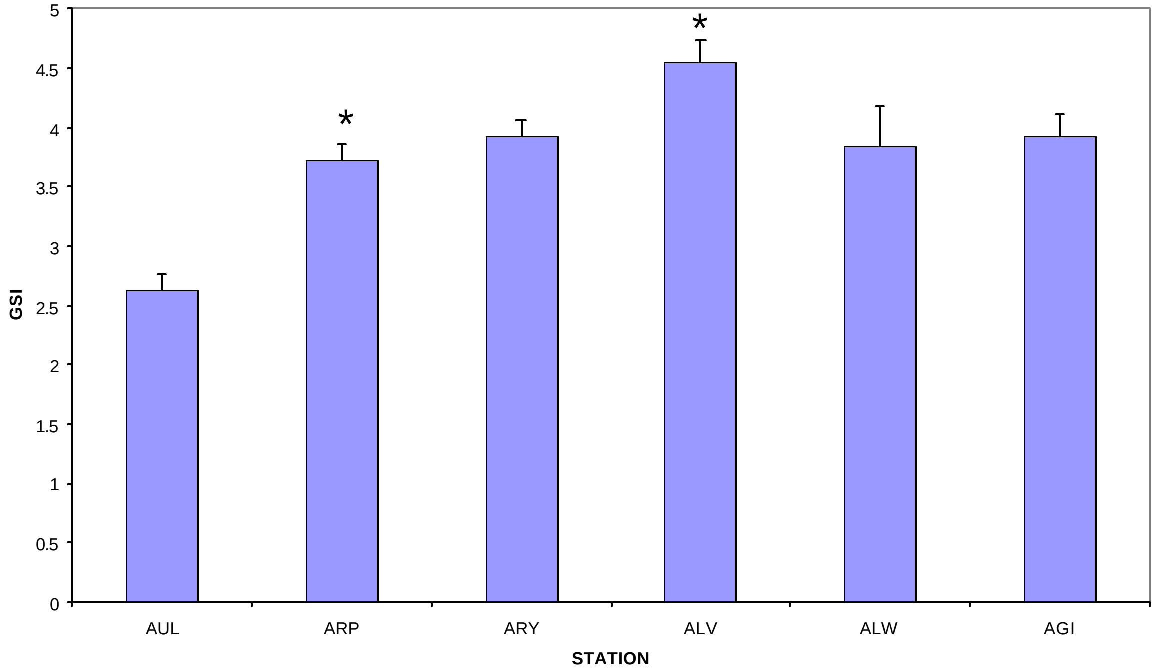
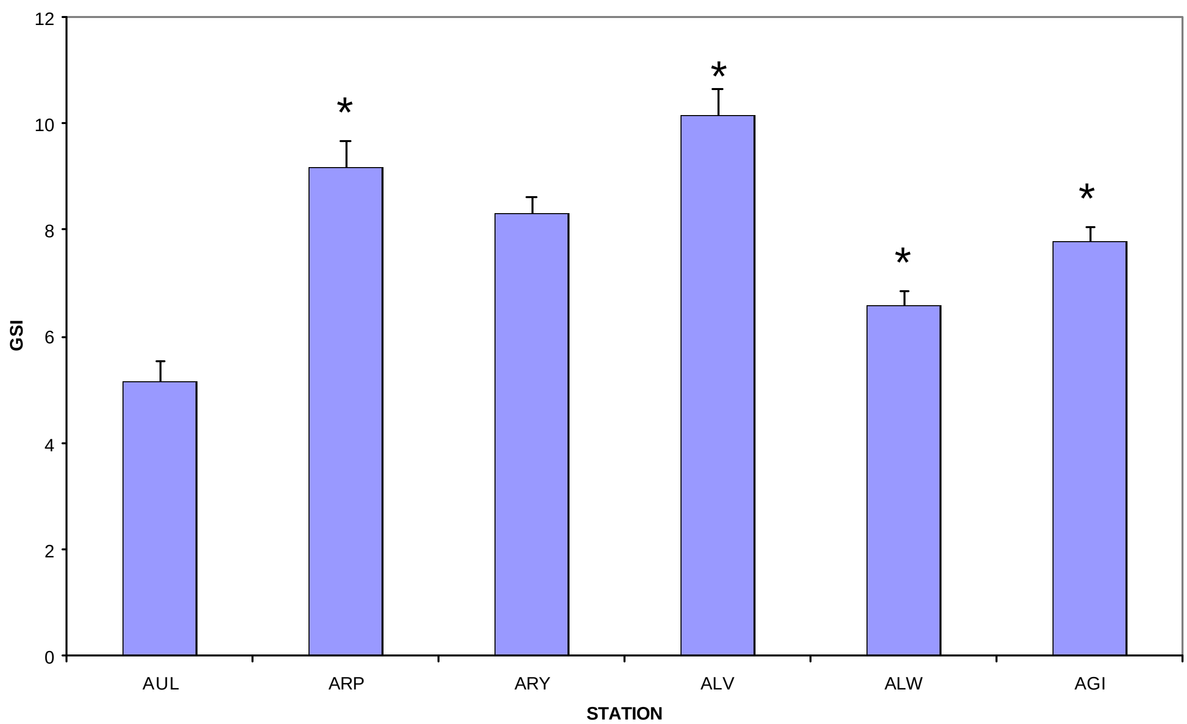


Figure 3.1.3.16 Mean GSI in male white suckers sampled from the Androscoggin River 2001



Raw field data

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT g	LIVER WT g	AGE yrs
AUL-WHS	2	9/4/01	F	422	786	21.09	7.46	7
AUL-WHS	3	9/4/01	F	479	1002	25.81	10.37	10
AUL-WHS	6	9/4/01	F	469	919	18.17	9.57	9
AUL-WHS	7	9/4/01	F	475	995	25.49	9.29	12
AUL-WHS	8	9/4/01	F	441	855	24.58	7.63	8
AUL-WHS	9	9/4/01	F	430	825	24.4	8.42	9
AUL-WHS	10	9/4/01	F	473	932	16.79	10.18	9
AUL-WHS	13	9/4/01	F	425	770	20.13	7.29	7
AUL-WHS	14	9/4/01	F	451	811	18.06	9.79	7
AUL-WHS	15	9/4/01	F	419	747	25.38	5.88	7
AUL-WHS	16	9/4/01	F	455	842	18.95	9.78	9
AUL-WHS	18	9/4/01	F	436	786	24.88	8.38	8
AUL-WHS	21	9/4/01	F	515	1245	33.46	12.39	7
AUL-WHS	22	9/4/01	F	380	539	13.08	4.85	6
AUL-WHS	23	9/4/01	F	465	866	18.38	8.15	10
AUL-WHS	24	9/4/01	F	460	1016	25.89	12.86	9
AUL-WHS	25	9/4/01	F	460	921	25.26	7.88	8
AUL-WHS	26	9/4/01	F	470	981	23.37	12.84	9
AUL-WHS	28	9/4/01	F	460	783	7.15	7.96	11
AUL-WHS	30	9/4/01	F	450	907	32.7	13.18	7
AUL-WHS	31	9/4/01	F	455	823		9.27	8
AUL-WHS	39	9/6/01	F	488	1016	21.54	9.2	10
AUL-WHS	40	9/6/01	F	460	895	25.28	8.55	9
AUL-WHS	41	9/6/01	F	442	863	37.09	9.35	7
AUL-WHS	46	9/6/01	F	485	999	16.24	11.13	8
mean				455	881.3	22.63	9.27	8.44
sd				27.2	131.7	6.52	2.09	1.45
se				5.45	26.34	1.30	0.42	0.29
AUL-WHS	12	9/4/01	F?	522	1074	8.83	14.34	
AUL-WHS	5	9/4/01	I	395	667		3.89	5
AUL-WHS	1	9/4/01	IF	464	876	6.76	9.61	9
AUL-WHS	11	9/4/01	IM	401	658		4.43	6

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT g	LIVER WT g	AGE yrs
AUL-WHS	4	9/4/01	M	424	713	1.66	5.8	8
AUL-WHS	17	9/4/01	M	361	513	25.7	5.03	5
AUL-WHS	19	9/4/01	M	430	791	37.32	5.91	8
AUL-WHS	20	9/4/01	M	430	737	43.71	5.46	9
AUL-WHS	27	9/4/01	M	438	711	17.79	4.94	8
AUL-WHS	29	9/4/01	M	417	732	41.06	5.29	7
AUL-WHS	32	9/4/01	M	395	543	21.62	3.44	9
AUL-WHS	33	9/4/01	M	440	761	34.35	8.74	9
AUL-WHS	34	9/4/01	M	421	687	35.15	4.56	NS
AUL-WHS	35	9/4/01	M	385	554	39.21	4.45	7
AUL-WHS	36	9/4/01	M	374	483	12.42		6
AUL-WHS	37	9/4/01	M	418	677	40.09	3.37	9
AUL-WHS	38	9/6/01	M	435	699	16.33	6.42	9
AUL-WHS	42	9/6/01	M	410	669	38.84	5.52	7
AUL-WHS	43	9/6/01	M	427	699	43.93	4.9	9
AUL-WHS	44	9/6/01	M	424	691	31.16	4.13	9
AUL-WHS	45	9/6/01	M	435	785	32.35	6.06	10
AUL-WHS	47	9/6/01	M	423	675	37.61	4.77	9
AUL-WHS	48	9/6/01	M	364	476	32.68	3.9	5
AUL-WHS	49	9/6/01	M	447	704	14.61	6.46	12
AUL-WHS	50	9/6/01	M	440	735	33.89	5.72	9
AUL-WHS	51	9/6/01	M	395	469	20.28	6.96	9
AUL-WHS	52	9/6/01	M	441	776	28.85	5.06	9
AUL-WHS	53	9/6/01	M	403	592	30.12	3.84	8
AUL-WHS	54	9/6/01	M	397	599	24.34	5.32	5
AUL-WHS	55	9/6/01	M	401	632	42.5	4.47	6
AUL-WHS	56	9/6/01	M	424	682	44.99	5.72	11
AUL-WHS	57	9/6/01	M	437	749	31.21	4.56	6
AUL-WHS	58	9/6/01	M	419	737	61.73	6.16	8
AUL-WHS	59	9/6/01	M	414	695	40.88	5.03	7
AUL-WHS	60	9/6/01	M	402	651	45.41	3.65	9
AUL-WHS	61	9/6/01	M	410	671	36.59	4.13	8
AUL-WHS	62	9/6/01	M	416	677	26.93	4.78	8
mean				415	662.8	32.28	5.14	8.06
sd				22.0	89.4	11.84	1.12	1.64
se				4.40	17.9	2.37	0.22	0.33

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
ARP-WHS	14	9/10/01	F	425	776.2	21.23	9.52	8
ARP-WHS	27	9/11/01	F	427	824.7	29.01	13.48	9
ARP-WHS	23	9/11/01	F	446	857.0	24.68	14.39	8
ARP-WHS	26	9/11/01	F	448	1024.3	43.72	12.56	7
ARP-WHS	34	9/12/01	F	448	1043.6	33.46	13.53	8
ARP-WHS	31	9/12/01	F	450	1010.2	47.98	14.41	8
ARP-WHS	16	9/11/01	F	451	915.0	36.68	10.27	6
ARP-WHS	28	9/11/01	F	462	968.6	43.12	15.05	7
ARP-WHS	11	9/10/01	F	470	1129.8	33.81	12.26	9
ARP-WHS	8	9/10/01	F	472	1095.3	44.32	12.58	9
ARP-WHS	3	9/10/01	F	475	1059.7	37.08	13.5	10
ARP-WHS	5	9/10/01	F	475	1185.7	42.12	14.03	10
ARP-WHS	17	9/11/01	F	477	990.1	36.92	15.65	9
ARP-WHS	7	9/10/01	F	480	986.9	30.78	11.01	8
ARP-WHS	32	9/12/01	F	480	972.7	34.29	14.96	8
ARP-WHS	4	9/10/01	F	482	1219.6	37.68	14.55	7
ARP-WHS	30	9/11/01	F	483	1066.4	46.24	12.46	9
ARP-WHS	24	9/11/01	F	491	1125.9	37.3	19.28	8
ARP-WHS	35	9/12/01	F	500	1215.5	44.19	14.29	13
ARP-WHS	33	9/12/01	F	505	1164.4	34.06	19.94	12
mean				467	1028.1	36.93	13.89	8.7
sd				22.1	125.6	7.12	2.53	1.7
se				4.91	27.90	1.58	0.56	0.37
ARP-WHS	39	9/13/01	I	375	579.6	-	6.84	5
ARP-WHS	1	9/10/01	IF	378	551.7	1.99	4.06	7
ARP-WHS	20	9/11/01	IF	383	497.9	1.05	5.11	5

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
ARP-WHS	13	9/10/01	M	350	432.4	16.22	3.3	5
ARP-WHS	15	9/11/01	M	357	474.1	33.18	2.62	5
ARP-WHS	25	9/11/01	M	376	615.1	43.24	7.12	6
ARP-WHS	22	9/11/01	M	384	573.7	46.04	6.15	7
ARP-WHS	9	9/10/01	M	410	700.5	54.82	5.72	5
ARP-WHS	41	9/14/01	M	415	884.5	80.17	9.61	7
ARP-WHS	29	9/11/01	M	416	752.8	81.08	6.58	9
ARP-WHS	21	9/11/01	M	424	788.9	74.7	8.57	8
ARP-WHS	10	9/10/01	M	425	839.1	86.9	7.61	6
ARP-WHS	42	9/14/01	M	426	681.4	90.42	5.94	7
ARP-WHS	2	9/10/01	M	427	815.8	88.08	5.15	9
ARP-WHS	40	9/13/01	M	430	942.3	78.54	9.59	8
ARP-WHS	12	9/10/01	M	436	956.8	78.98	12.53	8
ARP-WHS	19	9/11/01	M	436	900.5	65.29	11.57	10
ARP-WHS	43	9/14/01	M	440	947.7	94.78	7.62	8
ARP-WHS	44	9/14/01	M	442	1015.9	82.59	7.46	8
ARP-WHS	18	9/11/01	M	445	899.6	60.54	7.61	6
ARP-WHS	37	9/13/01	M	445	1017.6	80.05	10.61	8
ARP-WHS	6	9/10/01	M	449	938.8	60.44	8.96	8
ARP-WHS	36	9/13/01	M	467	1005.9	72.81	11.26	10
ARP-WHS	38	9/13/01	M	485	1194.3	92.95	13.31	11
mean				423	824.6	69.61	8.04	7.57
sd				33.3	192.6	20.99	2.84	1.69
se				7.24	41.87	4.56	0.62	0.37

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT g	AGE yrs
WHS-ARY	1	9/17/01	F	480	1249.7	37.4	18.37	12
WHS-ARY	2	9/17/01	F	506	1454.4	58.38	20.51	9
WHS-ARY	3	9/17/01	F	490	1304.8	43.04	15.59	7
WHS-ARY	5	9/17/01	F	520	1629.7	67.92	23.61	8
WHS-ARY	7	9/17/01	F	490	1590.0	54.81	23.64	8
WHS-ARY	8	9/17/01	F	475	1316.1	37.43	19.09	8
WHS-ARY	10	9/17/01	F	490	1240.1	52.46	16.37	8
WHS-ARY	16	9/18/01	F	536	1654.3	72.87	24	12
WHS-ARY	17	9/18/01	F	523	1552.3	63.23	24.4	10
WHS-ARY	18	9/18/01	F	485	1328.9	51.93	22.18	9
WHS-ARY	21	9/18/01	F	470	1204.8	52.65	19.51	9
WHS-ARY	23	9/20/01	F	507	1477.0	54.91	18.57	7
WHS-ARY	24	9/20/01	F	497	1379.4	59.31	19.15	10
WHS-ARY	25	9/20/01	F	490	1353.4	52.42	21.95	10
WHS-ARY	28	9/20/01	F	420	946.9	24.04	11.54	5
WHS-ARY	34	9/20/01	F	500	1522.6	54.75	15.74	10
WHS-ARY	36	9/20/01	F	494	1275.4	44.72	15.36	8
WHS-ARY	38	9/20/01	F	511	1486.8	63.82	21.92	11
WHS-ARY	39	9/20/01	F	509	1489.7	66.76	16.4	8
WHS-ARY	43		F	462	1253.7	44.04		7
mean				493	1382.1	52.8	19.4	
sd				25.0	172.3	11.9	3.6	
se				5.6	38.3	2.6	0.8	
WHS-ARY	12	9/18/01	I	295	260.8	1.06	2.84	
WHS-ARY	13	9/18/01	I	350	449.2	1.23	6.29	
WHS-ARY	14	9/18/01	I	339	461.9	2.26	9.76	

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
WHS-ARY	4	9/17/01	M	462	1183.4	101.94	25.97	10
WHS-ARY	6	9/17/01	M	430	1027.3	77.9	15.07	6
WHS-ARY	9	9/17/01	M	390	758.3	56.12	5.71	7
WHS-ARY	11	9/17/01	M	448	1105.2	60.64	11.73	7
WHS-ARY	15	9/18/01	M	455	1141.3	90.42	13.44	9
WHS-ARY	19	9/18/01	M	428	835.2	82.52	9.7	6
WHS-ARY	20	9/18/01	M	423	887.1	88.87	14.7	8
WHS-ARY	22	9/20/01	M	426	1053.8	81.53	10.29	9
WHS-ARY	26	9/20/01	M	456	1243.3	115.87	19.53	8
WHS-ARY	27	9/20/01	M	454	1138.3	70.42	13.76	8
WHS-ARY	29	9/20/01	M	409	812.4	70.58	8.48	5
WHS-ARY	30	9/20/01	M	438	1046.3	90.39	12.8	9
WHS-ARY	31	9/20/01	M	410	815.7	61.33	8.26	6
WHS-ARY	32	9/20/01	M	402	931.6	83.43	8.77	5
WHS-ARY	33	9/20/01	M	456	1092.4	77.16	11.35	9
WHS-ARY	35	9/20/01	M	442	1069.2	72.13	17.12	8
WHS-ARY	37	9/20/01	M	460	1165.2	90.97	15.53	11
WHS-ARY	40	9/20/01	M	390	719.8	68.6	8.4	5
WHS-ARY	41	9/20/01	M	460	1249.4	114.58	24.96	12
WHS-ARY	42	9/20/01	M	447	1127.0	93.24	15.23	10
WHS-ARY	50	10/23/01	M	430	1008.7	54.24	15.57	7
WHS-ARY	51	10/23/01	M	440	986.0	66.41	11.06	6
WHS-ARY	52	10/23/01	M	424	915.8	59.16	13.35	8
WHS-ARY	53	10/23/01	M	440	1077.2	71.21	16.5	7
WHS-ARY	54	10/23/01	M	435	966.1	69.63	21.45	9
WHS-ARY	55	10/23/01	M	445	1072.8	77.2	16.14	7
WHS-ARY	56	10/23/01	M	434	979.4	68.71	12.7	9
WHS-ARY	57	10/23/01	M	458	986.2	65.65	13.24	10
WHS-ARY	58	10/23/01	M	430	875.6	55.77	10.21	8
WHS-ARY	59	10/23/01	M	430	926.1	75.94	21.71	10
WHS-ARY	60	10/23/01	M	443	1022.6	63.49	16.98	11
WHS-ARY	61	10/23/01	M	435	1023.3	87.35	13.31	9
WHS-ARY	99		M	435	1070.3	76.98		8
WHS-ARY	100		M	434	917.1	76.98		8
mean				436	1006.0	76.05	14.4	
sd				17.9	127.1	15.5	4.4	
se				3.7	25.9	3.2	0.9	

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
WHS-ALV	4	9/26/01	F	491	1425.0	70.79	24.85	9
WHS-ALV	5	9/26/01	F	473	1182.9	34.89	24.87	7
WHS-ALV	6	9/26/01	F	457	1214.6	56.02	27.06	7
WHS-ALV	8	9/26/01	F	480	1376.0	48.91	15.8	8
WHS-ALV	9	9/26/01	F	470	1032.4	44.64	11.57	5
WHS-ALV	10	9/26/01	F	475	1355.8	54.88	28.89	6
WHS-ALV	12	9/26/01	F	455	1059.1	38.89	11.93	6
WHS-ALV	13	9/26/01	F	470	1301.7	49.58	17.09	6
WHS-ALV	15	9/26/01	F	470	1424.8	75.05	20.9	9
WHS-ALV	17	9/26/01	F	462	1232.9	53.7	14.72	10
WHS-ALV	21	9/27/01	F	425	1070.9	41.81	13.61	7
WHS-ALV	22	9/27/01	F	485	1410.8	58.83	21.1	6
WHS-ALV	23	9/27/01	F	475	1161.5	61.4	17.97	8
WHS-ALV	24	9/27/01	F	440	1040.4	32.49	15.07	7
WHS-ALV	25	9/27/01	F	479	1210.3	58.1	20.65	6
WHS-ALV	26	9/27/01	F	486	1398.5	53	20.08	10
WHS-ALV	27	9/27/01	F	455	1068.2	53.78	13.52	6
WHS-ALV	38	9/27/01	F	454	1334.9	70.16	20.6	7
WHS-ALV	39	9/27/01	F	449	1215.8	51.23	13.81	7
WHS-ALV	40	9/27/01	F	463	1024.3	59.2	16.12	6
mean				466	1223.8	53.4	18.51	
sd				16.5	144.5	11.4	5.07	
se				3.66	32.11	2.52	1.13	

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
WHS-ALV	1	9/25/01	M	416	629.0	85.41	8.1	6
WHS-ALV	2	9/25/01	M	435	938.4	76.14	18.32	5
WHS-ALV	3	9/25/01	M	434	1031.7	103.23	20.21	5
WHS-ALV	7	9/26/01	M	435	889.7	81.45	15.54	6
WHS-ALV	11	9/26/01	M	438	972.1	84.83	8.59	8
WHS-ALV	14	9/26/01	M	435	1123.9	86.52	15.65	6
WHS-ALV	16	9/26/01	M	425	989.2	88.45	5.58	7
WHS-ALV	18	9/26/01	M	445	1100.7	102.65	17.21	6
WHS-ALV	19	9/27/01	M	440	1194.9	81.32	13.02	8
WHS-ALV	20	9/27/01	M	439	1237.6	110.18	13.13	5
WHS-ALV	28	9/27/01	M	425	1000.0	113.35	11.56	8
WHS-ALV	29	9/27/01	M	439	1049.0	93.58	14.33	6
WHS-ALV	30	9/27/01	M	446	1077.6	113.63	13.51	8
WHS-ALV	31	9/27/01	M	455	1202.7	112.57	11.62	8
WHS-ALV	32	9/27/01	M	418	956.8	90.51	9.42	7
WHS-ALV	33	9/27/01	M	422	906.2	84.84	9.21	9
WHS-ALV	34	9/27/01	M	467	1333.4	133.89	19.07	9
WHS-ALV	35	9/27/01	M	415	1110.2	107.71	11.55	7
WHS-ALV	36	9/27/01	M	421	1037.5	95.78	11.26	7
WHS-ALV	37	9/27/01	M	448	1231.7	97.11	12.25	7
WHS-ALV	41	9/27/01	M	450	1093.8	112.42	14.69	6
WHS-ALV	42	9/27/01	M	407	835.4	18.34	9.75	7
WHS-ALV	43	9/27/01	M	451	1044.5	117.05	16.56	7
mean				435	1039.5	95.26	13.05	
sd				14.71	152.2	22.21	3.76	
se				3.06	31.71	4.63	0.78	

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
WHS-AGI	1	10/5/01	F	390	562.8	19.9	7.55	8
WHS-AGI	3	10/5/01	F	365	453.0	6.8	5.74	5
WHS-AGI	4	10/5/01	F	368	456.6	12.64	4.13	6
WHS-AGI	5	10/5/01	F	376	517.7	22	6.53	4
WHS-AGI	6	10/5/01	F	405	577.0	20.33	7.28	9
WHS-AGI	7	10/5/01	F	412	592.6	21.56	6.41	9
WHS-AGI	10	10/5/01	F	442	784.2	26.53	9.12	8
WHS-AGI	13	10/8/01	F	415	656.4	24.91	7.56	7
WHS-AGI	14	10/8/01	F	415	737.1	34.45	10.09	8
WHS-AGI	15	10/8/01	F	426	741.1	34.49	9.56	8
WHS-AGI	22	10/9/01	F	401	635.5	28.59	8.39	7
WHS-AGI	23	10/9/01	F	442	889.5	38.46	17.54	9
WHS-AGI	25	10/9/01	F	420	773.7	32.58	12.45	9
WHS-AGI	26	10/9/01	F	440	807.3	40.45	13.65	8
WHS-AGI	27	10/10/01	F	472	1051.2	34.59	11.26	11
WHS-AGI	28	10/10/01	F	440	819.2	32.88	10.39	9
WHS-AGI	29	10/10/01	F	465	920.4	34.48	10.92	7
WHS-AGI	30	10/10/01	F	461	845.4	27.58	11.35	9
WHS-AGI	31	10/10/01	F	370	507.3	19.34	5.47	5
WHS-AGI	32	10/10/01	F	432	800.6	30.21	12.92	8
WHS-AGI	33	10/10/01	F	426	691.5	24.78	10.28	9
WHS-AGI	34	10/10/01	F	400	599.8	21.52	9.2	10
mean				419	704.3	27.1	9.5	
sd				31.3	160.0	8.4	3.2	
se				6.7	34.0	1.8	0.7	

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
WHS-AGI	2	10/5/01	M	355	449.0	42.91	3.39	6
WHS-AGI	8	10/5/01	M	392	563.8	36.31	4.07	7
WHS-AGI	9	10/5/01	M	382	507.7	38.64	4.18	8
WHS-AGI	11	10/8/01	M	405	637.3	34.63	5.82	7
WHS-AGI	12	10/8/01	M	380	507.0	36.68	4.58	11
WHS-AGI	16	10/8/01	M	390	539.0	39.91	5.07	8
WHS-AGI	17	10/8/01	M	370	494.5	41.42	5.33	8
WHS-AGI	18	10/8/01	M	404	691.9	46.44	5.5	10
WHS-AGI	19	10/8/01	M	392	528.2	41.37	5.24	10
WHS-AGI	20	10/8/01	M	360	415.7	36.78	3.29	4
WHS-AGI	21	10/9/01	M	384	554.1	45.02	5.42	9
WHS-AGI	24	10/9/01	M	414	704.3	51.41	7.88	9
WHS-AGI	35	10/10/01	M	371	456.9	32.56	3.24	4
WHS-AGI	36	10/10/01	M	345	389.4	29	3.12	4
WHS-AGI	37	10/10/01	M	321	348.8	26.55	4.67	4
WHS-AGI	38	10/10/01	M	348	429.8	28.17	5.29	4
WHS-AGI	39	10/10/01	M	415	608.9	31.91	4.23	5
WHS-AGI	40	10/10/01	M	353	445.9	29.38	6.11	7
WHS-AGI	41	10/10/01	M	353	449.6	27.42	4.52	8
WHS-AGI	42	10/10/01	M	358	471.9	31.08	5.3	4
mean				375	506.7	36.38	4.81	
sd				25.4	95.80	6.98	1.15	
se				5.65	21.29	1.55	0.26	

LOC. SPECIES	NO.	DATE	SEX	LENGTH mm	WEIGHT g	GONAD WT. g	LIVER WT. g	AGE yrs
WHS-ALW	1	10/11/01	F	460	865.8	23.99	9.52	10
WHS-ALW	2	10/11/01	F	460	990.9	7.18	9.22	10
WHS-ALW	3	10/11/01	F	480	936.4	32.25	10.97	10
WHS-ALW	5	10/11/01	F	475	984.0	42.91	12.68	9
WHS-ALW	6	10/11/01	F	442	740.5	34.62	7.62	9
WHS-ALW	7	10/11/01	F	474	976.1	38.36	11.03	12
WHS-ALW	8	10/11/01	F	450	891.3	5.83	7.71	9
WHS-ALW	10	10/11/01	F	450	988.3	35.76	15.04	13
WHS-ALW	12	10/11/01	F	471	945.8	35.53	13.21	12
WHS-ALW	13	10/11/01	F	450	943.6	64.46	13.35	15
WHS-ALW	14	10/11/01	F	453	765.9	28.44	8.92	11
WHS-ALW	17	10/11/01	F	437	712.9	6.04	7.39	11
WHS-ALW	25	10/12/01	F	466	933.1	38.52	11.99	11
WHS-ALW	26	10/12/01	F	465	1056.4	38.11	14.31	9
WHS-ALW	35	10/12/01	F	455	938.2	29.62	12.59	7
WHS-ALW	36	10/12/01	F	440	733.6	20.62	9.88	11
WHS-ALW	37	10/16/01	F	455	763.4	30.54	7.98	9
WHS-ALW	38	10/16/01	F	455	768.9	27.18	10.73	13
WHS-ALW	39	10/16/01	F	487	1105.5	48.46	16.99	16
WHS-ALW	42	10/16/01	F	430	767.6	46.97	10.97	9
WHS-ALW	43	10/16/01	F	475	957.2	39.86	10.33	9
WHS-ALW	44	10/16/01	F	445	929.4	46.41	12.3	9
WHS-ALW	46	10/16/01	F	460	877.4	39.86	9.44	11
mean				458	891.2	33.11	11.1	
sd				14.6	110.4	14.0	2.5	
se				3.0	23.0	2.9	0.5	
WHS-ALW	16	10/11/01	IF	450	869.0	5.06	8.24	9
WHS-ALW	18	10/11/01	IF	432	737.3	4.47	6.92	11
WHS-ALW	21	10/12/01	IF	460	745.1	3.86	6.5	10
WHS-ALW	23	10/12/01	IF	437	799.8	4.75	6.46	9
WHS-ALW	9	10/11/01	IM	427	735.9	5.15	6.61	8

LOC. SPECIES	NO.	DATE	SEX	LENGTH	WEIGHT	GONAD WT.	LIVER WT.	AGE
				mm	g	g	g	yrs
					0.0			
WHS-ALW	4	10/11/01	M	380	533.5	37.37	5.19	7
WHS-ALW	11	10/11/01	M	392	638.2	36.91	4.89	9
WHS-ALW	15	10/11/01	M	389	619.8	41.67	6.07	10
WHS-ALW	19	10/11/01	M	345	417.6	28.7	2.94	5
WHS-ALW	20	10/12/01	M	410	568.5	23.34	4.56	9
WHS-ALW	22	10/12/01	M	415	726.8	33.66	6.2	8
WHS-ALW	24	10/12/01	M	395	662.5	43.18	6.69	9
WHS-ALW	27	10/12/01	M	398	598.4	37.02	5.78	10
WHS-ALW	28	10/12/01	M	425	805.1	42.55	8.6	11
WHS-ALW	29	10/12/01	M	405	692.7	39.29	6.89	8
WHS-ALW	30	10/12/01	M	412	813.3	51.22	8.18	8
WHS-ALW	31	10/12/01	M	420	861.8	45.2	16.7	10
WHS-ALW	32	10/12/01	M	415	684.0	44.08	7.09	10
WHS-ALW	33	10/12/01	M	420	743.1	55.14	6.95	10
WHS-ALW	34	10/12/01	M	395	663.5	34.71	6.51	9
WHS-ALW	40	10/16/01	M	400	580.9	36.78	4.76	7
WHS-ALW	41	10/16/01	M	400	622.0	30.78	5.21	8
WHS-ALW	45	10/16/01	M	408	778.1	53.9	9.23	11
WHS-ALW	47	10/16/01	M	405	669.6	44.9	5.73	10
WHS-ALW	48	10/16/01	M	385	491.5	43.4	3.68	8
mean				401	655.6	40.2	6.6	
sd				17.9	111.7	8.1	2.8	
se				4.0	24.8	1.8	0.6	

raw steroid data

STATION	KTM pg/ml	TM pg/ml	TF pg/ml	E2F pg/ml	MFO F (pmoles/min*mg)	MFO M (pmoles/min*mg)
AUL	3180	830	1704	1388	2.83	5.38
AUL	1257	811	731	1264	3.43	6.36
AUL	3126	939	113	146	1.98	12.01
AUL	3872	1204	656	1271	3.40	11.61
AUL	1878	757	241	343	0.46	10.89
AUL	2004	839	410	611	3.69	8.39
AUL	3042	1255	398	527	5.45	14.66
AUL	1182	460	290	489	9.96	2.57
AUL	1974	696	577	938	2.32	15.48
AUL	3012	1329	339	362	5.05	10.40
AUL	3686	1354	947	896	5.91	4.56
AUL	2382	779	658	1008	5.35	17.76
AUL	3096	845	485	539	5.58	13.35
AUL	2400	982	723	892	1.28	5.49
AUL	1848	688	175	178	2.30	10.92
AUL	1939	761	1344	1789	3.00	7.49
AUL	2596	864	432	454	2.56	4.42
AUL	2083	716	540	767	5.47	10.27
AUL	1409	513	965	1447	6.29	8.02
AUL	628	504	260	542	5.99	5.17
ARP	516	502	252	163	0.78	1.06
ARP	114	344	555	538	1.95	1.68
ARP	321	487	426	884	3.99	2.56
ARP	1040	852	419	411	1.11	1.60
ARP	305	558	201	331	1.47	1.04
ARP	312	390	286	483	1.58	1.08
ARP	380	482	213	410	1.26	10.71
ARP	2285	651	1033	1437	3.82	7.68
ARP	1717	686	879	1037	3.01	11.75
ARP	2519	597	508	798	3.69	21.87
ARP	5893	1634	1264	1237	3.98	19.56
ARP	2550	837	1733	1744	2.74	11.29
ARP	3181	926	630	1136	10.17	21.86
ARP	4388	1239	1422	1414	2.87	5.50
ARP	2519	865	1468	1615	2.58	6.10
ARP	2218	741	2174	1956	3.63	9.24
ARP	572	389	1374	1606	2.51	13.73
ARP	3423	1119	1223	1430	1.34	8.59
ARP	4025	1400	1034	1366	2.54	8.63
ARP	1377	609	399	597	2.04	11.34

STATION	KTM pg/ml	TM pg/ml	TF pg/ml	E2F pg/ml	MFO F (pmoles/min*mg)	MFO M (pmoles/min*mg)
ARY	4621	1534	1818	187	1.39	8.19
ARY	485	304	1659	2589	2.86	29.18
ARY	5128	1435	1420	1748	3.71	6.92
ARY	1007	591	525	2271	2.18	6.70
ARY	732	349	2254	2259	2.78	4.97
ARY	238	327	2892	2892	2.86	7.34
ARY	1682	627	1446	2876	2.74	11.11
ARY	1658	935	440	1321	2.03	26.59
ARY	3669	1100	593	1872	1.80	16.00
ARY	2263	629	1533	2098	1.86	12.30
ARY	3010	610	3670	3921	3.36	13.31
ARY	5842	2105	357	962	3.02	32.24
ARY	8213	2135	401	737	2.37	27.81
ARY	4027	1023	920	2082	3.12	13.88
ARY	4479	997	254	433	3.86	11.10
ARY	4085	959	236	395	1.38	8.82
ARY	3595	837	303	764	1.34	10.32
ARY	6709	1928	470	1899	2.91	53.51
ARY	7769	2221	392	801	2.20	12.04
ARY	9600	3003	309	578	6.24	28.83
ALV	496	400	249	765	2.27	8.07
ALV	2073	921	1320	1649	3.14	23.57
ALV	698	611	605	1118	4.05	7.74
ALV	2230	1437	262	519	1.73	5.11
ALV	1885	738	357	451	2.44	16.94
ALV	1301	797	500	975	2.88	5.59
ALV	1334	988	331	480	1.62	8.73
ALV	895	793	304	620	2.22	18.19
ALV	2106	941	556	1067	2.16	10.83
ALV	1420	704	565	790	2.78	13.13
ALV	336	315	375	495	4.35	11.82
ALV	422	400	459	656	1.84	21.18
ALV	741	673	366	776	2.04	13.06
ALV	676	499	1285	1606	5.14	8.18
ALV	677	657	355	852	2.50	7.22
ALV	735	714	340	674	1.95	8.42
ALV	837	549	606	349	1.05	13.03
ALV	1473	784	664	1141	0.98	8.29
ALV	953	665	313	251	1.38	9.53
ALV	628	461	1036	991	1.46	11.08
ALV	4771	1426	.	.	.	10.70
ALV	5559	1429	.	.	.	9.69
ALV	2234	1177	.	.	.	14.63
ALV	736	431	.	.	.	

STATION	KTM pg/ml	TM pg/ml	TF pg/ml	E2F pg/ml	MFO F (pmoles/min*mg)	MFO M (pmoles/min*mg)
AGI	4008	1925	622	604	2.91	13.45
AGI	1889	931	343	497	7.04	6.98
AGI	2477	1268	1183	2242	1.91	12.16
AGI	4141	1919	667	719	3.98	9.92
AGI	6150	2306	626	871	1.61	11.13
AGI	2727	1108	656	1142	1.48	9.64
AGI	3499	1150	870	1116	1.63	4.65
AGI	3146	1437	1187	1500	2.08	12.76
AGI	3151	1421	135	397	6.84	6.82
AGI	3209	1632	1278	1458	1.41	7.80
AGI	4158	1113	1590	2377	2.95	5.10
AGI	5424	1875	1246	2036	2.34	30.68
AGI	6606	2589	1755	2410	4.32	13.14
AGI	3205	1188	616	631	3.22	8.52
AGI	4496	1611	1144	1395	3.12	14.22
AGI	3679	1341	648	876	2.16	43.16
AGI	4394	1256	441	864	1.93	16.36
AGI	5833	1842	469	713	1.04	36.38
AGI	4282	1402	497	1004	2.77	12.50
AGI	2327	967	740	748	2.71	10.96
AGI	.	.	1294	1693	1.50	
ALW	3984	1194	144	114	3.95	5.31
ALW	2572	777	734	125	2.86	25.34
ALW	2337	833	705	1047	1.82	7.71
ALW	1516	663	456	1740	1.62	2.41
ALW	280	217	667	1203	1.98	1.70
ALW	2665	656	54	1339	2.22	6.22
ALW	2616	838	1013	182	9.16	11.96
ALW	1710	658	912	1980	4.73	15.38
ALW	1821	596	178	1665	3.28	20.46
ALW	2724	751	604	1867	1.98	19.32
ALW	2866	694	772	1017	2.61	5.06
ALW	3766	1159	138	89	3.43	8.74
ALW	2163	549	367	717	3.65	9.99
ALW	2680	732	371	928	2.28	10.50
ALW	1929	467	418	597	1.52	3.18
ALW	1504	657	476	858	1.56	9.40
ALW	1904	573	626	1335	2.67	14.47
ALW	5300	1367	631	709	2.34	10.08
ALW	2289	1130	1414	952	1.91	2.03
ALW	1555	806	688	2154	1.47	
ALW	.	.	538	394	1.77	
ALW	.	.	1135	1322	1.64	
ALW	.	.	927	1308	0.93	

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3.2

AMBIENT BIOLOGICAL MONITORING

AMBIENT BIOLOGICAL MONITORING

Thirty-five stations were sampled during the 2001 sampling season to evaluate benthic macroinvertebrate communities for evidence of impairment due to toxic contamination. Biological monitoring in 2001 was concentrated in the Penobscot and North Coastal River Basins, in keeping with the Land and Water Bureau Five-Year Basin sampling rotation. The station list is essentially unchanged from that proposed in the 2001 SWAT workplan, except for minor substitutions.

Table 3.2.1 summarizes the results of biological monitoring activities for the 2001 SWAT Program, which are sorted by waterbody name. Since waterbodies are sometimes sampled in more than one location, each sampling event was assigned a “Log” number and each sampling station was assigned a “Station Number”, which are listed in Table 3.2.1. Table 3.2.1 also includes a “Map” number for each sampling event. Using the “Map” number and the “Station Number”, locations of each sampling location can be found on Maps 1-15. Individual data reports for each sampling event (Aquatic Life Classification Attainment Reports) are presented following the summary table, temperature graphs, and maps. Use the “Log” number associated with a sampling event to identify the correct Aquatic Life Classification Attainment Report.

Supporting water chemistry data are given in Tables 3.2.2 (Nutrients and Solids) and 3.2.3 (Metals). Water temperature data are given in Figure 3.2.1.

Results Summary

- Thirty-five stations were assessed for the condition of the benthic macroinvertebrate community.
- Ten of the thirty-five stations reported fail to attain aquatic life standards of their assigned class.
- Eighteen of the thirty-five stations exhibit natural aquatic communities (Class A).

Historical Notes

- Birch Stream (previously called Ohio Street Stream; Station 312) did not attain Class B conditions in 1997, 1999, and 2001.
- Penjajawoc Stream (Station 313) did not attain water quality standards in 1997 and 2001.
- Pushaw Stream (Station 311) did not meet water quality standards in 1997. In 2001, there were insufficient data to make a determination because two samples were vandalized.

TABLE 3.2.1 - 2001 SWAT Benthic Macroinvertebrate Biomonitoring Results

Name	Map	Station	Log	Town	Location	Issue[1]	Statutory Class/ Attained Class	Attains Class?	Probable Cause[1]
Allen Stream	1	S308	1044	Exeter	below	Agricultural NPS	B/A	**Y**	Exceeds Class
Babel Brook	2	S305	1001	T5R9 NWP		Reference	A/A	**Y**	
Birch Stream[2]	11	S312	1006	Bangor	below	Urban NPS	B/C	**N**	NPS Toxics; Habitat
Bog Stream	3	S514	1040	T18MD BPP	below	Agricultural NPS/PS	B/C	**N**	
Burnham Brook	1	S506	1046	Garland	below	Agricultural NPS	B/-		Insufficient Data
Chandler River	4	S503	1038	Jonesboro	below	Reference	A/B	**N**	
Crooked Brook	1	S509	1050	Garland	above	Reference	B/A	**Y**	Exceeds Class
Crooked Brook	1	S510	1051	Corinth	below	Agricultural NPS	B/A	**Y**	Exceeds Class
Crooked Stream	5	S500	1035	T30MD BPP		Agricultural NPS	AA/A	**Y**	
East Machias River	6	S494	1026	Crawford		Reference	AA/B	**N**	Lake Outlet Enrichment Effect
Footman Brook	1	S309	1045	Exeter	below	Agricultural NPS	B/A	**Y**	Exceeds Class
French Stream	1	S505	1043	Exeter	below	Agricultural NPS	B/A	**Y**	Exceeds Class
Great Falls Branch	7	S504	1042	Deblois	below	Agricultural NPS	A/C	**N**	Possible NPS Toxics
Kenduskeag Stream	1	S508	1048	Corinth	below	Agricultural NPS	B/A	**Y**	Exceeds Class
Kenduskeag Stream	1	S145	1049	Kenduskeag	below	Agricultural NPS	B/B	**Y**	
Machias River	5	S499	1033	T31MD BPP		Reference	AA/A	**Y**	
Machias River	5	S495	1027	Northfield	below	Agricultural NPS	AA/A	**Y**	
Mill Stream	8	S283	1013	Orrington	below	Agricultural NPS	B/-		Insufficient Data
Mopang Stream	9	S501	1034	T30MD BPP		Reference	AA/A	**Y**	

[1] NPS = non-point source pollution; PS = point source pollution
[2] Birch Stream was previously called Ohio Street Stream

TABLE 3.2.1 - 2001 SWAT Benthic Macroinvertebrate Biomonitoring Results (cont.)

Name	Map	Station	Log	Town	Location	Issue[1]	Statutory Class/ Attained Class	Attains Class?	Probable Cause[1]
Narraguagus River	7	S111	1041	Deblois	above	Reference	AA/A	**Y**	
Narraguagus River	10	S81	1037	Cherryfield	below	Agricultural NPS	B/A	**Y**	Exceeds Class
Penjajawoc Stream	12	S511	1052	Bangor	above	Urban NPS	B/NA	**N**	NPS Toxics; Habitat
Penjajawoc Stream	12	S512	1053	Bangor	below	Urban NPS	B/NA	**N**	NPS Toxics; Habitat
Penjajawoc Stream	12	S314	1054	Bangor	below	Urban NPS	B/NA	**N**	NPS Toxics; Habitat
Penjajawoc Stream	12	S513	1055	Bangor	below	Urban NPS	B/NA	**N**	NPS Toxics; Habitat
Penjajawoc Stream	12	S315	1056	Bangor	below	Urban NPS	B/B	**Y**	
Piper Brook	1	S507	1047	Kenduskeag	below	NPS	B/B	**Y**	
Pleasant River	3	S293	1039	T18MD BPP	below	Agricultural NPS	AA/A	**Y**	
Pollard Brook	13	S485	1014	Edinburg		Reference	B/B	**Y**	
Pushaw Stream	11	S311	1005	Bangor	below	Urban NPS	B/-		Insufficient Data
Reeds Brook	8	S481	1009	Hampden	below	NPS	B/A	**Y**	Exceeds Class
Shaw Brook	14	S480	1008	Bangor	below	Urban NPS	B/C	**N**	NPS Toxics; Habitat
Stinking Brook	2	S306	1002	T5R9 NWP		Reference	A/A	**Y**	
West Branch Narraguagus River	10	S502	1036	Cherryfield	below	Agricultural NPS	AA/A	**Y**	
West Branch Pleasant River	15	S286	1004	KIW	below	NPS; Metals	AA/A	**Y**	Best Professional Judgement

[1] NPS = non-point source pollution

Table 3.2.2 – Nutrients and Solids Data

Log	Waterbody	Collect Date	DOC	Si	NO_3-N	Total P	Total N	NH_4	TSS
			mg/L	mg/L	mg/L N	µg/L	mg/L	mg/L	mg/L
1001	Babel Brook	19-Jul-01	6.5	3.0	0.010	10	0.271	0.03	0.5
1004	W. Br. Pleasant	19-Jul-01	3.1	3.0	0.001	9	0.236	0.03	4.9
1006	Birch Stream[1]	20-Jul-01	3.0	3.2	0.413	27	0.709	0.06	2.2
1008	Shaw Brook	20-Jul-01	6.1	1.4	0.069	16	0.450	0.05	1.0
1009	Reeds Brook	20-Jul-01	6.4	2.5	0.236	14	0.657	0.03	4.9
1026	East Machias River	26-Jul-01	8.1	0.9	0.001	12	0.361	0.03	0.6
1027	Machias River	27-Jul-01	8.0	1.1	0.001	14	0.296	0.03	1.8
1033	Machias River	26-Jul-01	7.4	1.4	0.001	11	0.399	0.03	0.2
1037	Narraguagus River	26-Jul-01	6.4	1.6	0.002	ND	0.306	0.03	0.8
1038	Chandler River	26-Jul-01	10.4	3.4	0.008	28	0.475	0.03	0.2
1041	Narraguagus River	26-Jul-01	6.2	1.7	0.005	11	0.307	0.03	0.2
1043	French Stream	02-Aug-01	8.9	1.7	0.064	24	0.790	0.04	2.3
1044	Allen Stream	01-Aug-01	7.1	1.5	0.445	13	0.911	0.04	1.3
1045	Footman Brook	01-Aug-01	12.4	2.9	0.096	15	0.815	0.04	12.0
1046	Burnham Brook	01-Aug-01	2.2	3.6	0.360	21	0.829	0.04	6.0
1052	Penjajawoc Stream	03-Aug-01	2.1	7.4	0.957	26	1.267	0.03	2.5
1053	Penjajawoc Stream	03-Aug-01	4.9	1.8	0.206	37	0.662	0.05	22.0
1054	Penjajawoc Stream	03-Aug-01	4.4	1.6	0.007	19	0.359	0.02	7.8
1055	Penjajawoc Stream	03-Aug-01	4.4	1.7	0.037	18	0.456	0.04	2.9
1056	Penjajawoc Stream	03-Aug-01	3.5	2.6	0.046	11	0.473	0.04	4.2

DOC = dissolved organic carbon, Si = silicon, NO_3-N = nitrate, Total N = total nitrogen, Total P = total phosphorus, NH_4 = ammonia, and TSS = total suspended solids; ND = no data.

[1] Birch Stream was previously called Ohio Street Stream

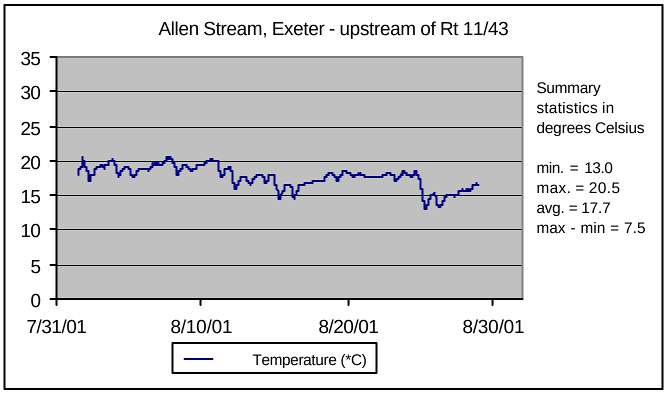
TABLE 3.2.3 – Metal Data

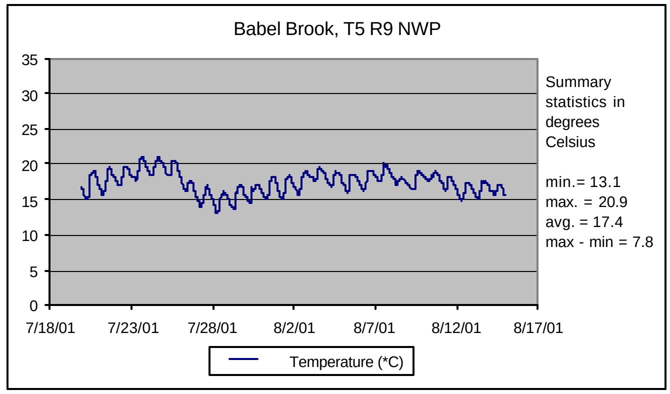
Log	Waterbody	Cd mg/L digest	Cr mg/L digest	Fe mg/L digest	Pb mg/L digest	Zn mg/L digest
1001	Babel Brook	<0.05	0.69	130	<0.50	26.22
1004	W. Br. Pleasant R.	<0.05	1.33	519	<0.50	4.54
1006	Birch Stream[1]	<0.05	0.78	510	<0.50	4.10
1008	Shaw Brook	<0.05	0.61	473	<0.50	8.27
1009	Reeds Brook	<0.05	0.60	460	<0.50	8.89
1026	East Machias River	<0.05	1.39	184	<0.50	2.50
1027	Machias River	<0.05	<0.50	333	<0.50	<1.00
1033	Machias River	<0.05	1.99	233	<0.50	5.39
1037	Narraguagus River	0.37	0.69	368	<0.50	2.57
1038	Chandler River	<0.05	1.05	1267	<0.50	3.91
1041	Narraguagus River	<0.05	<0.50	183	<0.50	2.82
1043	French Stream	<0.05	<0.50	664	<0.50	2.39
1044	Allen Stream	<0.05	<0.50	229	<0.50	<1.00
1045	Footman Brook	0.15	<0.50	416	<0.50	1.07
1046	Burnham Brook	<0.05	<0.50	948	<0.50	3.27
1052	Penjajawoc Stream	<0.05	<0.50	233	<0.50	<1.00
1053	Penjajawoc Stream	<0.05	0.74	1422	<0.50	7.88
1054	Penjajawoc Stream	<0.05	<0.50	722	<0.50	5.74
1055	Penjajawoc Stream	<0.05	<0.50	443	<0.50	3.02
1056	Penjajawoc Stream	<0.05	<0.50	180	<0.50	1.32

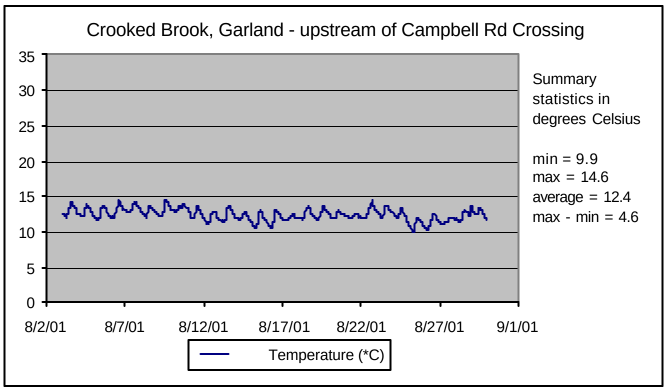
Cd = cadmium, Cr = chromium, Fe = iron, Pb = lead, and Zn = zinc.

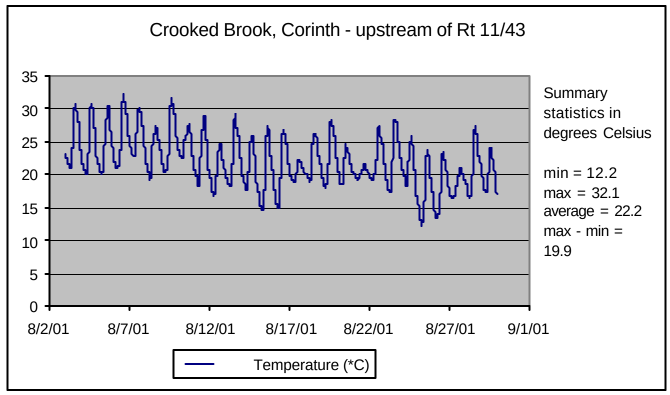
[1] Birch Stream was previously called Ohio Street Stream

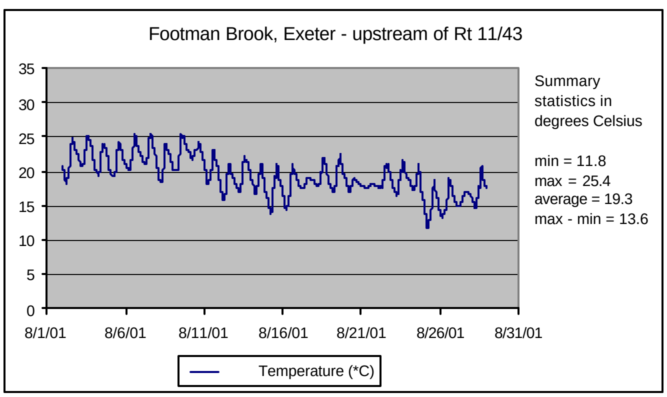
Figure 3.2.1 – In-Stream Temperature Data

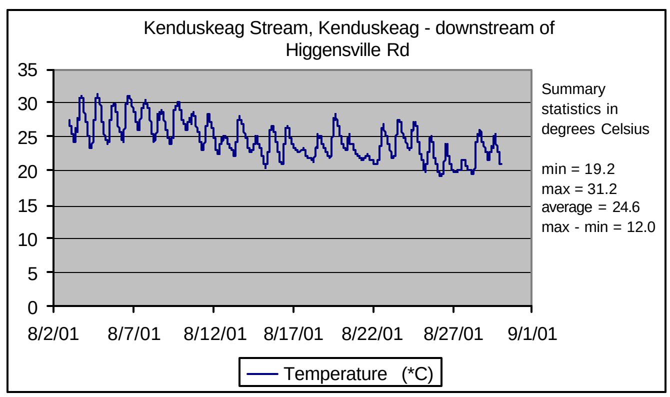


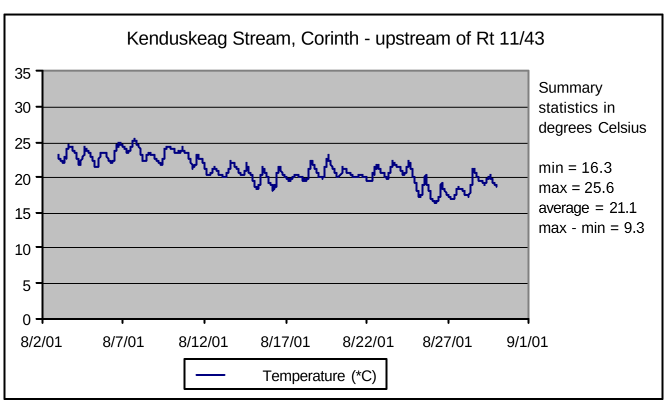












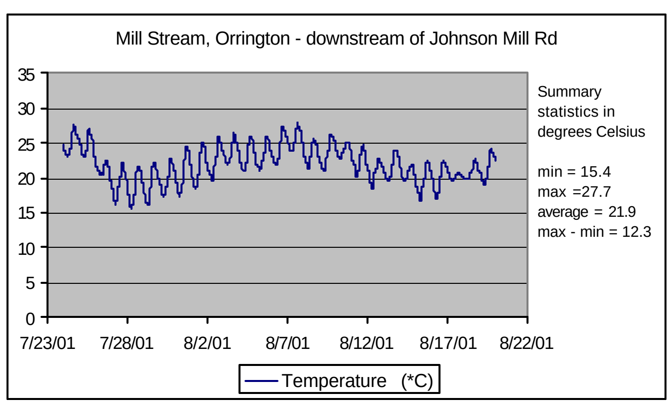
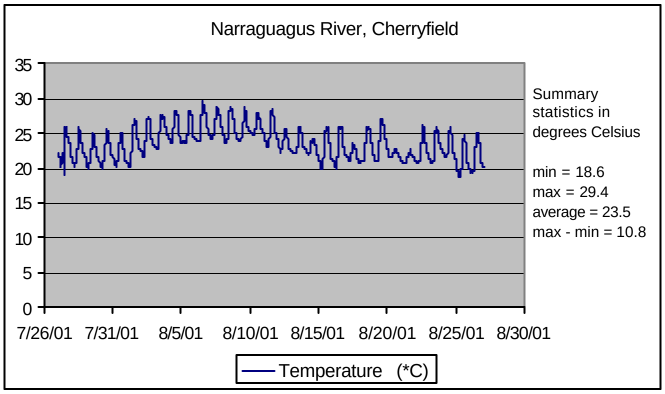
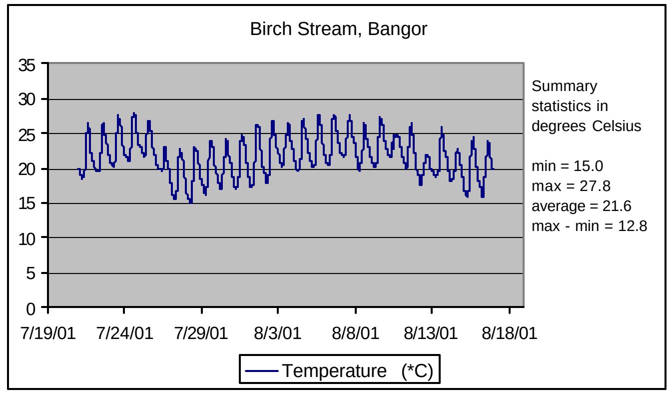
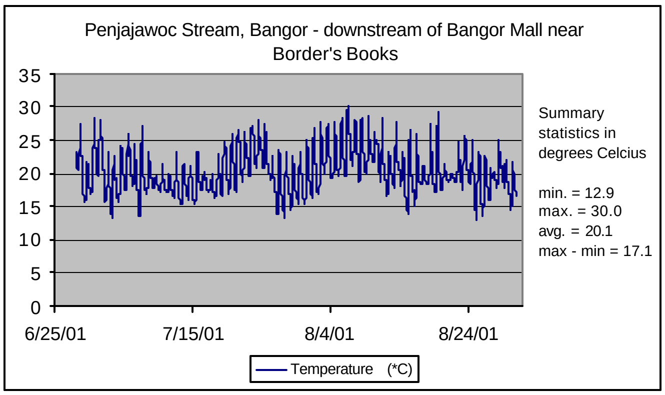
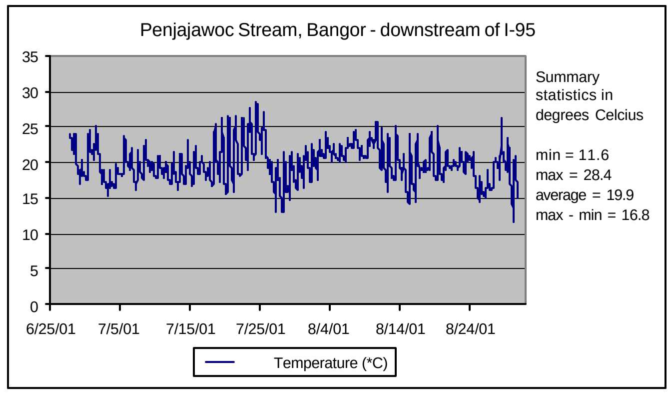


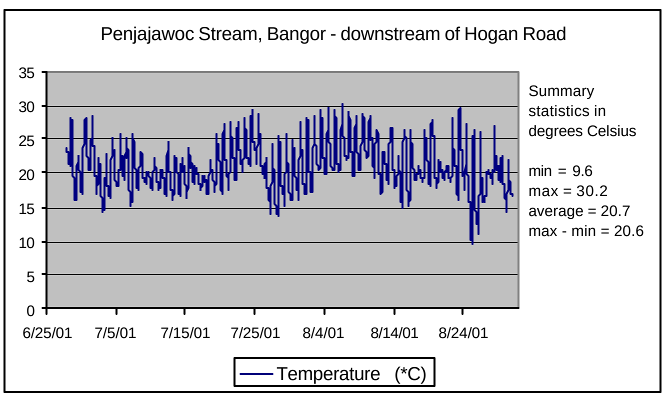
Figure 3.2.1 – In-Stream Temperature Data (Continued)

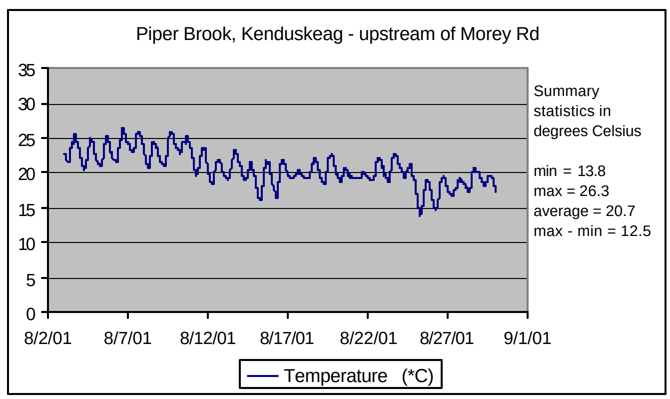


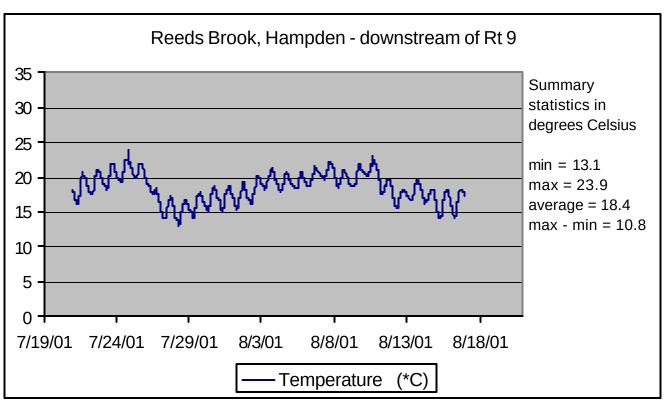


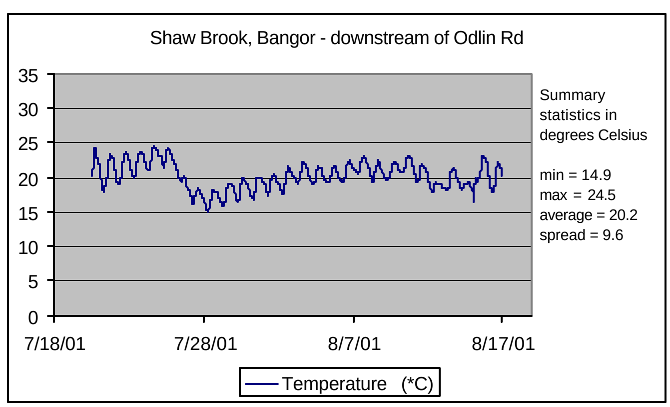




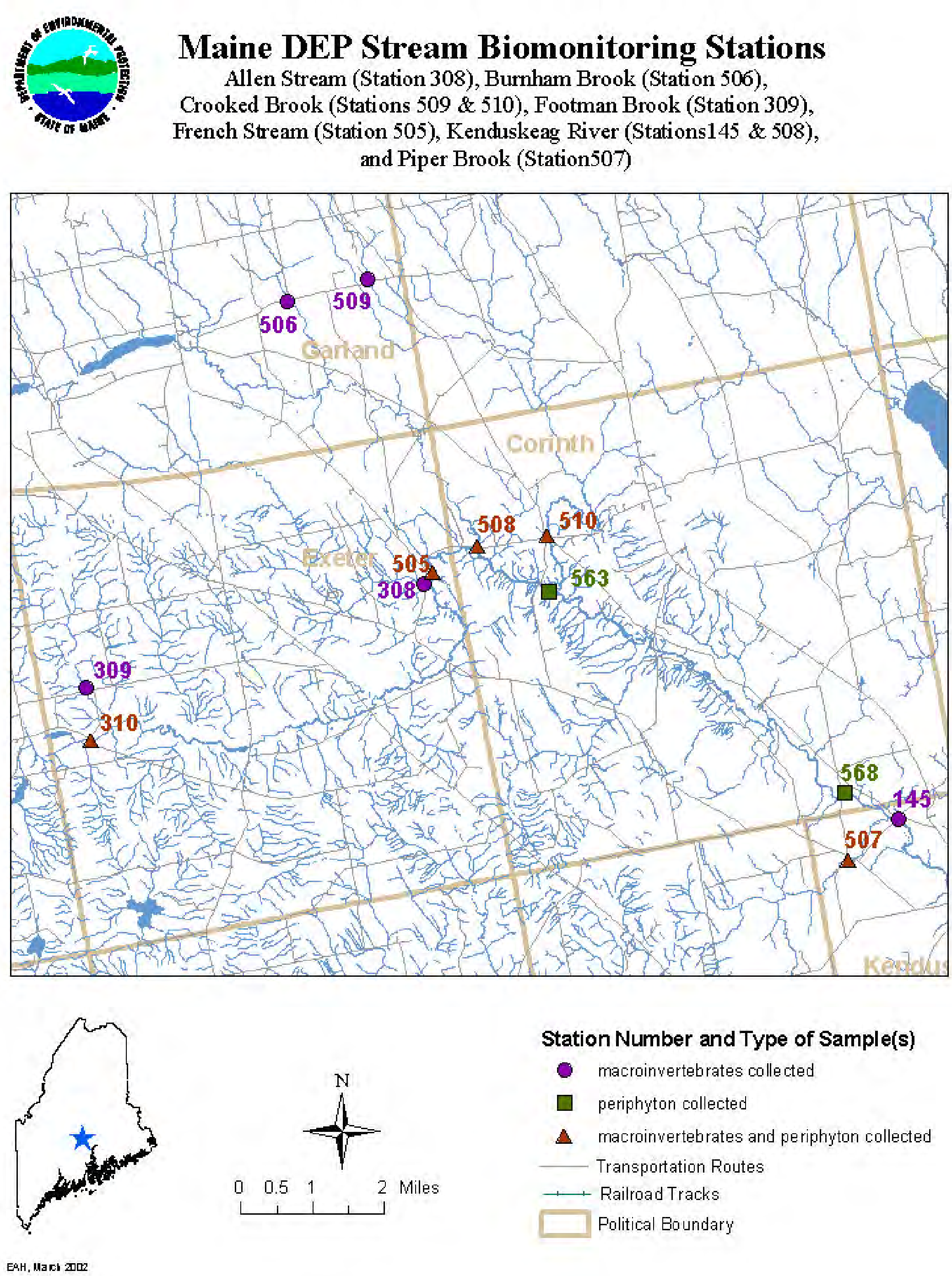




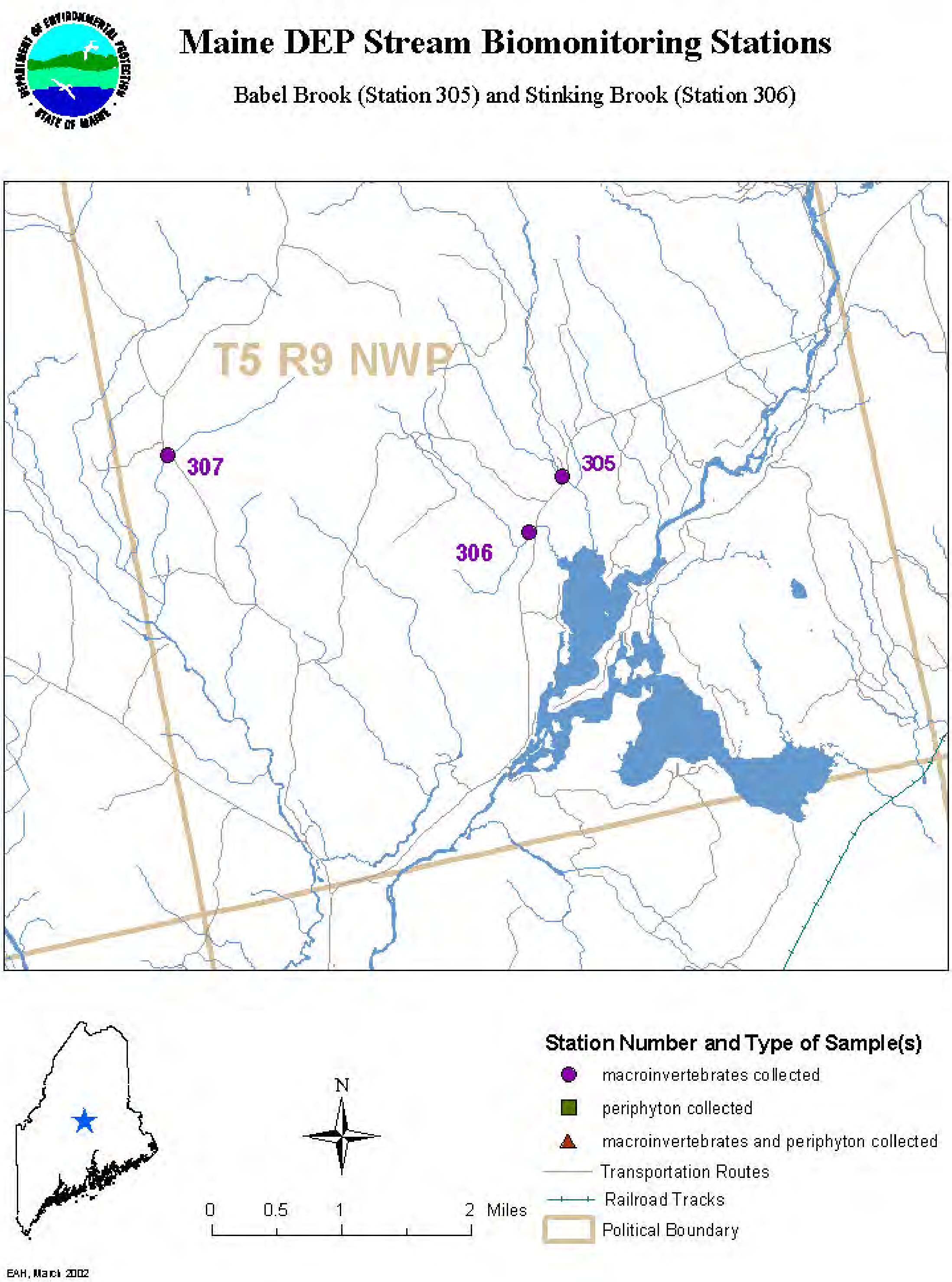




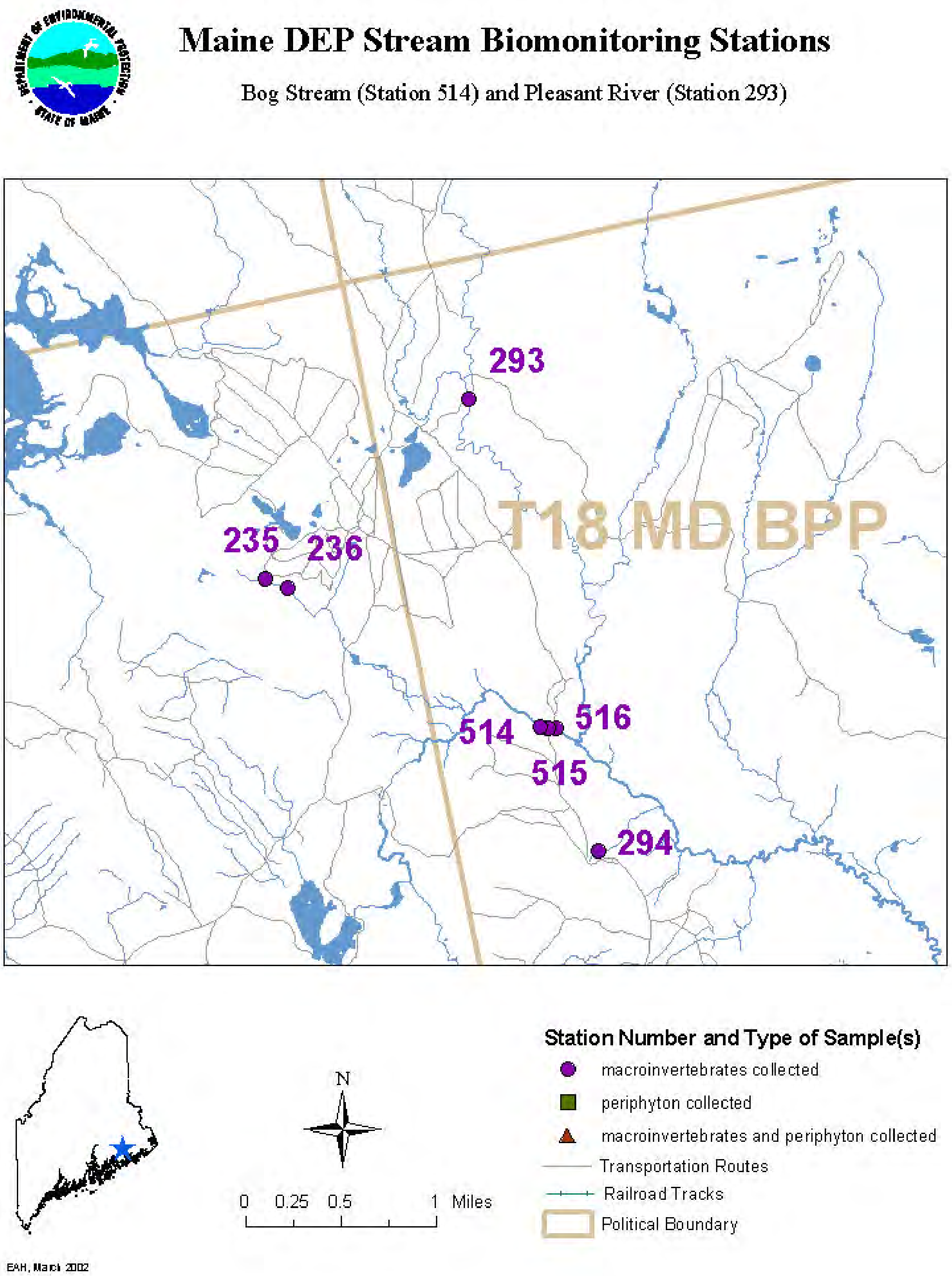
Map 1 – Allen Stream, Burnham Brook, Crooked Brook, Footman Brook, French Stream, Kenduskeag River, and Piper Brook



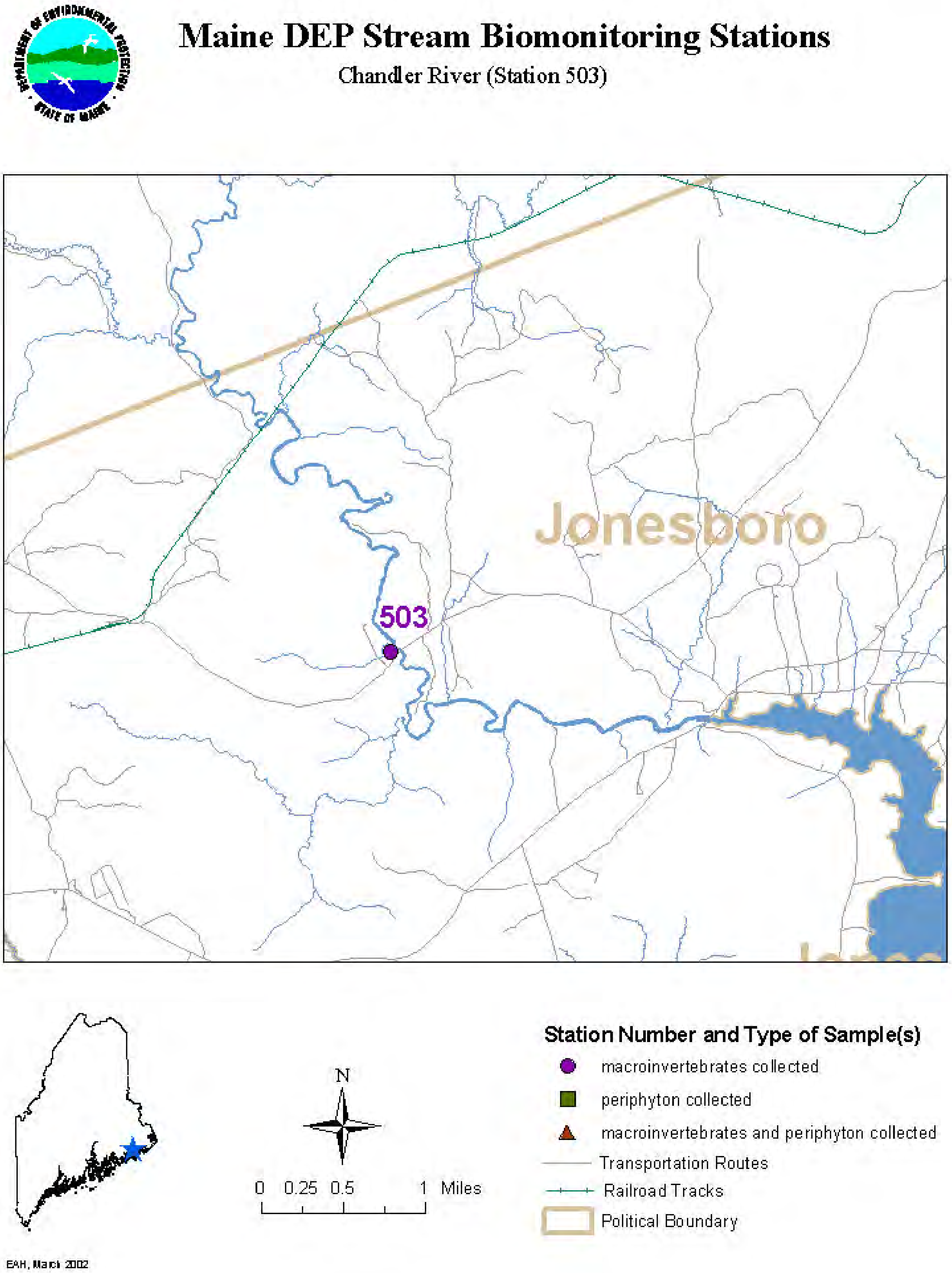
Map 2 – Babel Brook and Stinking Brook



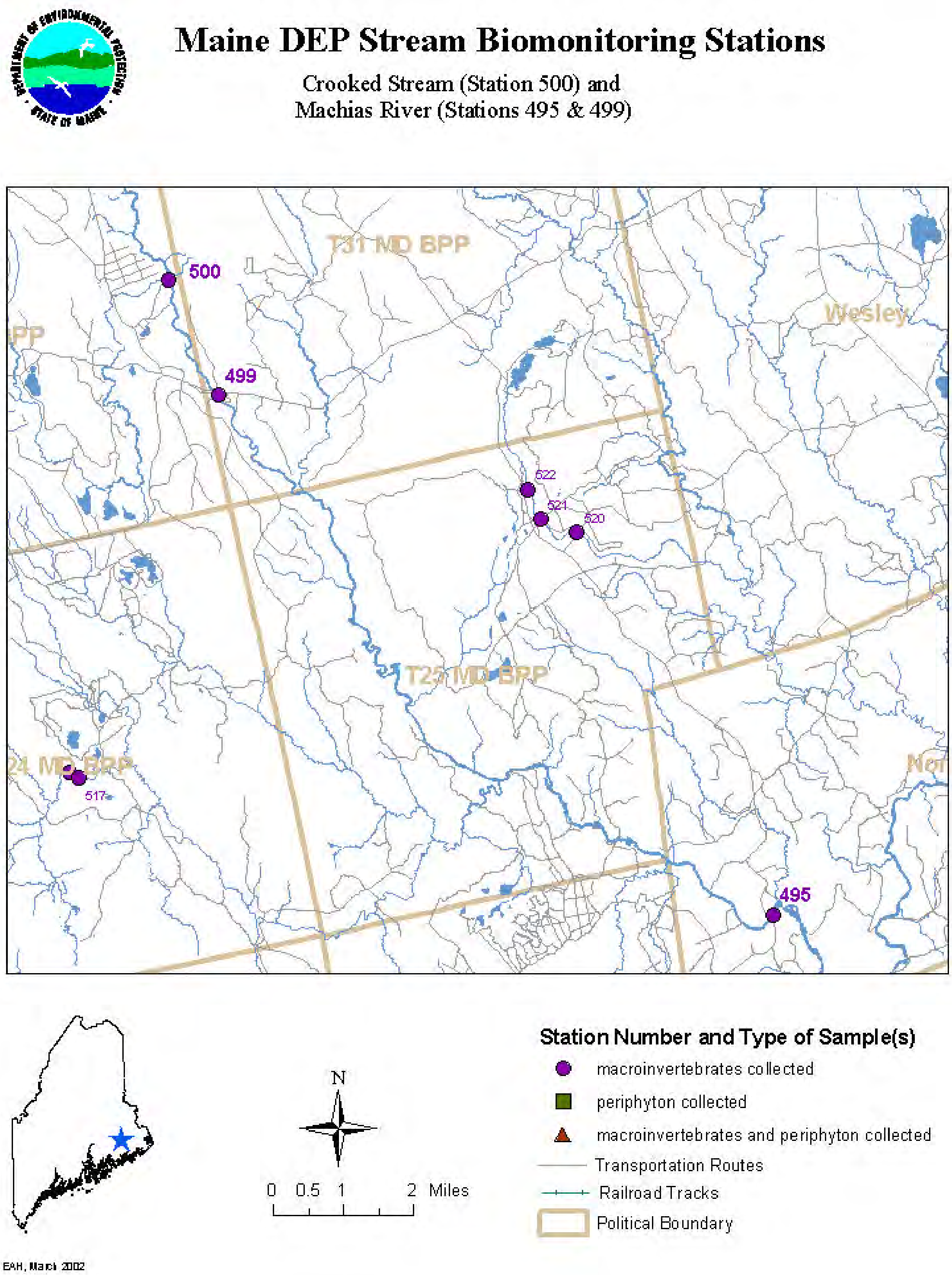
Map 3 – Bog Stream and Pleasant River



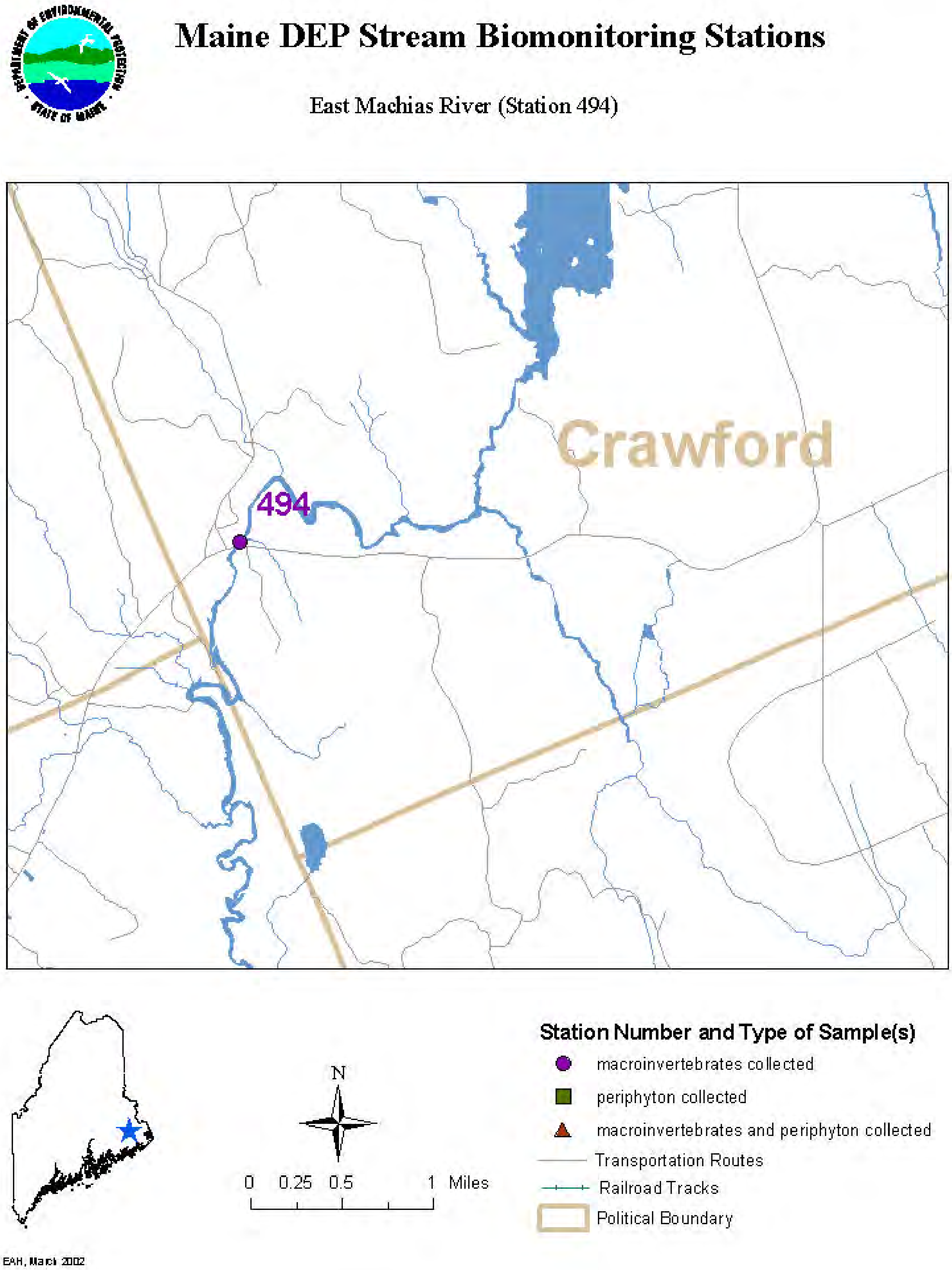
Map 4 – Chandler River



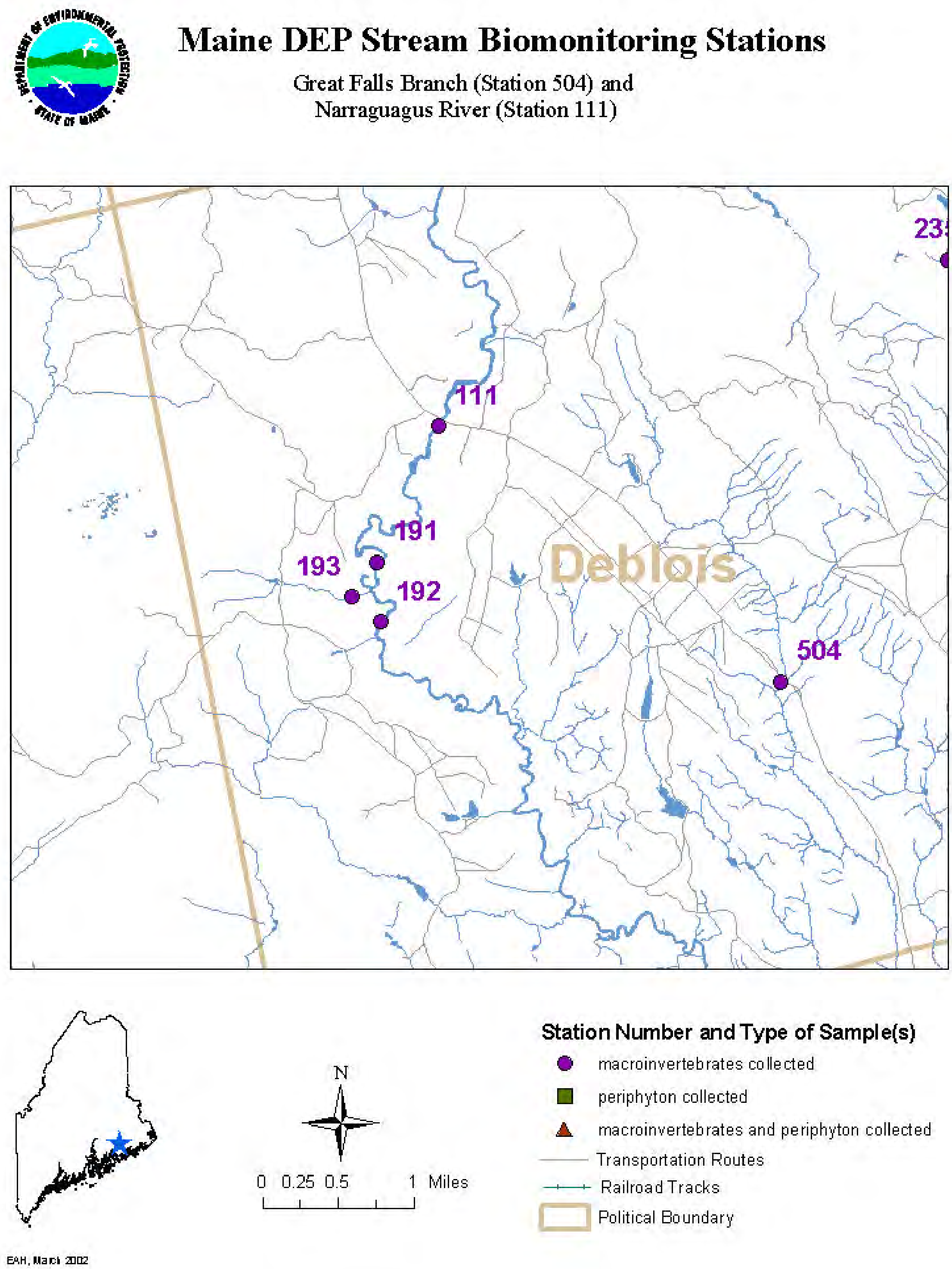
Map 5 – Crooked Stream and Machias River



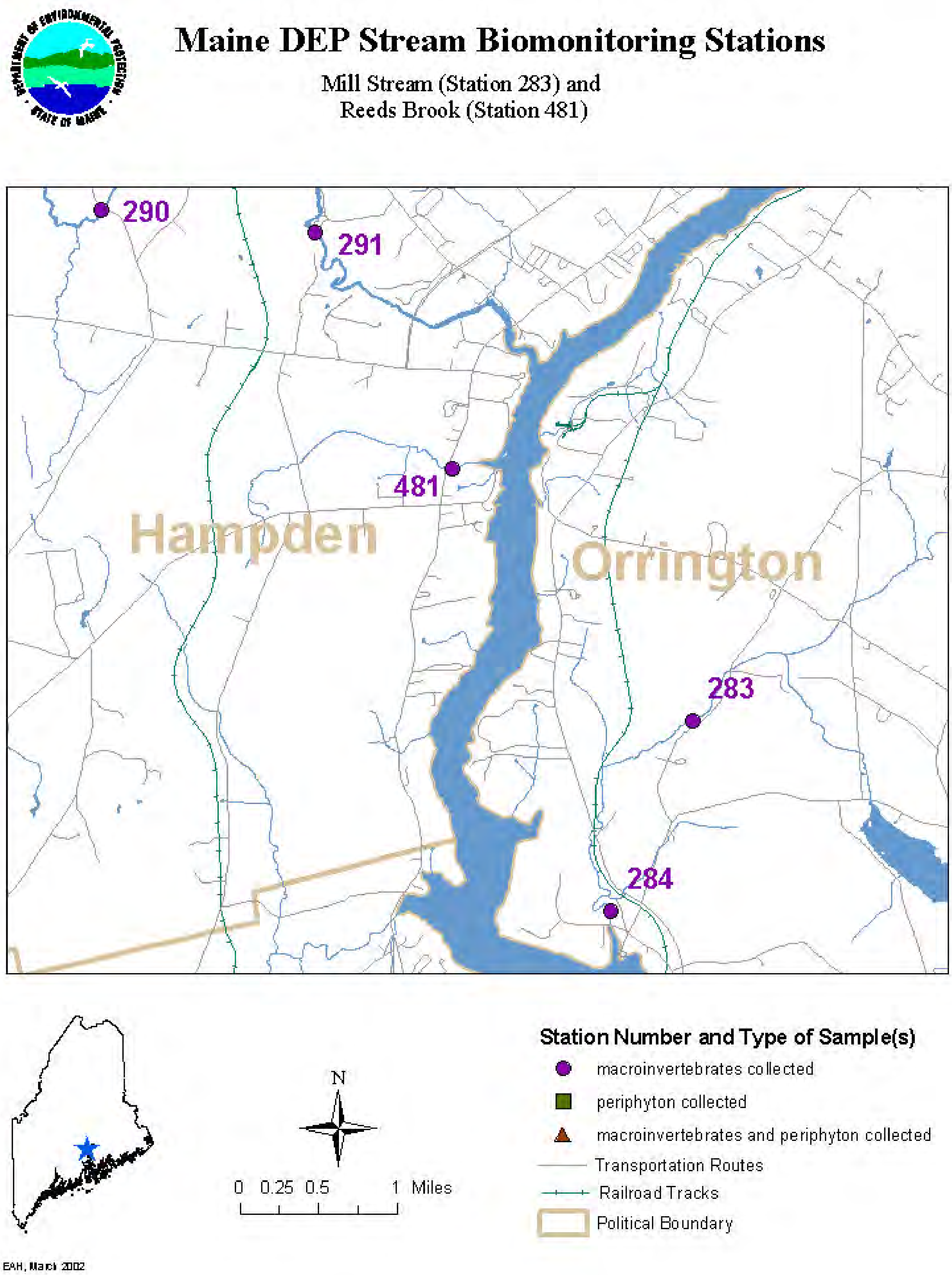
Map 6 – East Machias River



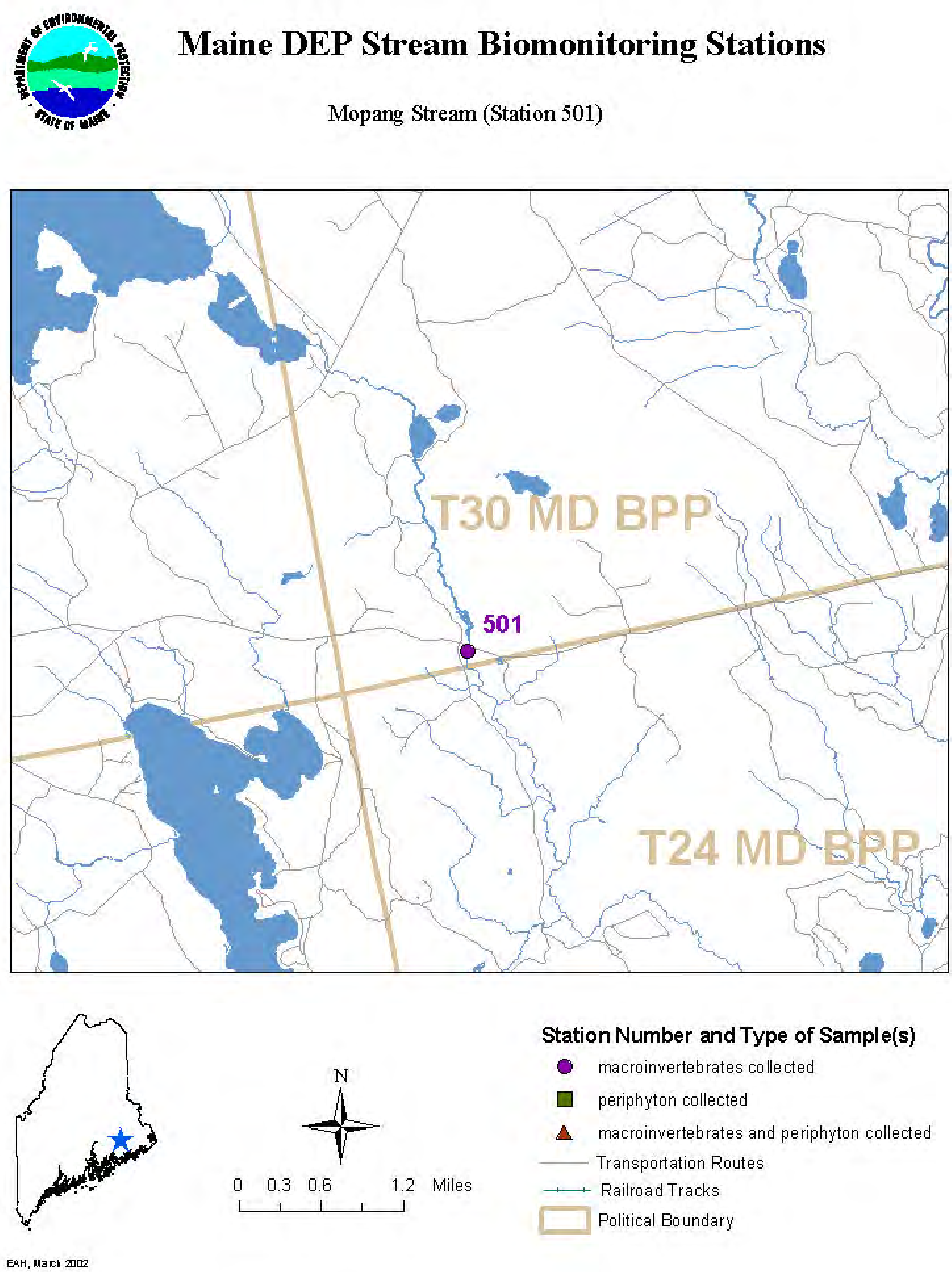
Map 7 – Great Falls Branch and Narraguagus River



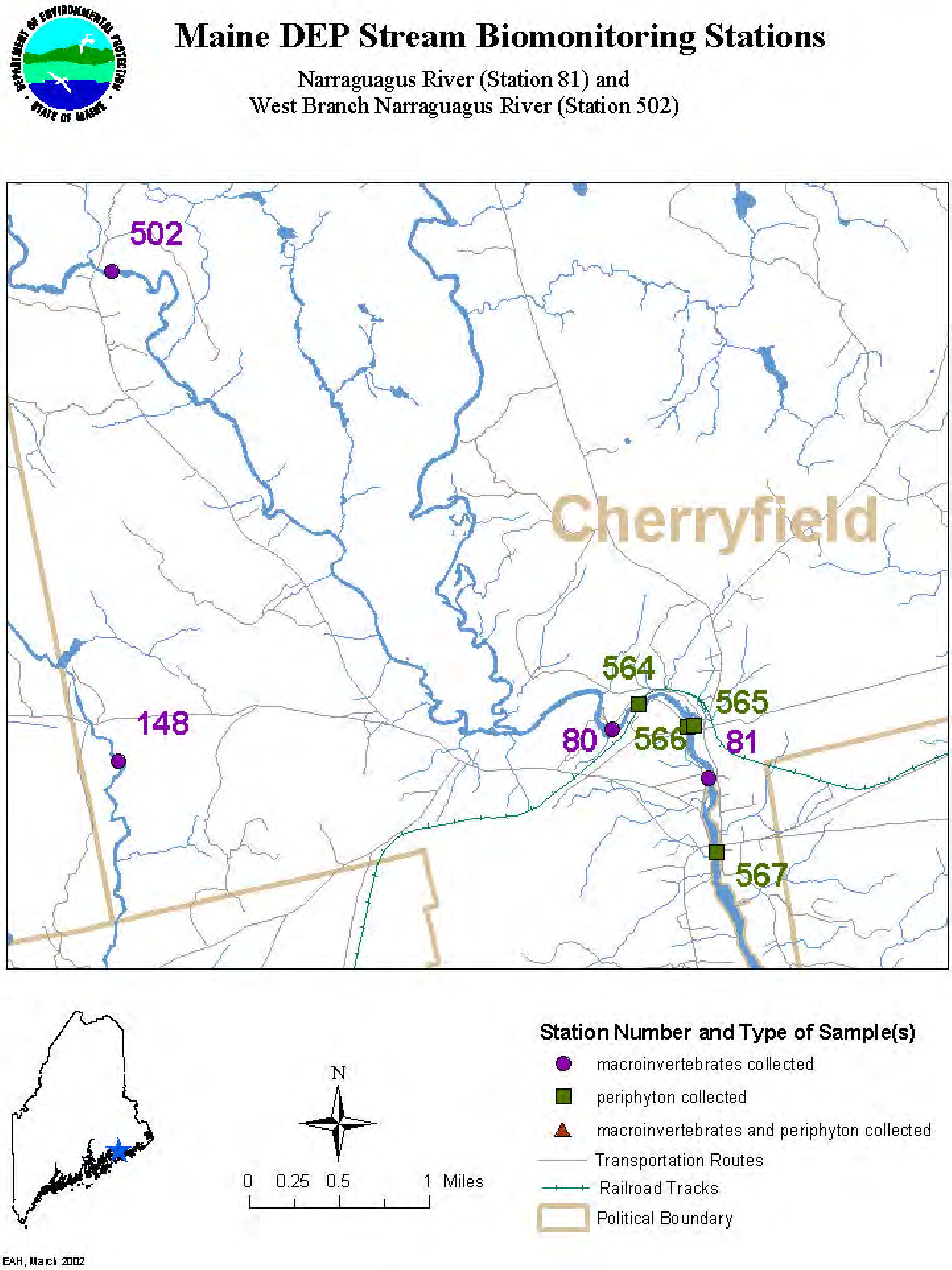
Map 8 – Mill Stream and Reeds Brook



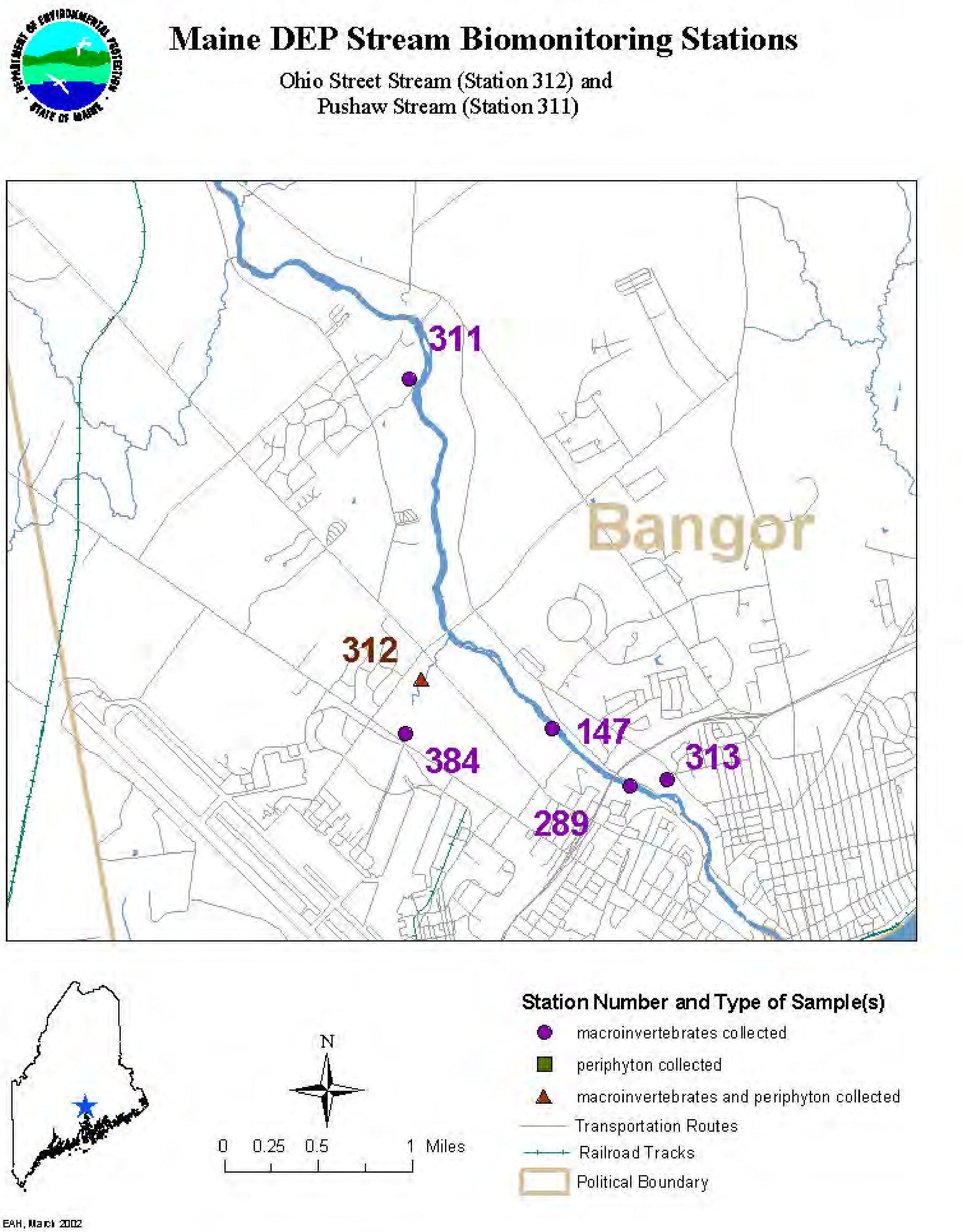
Map 9 – Mopang Stream



Map 10 – Narraguagus River and West Branch Narraguagus River



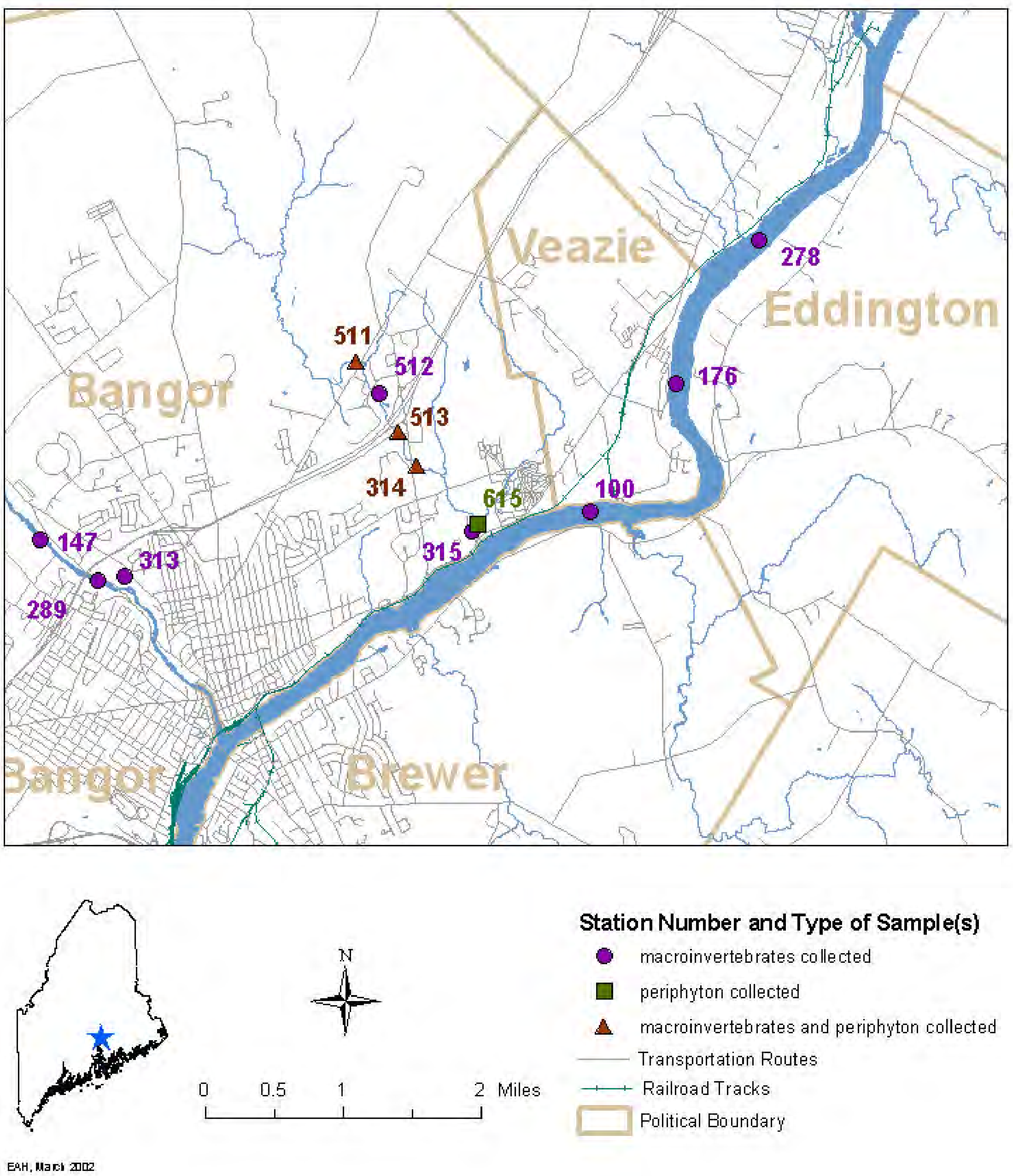
Map 11 – Ohio Street Stream and Pushaw Stream



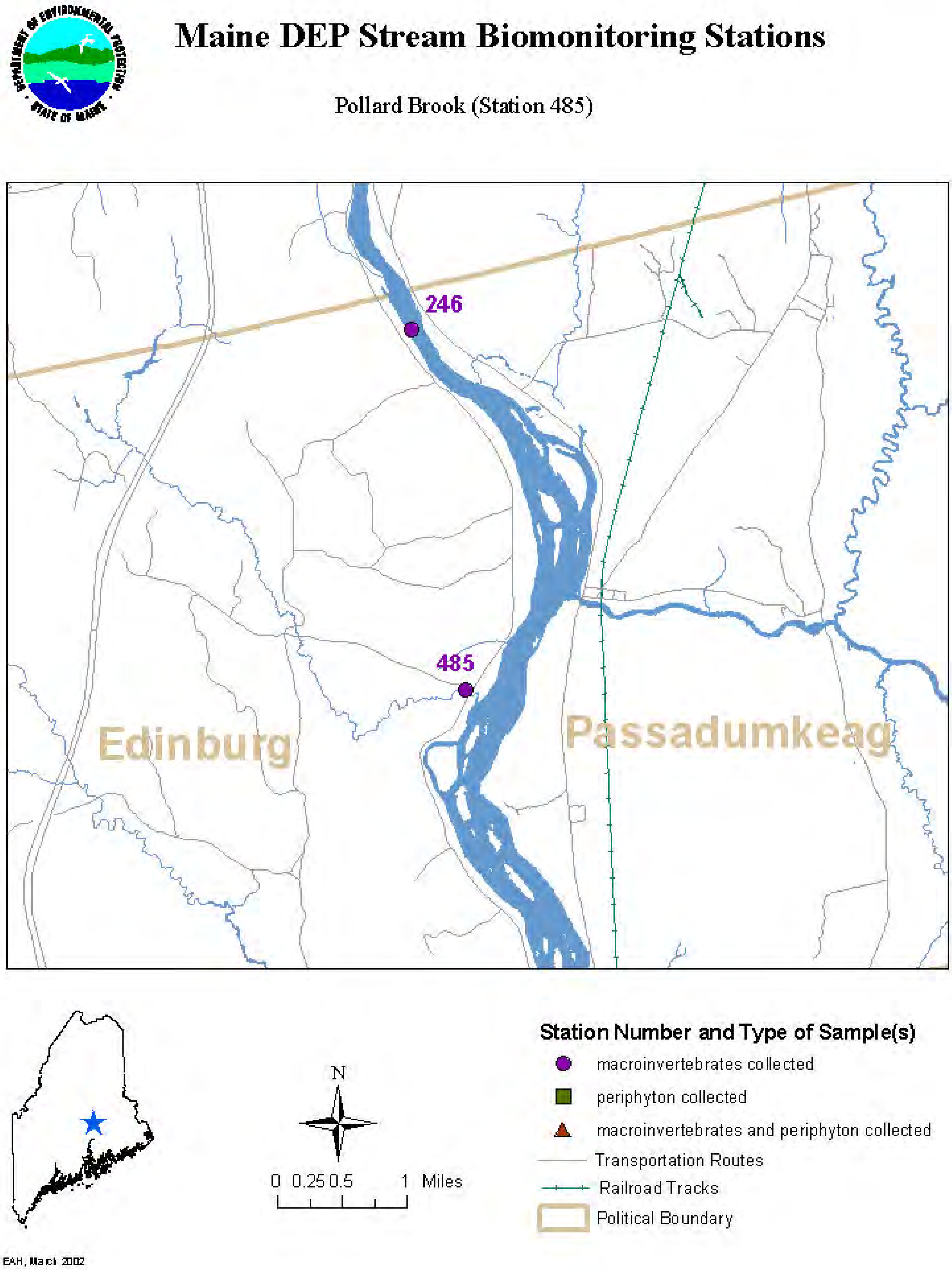
Map 12 – Penjajawoc Stream

Maine DEP Stream Biomonitoring Stations

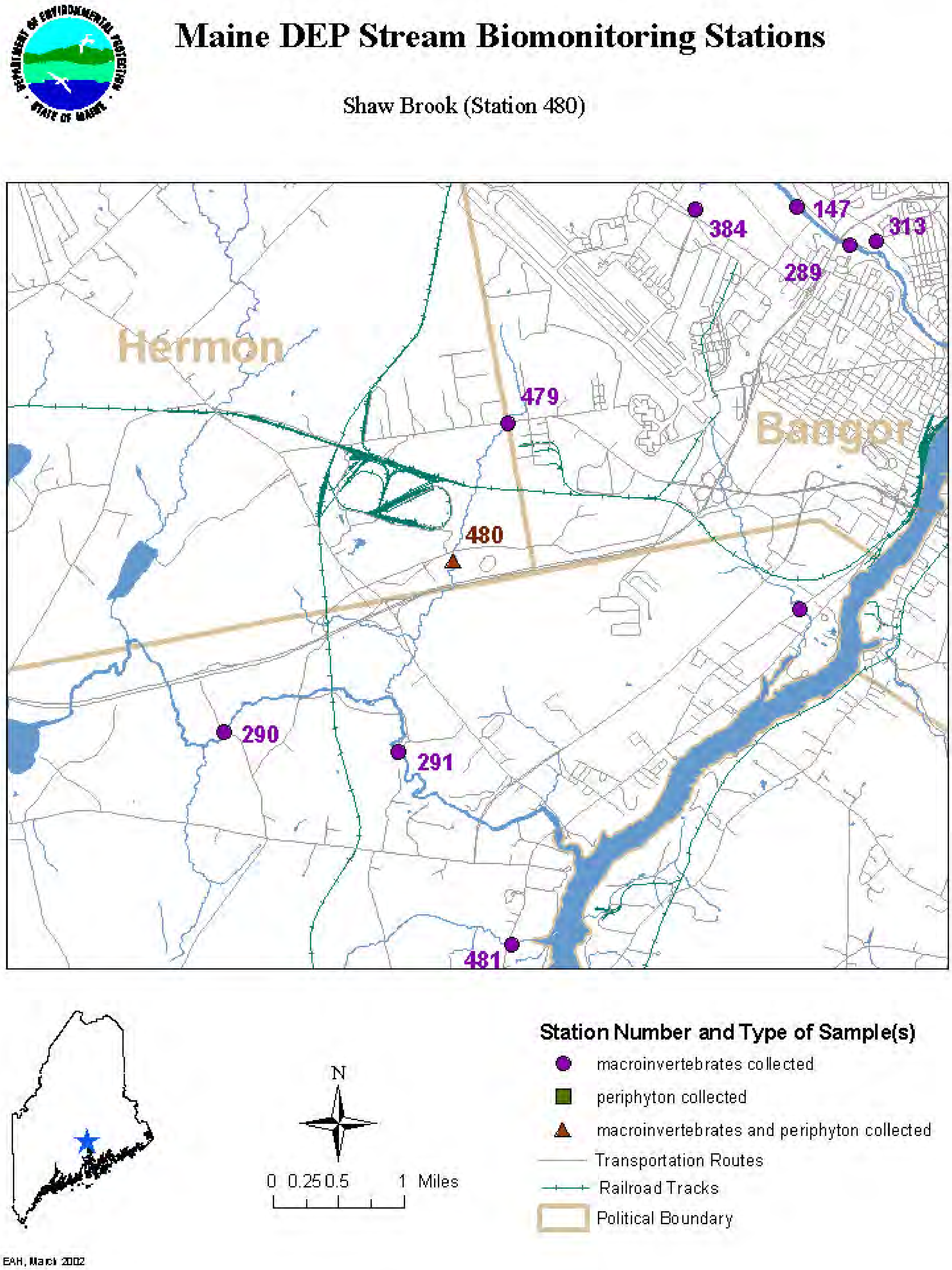
Penjajawoc Stream (Stations 314, 315, & 511-315)



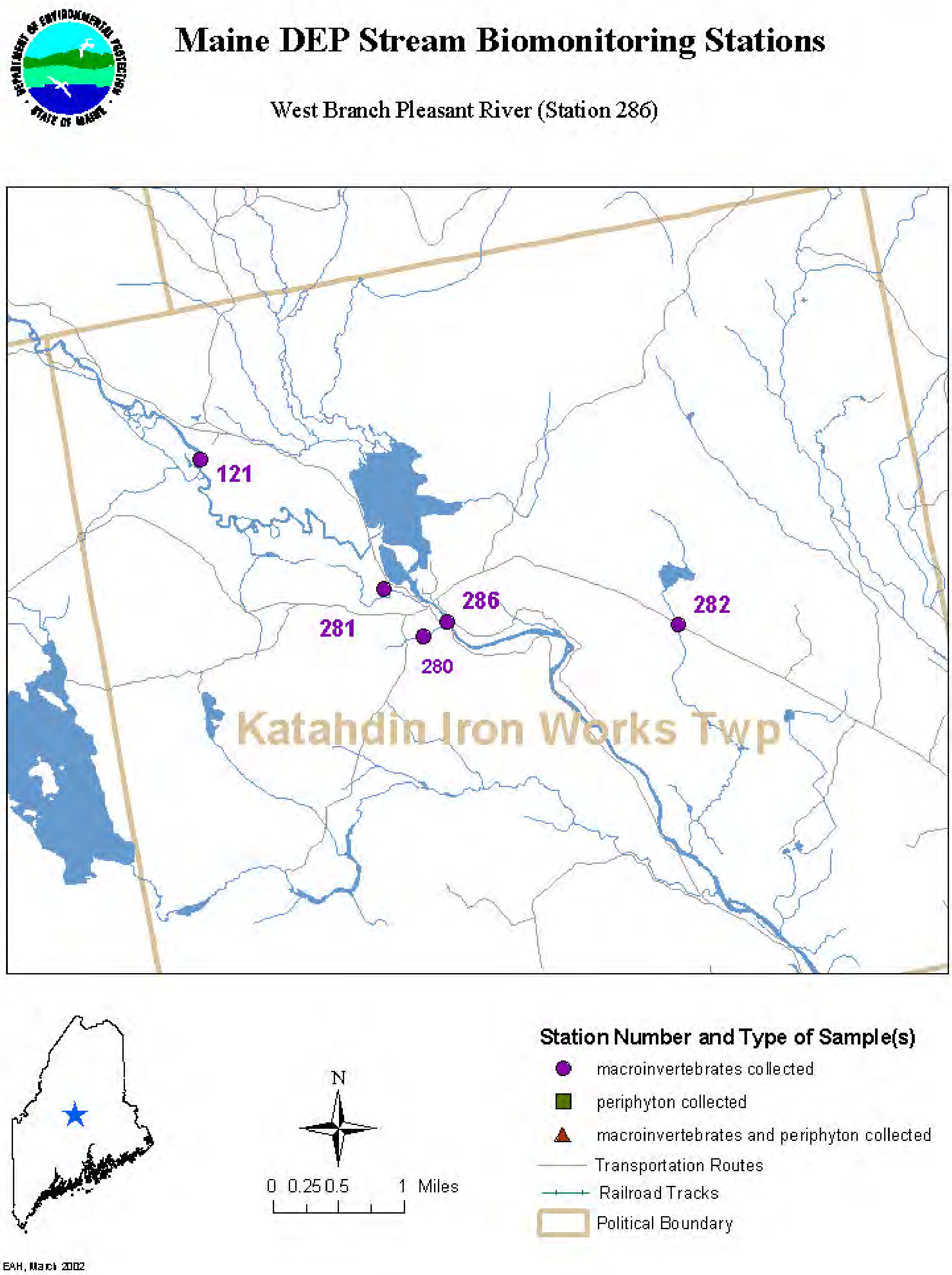
Map 13 – Pollard Brook



Map 14 – Shaw Brook



Map 15 – West Branch Pleasant River



MODULE 4 SPECIAL STUDIES

4.1

SEMI-PERMEABLE MEMBRANE DEVICES

SEMI-PERMEABLE MEMBRANE DEVICES (SPMDS)

SPMDs (SEMI-PERMEABLE MEMBRANE DEVICES)

Semipermeable membrane devices (SPMDs) are passive integrative sampling devices which combine membrane diffusion and liquid-liquid partitioning to concentrate low to moderate molecular mass hydrophobic compounds from water (Huckins et al, 1996). Made of low-density polyethylene lay-flat tubing (2.5 cm wide by 91.4 cm long), containing a thin film of neutral triolein and placed inside stainless steel canisters, SPMDs are deployed in the waterbody where they accumulate contaminants until retrieved.

SPMDs have some features that give them advantages over monitoring contaminants in fish. SPMDs can be deployed in water to accumulate single, pulsed, or continuous contaminant releases over time. SPMDs are anchored to sample at specific locations, thereby avoiding any question of origin of contaminants caused by fish movement. SPMDs do not change function under stress, unlike gills of fish. There are no biotransformations or elimination like that in fish. And accumulation of contaminants does not occur by the same process of uptake in fish, thereby potentially limiting their use to accumulation in a relative sense.When deployed in Maine Rivers for approximately a month, SPMDs are able to sequester enough dioxin/furans for quantification by HRGC/HRMS (Shoven, 2001). SPMD uptake rates have been determined for dioxin/furans in order to calculate dissolved water concentrations (Rantalainen et al, 2000).

There are, however, a number of environmental factors, such as water temperature, biofouling, dissolved organic carbon (DOC), suspended solids, and flow velocity that affect the uptake kinetics of SPMDs.Assuming isotropic exchange kinetics, permeability reference compounds (PRCs) can be added to the SPMD prior to deployment to calibrate the rate change of dioxin/furan uptake caused by environmental conditions (Huckins et al., 2002)

In order to assess the potential of SPMDs to determine if mills are discharging dioxin, DEP has funded studies at the University of Maine Environmental Chemistry Laboratory (formerly the Water Research Institute) since 1999 through the Surface Water Ambient Toxics (SWAT) program. In 1999, the focus was development and refinement of field and laboratory techniques by deploying the SPMDs in the nearby Penobscot River for 3 one-month trials and then retrieving them for laboratory analysis. In 2000, two deployments were made in the Androscoggin River to investigate the effect of time and duration of deployment on biofouling. An above/below trial was also made in both the Androscoggin and Kennebec rivers.

2001

In 2001 the goals were as follows:

1. Validate the deployment scheme and analytical method developed in 2000.
2. Increase the sample size for more statistical power.
3. Decrease the variability between samples to lower the minimal statistical difference and improve the sensitivity of the A/B test.
4. Compare the results from 2000 with 2001.

Site Location

The SPMD field deployments for 2001 were above and below the MeadWestvaco Mill in Rumford from 7/13/01 to 8/10/01 and the International Paper Mill in Jay from 9/22/01 to 10/20/01 on the Androscoggin River. The GPS determined latitude-longitudes for the sites were:

Site	Latitude (DegMinSec)	Longitude (DegMinSec)
Upstream Rumford	N44*31’04”	W70*33’05”
Downstream Rumford	N44*30’10.5”	W70*23’53.3”
Upstream Jay	N44*28’42.4”	W70*16’18.7”
Downstream Jay	N44*29’06.2”	W70*12’13.8”

The Rumford site was chosen to compare the SPMD results from 2001 with those from 2000 at that site. Originally, both 2001 deployments were going to be at the Rumford site. However, due to a shutdown of the MeadWestvaco mill in September, the second deployment was downstream above and below the International Paper mill at Jay. The below sites were a sufficient distance below the mills to ensure proper mixing of the effluent so the dioxin/furans river concentrations were assumed to be at equilibrium.

Deployment Scheme

The Rumford deployment scheme used an elaborate system of surface buoys, ropes and anchors to submerge the SPMD-filled canisters (Shoven, 2001). The system was developed so the canisters would remain approximately 3 feet under the water surface regardless of the water level making sure the canisters avoided contact with the sediment. The deployment consisted of 40 SPMDs in 8 canisters submerged by two buoy systems at each site. Upon retrieval of the SPMDs, one buoy system at the upstream site had been vandalized by one of the buoys being punctured. Those 20 SPMDs had been resting on the bottom for an unknown amount of time. Due to the difficulties at Rumford, the deployment scheme was changed for Jay. In an effort to avoid vandalism, submerged milk jugs were used as floats to keep the canisters upright at ~10 feet above the sediment with a water depth of ~15 feet. There were four sets of submerged milk jugs with two canisters and 10 SPMDs at each site. No vandalism occurred. However, at the upstream site, 3 sets of milk jugs lost buoyancy and six canisters with 30 SPMDs were found near the sediment. The sediment at this site was sand and gravel; therefore, there was probably no contamination of dioxin from the sediments. For each site, appropriate measures were taken to ensure no contamination during transport, deployment, and retrieval. Also, attached to one canister at each site was a HOBO temperature logger to monitor the hourly water temperature throughout the deployment.

Laboratory Methods

All SPMDs and deployment canisters are purchased from Environmental Sampling Technologies, St. Joseph, MO. All standards are purchased from Cambridge Isotope Laboratories, Andover, MA. All solvents are GC-resolve grade.

The Rumford samples were analyzed according to the 2000 procedural method (Shoven, 2001). The procedure consisted of external washing of the SPMD to remove any periphytic growth followed by an injection of carbon-labeled dioxin/furan and PCB standards to accurately quantify the congeners using the isotope dilution method outlined in EPA Method 1613 (Telliard, 1994). After spiking and drying, the samples underwent a two-stage 24 hour dialysis with 150 ml of hexane at sub-ambient temperatures (~18 C?The dialysates of two SPMDs were then combined into one composite sample to make an N=20 composite samples for each site. The samples were cleaned up using acidified silica gel slurry to hydrolyze any remaining lipid after dialysis. Gel permeation chromatography (GPC) was then used as a further clean up before quantification by HRGC/HRMS. Quality control samples consisted of a trip blank for each site, a lab dialysis blank, a lab matrix spike, and a lab procedural blank. Water samples were collected at the beginning and end of each deployment to measure total organic carbon (TOC), dissolved organic carbon (DOC), and specific conductivity.

Due to preliminary results from Rumford, the Jay samples were analyzed differently. The chromatograms for the Rumford deployment had numerous interferents causing quantification problems such as concentration over-estimation or, conversely, non-detection. The physical clean up and the two-stage 24 hour dialysis remained the same. However, the dialysates were combined into composite samples of 5 SPMDs each resulting in an N=8 for each site. Also, the PCB standards were not injected because PCBs are a known interferent during dioxin/furan quantification. The same acidified silica gel slurry and GPC method were performed on the samples, but a fractionation with ENVI-carb reversible tubes from Supelco, Bellafonte, PA was utilized to ensure a better clean up of the samples. The same quality control was performed for the Jay samples.

Results

The results from the 2001 field season were calculated as nanogram of dioxin/furan per kilogram of SPMD. Estimated dissolved dioxin/furan concentrations in the river have yet to be determined for each of the sites. The coefficient of variation (CV) for the

Rumford deployment ranged from 29 to 368% with an average of 92% for all the congeners. The Rumford data are not yet completed (12 of the 40 still have not been quantified). Most of the variation from Rumford originates from an ineffective clean up procedure and laboratory inexperience. The CV for the Jay deployment ranged from 9 to 115% with an average of 42%. However, after removing one statistical outlier (> 2 standard deviations from the mean) from the upstream data and two downstream samples that didn't satisfy EPA Method 1613 quality assurance, the CV ranged from 6% to 38% with an average of 18%. Both data sets have a co-eluting peak with 2,3,7,8-TCDD leading to quantification problems for that congener. The toxic equivalency values (DTE) were determined using the World Health Organization's toxic equivalency factors for mammals.

Concentrations of most congeners were lower below the mills than above (Figures 1 and 2). The comparison between the 2000 and 2001 Rumford deployments show distinct similarities in congener profile for the population of samples with the exception of less non-detections in the 2001 data. However, with the amount of variability present in each set of samples, more validation is needed for that site.

Objectives for 2002

1. Reduce the variability between replicates to facilitate development of a more sensitive A/B test. A coefficient of variation of ~20% is expected.

2. Use PRCs as an *in situ* calibration for varying environmental conditions such as water velocity, temperature, and biofouling.

3. Develop a deployment scheme to eliminate possible vandalism and other logistical problems.

4. Perform a method detection limit study with composites of 4 SPMDs.

Conclusions

Of all the test types (large and small bass, large sucker filets and whole fish, sucker liver composites, freshwater mussels, and SPMDs) tested since 1997, only the fish and livers were able to detect significant differences between stations above and below some bleached kraft pulp and paper mills. MSDs were generally lower for mature or juvenile bass or for suckers depending on station, contaminant and year, but none have attained or consistently approached the goal of an MSD of 10% of background concentrations. SPMDs have not performed as well as fish, but new sampling design and cleanup techniques promise better results. These devices will be tested again along with fish in 2002.

Figure 1. DTE values for 2001 deployments.

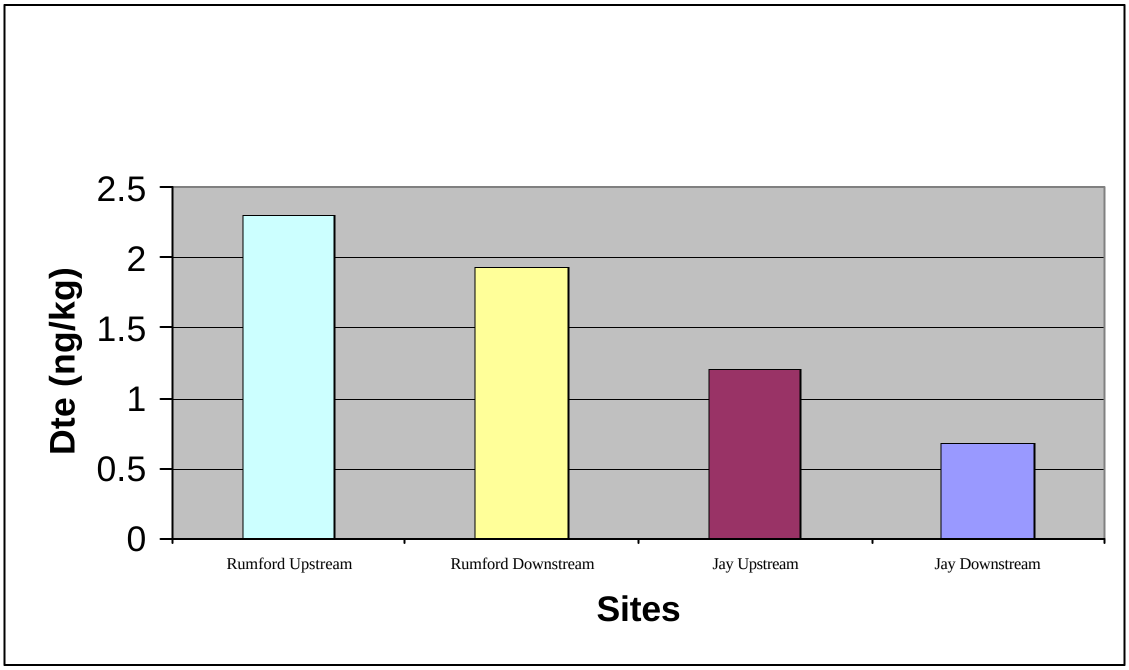
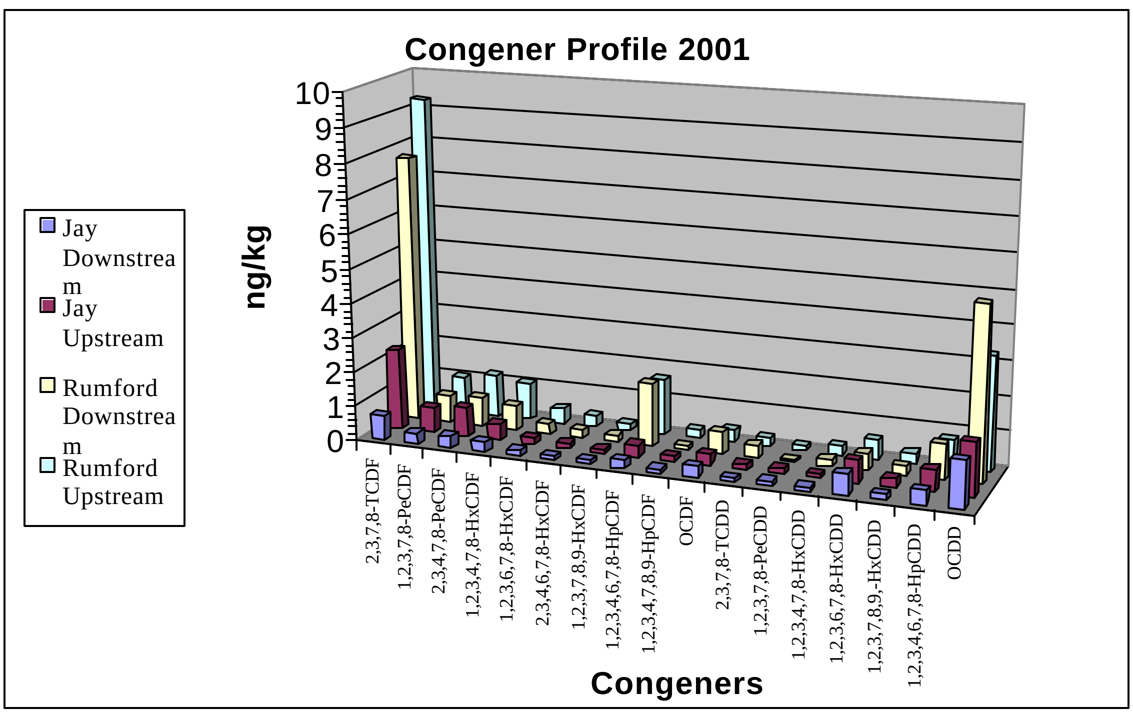


Figure 2. Congener Profile for the 2001 deployments.



Rumford Upstream Data July 2001 N=20 2 SPMDs per sample <DL=0

						Average Temperature		DOC 8/10
						19.34		4.6
Congener	MDL*	SPMD 21	SPMD 22	SPMD 23	SPMD 24	SPMD 25	SPMD 26	SPMD 33
2,3,7,8-TCDF	0.8		11.815	7.814	11.072	8.941		
1,2,3,7,8-PeCDF	2.08		0.626	0.838	1.363	0.612		
2,3,4,7,8-PeCDF	3.13		1.069	1.229	1.148	1.036		
1,2,3,4,7,8-HxCDF	2.59		1.228	0.990	0.934	1.064		
1,2,3,6,7,8-HxCDF	2.46		0.340	0.306	0.557	0.427		
2,3,4,6,7,8-HxCDF	2.88		0.201	0.386	0.342	0.286		
1,2,3,7,8,9-HxCDF	1.68		0.130	0.183	0.135	0.221		
1,2,3,4,6,7,8-HpCDF	2.65		0.390	1.173	0.164	2.896		
1,2,3,4,7,8,9-HpCDF	1.56		0.000	0.108	0.000	0.200		
OCDF	7.18		0.000	0.401	0.000	0.704		
2,3,7,8-TCDD	2.1		0.219	0.243	0.198	0.222		
1,2,3,7,8-PeCDD	2.14		0.166	0.000	0.163	0.088		
1,2,3,4,7,8-HxCDD	3.08		0.195	0.277	0.288	0.287		
1,2,3,6,7,8-HxCDD	1.22		0.611	0.573	0.930	0.506		
1,2,3,7,8,9,-HxCDD	2.84		0.000	0.247	0.355	0.362		
1,2,3,4,6,7,8-HpCDD	2.31		1.077	0.825	0.757	0.876		
OCDD	6.7		3.938	2.056	5.764	3.944		
TEQ			2.418	1.998	2.474	2.108		

			DOC 7/17	TOC 7/17	Sp. Cond.	Flow 7/13		
			4.5042	4.5066	55.57	1.8		
Congener	MDL*	SPMD 27	SPMD 28	SPMD 29	SPMD 30	SPMD 31	SPMD 32	SPMD 39
2,3,7,8-TCDF	0.8			0.000		11.079	10.818	12.083
1,2,3,7,8-PeCDF	2.08			1.741		1.159	0.793	2.765
2,3,4,7,8-PeCDF	3.13			1.539		1.381	0.764	2.789
1,2,3,4,7,8-HxCDF	2.59			1.077		0.987	0.964	2.163
1,2,3,6,7,8-HxCDF	2.46			0.430		0.287	0.277	1.316
2,3,4,6,7,8-HxCDF	2.88			0.308		0.240	0.168	1.126
1,2,3,7,8,9-HxCDF	1.68			0.046		0.124	0.060	1.220
1,2,3,4,6,7,8-HpCDF	2.65			3.051		1.377	1.770	2.398
1,2,3,4,7,8,9-HpCDF	1.56			0.000		0.127	0.126	1.028
OCDF	7.18			0.000		0.000	0.000	1.979
2,3,7,8-TCDD	2.1			0.344		0.263	0.305	0.419
1,2,3,7,8-PeCDD	2.14			0.077		0.029	0.016	0.629
1,2,3,4,7,8-HxCDD	3.08			0.000		0.216	0.029	1.227
1,2,3,6,7,8-HxCDD	1.22			0.190		0.367	0.204	1.484
1,2,3,7,8,9,-HxCDD	2.84			0.048		0.270	0.136	1.324
1,2,3,4,6,7,8-HpCDD	2.31			0.000		0.694	0.535	1.461
OCDD	6.7			2.291		2.135	2.472	3.766
TEQ		0	0	1.518		2.420	2.033	4.824

M/z ion ratio data flags, DPE,co-elution etc.

Surrogate recovery data flags

Both M/z ratio and Surrogate Recovery data flags

* MDL from Heather's work

Major problems with pentachlorinated dioxin/furans

Rumford Upstream Data July 20		TOC 8/10	Sp. Cond.	Flow 8/10		
		4.5	61.8	0.5		
Congener	MDL*	SPMD 34	SPMD 35	SPMD 36	SPMD 37	SPMD 38
2,3,7,8-TCDF	0.8				12.816	13.735
1,2,3,7,8-PeCDF	2.08				0.153	1.205
2,3,4,7,8-PeCDF	3.13				0.440	1.621
1,2,3,4,7,8-HxCDF	2.59				1.004	1.155
1,2,3,6,7,8-HxCDF	2.46				0.279	0.236
2,3,4,6,7,8-HxCDF	2.88				0.261	0.158
1,2,3,7,8,9-HxCDF	1.68				0.096	0.026
1,2,3,4,6,7,8-HpCDF	2.65				1.480	1.853
1,2,3,4,7,8,9-HpCDF	1.56				0.208	0.898
OCDF	7.18				0.283	0.223
2,3,7,8-TCDD	2.1				0.241	0.241
1,2,3,7,8-PeCDD	2.14				0.000	0.009
1,2,3,4,7,8-HxCDD	3.08				0.110	0.051
1,2,3,6,7,8-HxCDD	1.22				0.488	0.486
1,2,3,7,8,9,-HxCDD	2.84				0.134	0.066
1,2,3,4,6,7,8-HpCDD	2.31				0.881	0.842
OCDD	6.7				3.309	2.501
TEQ		0	0	0	2.013	2.749

Congener	MDL*	SPMD 40	Mean	Std. Dev.	%RSD
2,3,7,8-TCDF	0.8	1.623	9.254	4.500	48.621
1,2,3,7,8-PeCDF	2.08	0.176	1.039	0.748	72.002
2,3,4,7,8-PeCDF	3.13	0.351	1.215	0.662	54.474
1,2,3,4,7,8-HxCDF	2.59	0.445	1.092	0.407	37.313
1,2,3,6,7,8-HxCDF	2.46	0.314	0.434	0.307	70.795
2,3,4,6,7,8-HxCDF	2.88	0.254	0.339	0.270	79.676
1,2,3,7,8,9-HxCDF	1.68	0.147	0.217	0.338	155.455
1,2,3,4,6,7,8-HpCDF	2.65	1.307	1.624	0.915	56.330
1,2,3,4,7,8,9-HpCDF	1.56	0.120	0.256	0.358	140.042
OCDF	7.18	0.504	0.372	0.586	157.355
2,3,7,8-TCDD	2.1	0.130	0.257	0.077	29.938
1,2,3,7,8-PeCDD	2.14	0.206	0.126	0.182	145.091
1,2,3,4,7,8-HxCDD	3.08	0.162	0.258	0.338	130.647
1,2,3,6,7,8-HxCDD	1.22	0.194	0.549	0.380	69.201
1,2,3,7,8,9,-HxCDD	2.84	0.224	0.288	0.364	126.607
1,2,3,4,6,7,8-HpCDD	2.31	0.686	0.785	0.355	45.264
OCDD	6.7	4.270	3.313	1.153	34.803
TEQ		0.878	2.312	0.977	42.251

M/z ion ratio data flags, DPE,co-elution etc.
Surrogate recovery data flags
Both M/z ratio and Surrogate Recovery data flags
* MDL from Heather's work
# Major problems with pentachlorinated dioxin/furans

Rumford Downstream Data July 2001 N=20 2 SPMDs per sample <DL=0

						Average Temperature		DOC 8/10
						23.7909		6.2
Congener	MDL*	SPMD 1	SPMD 2	SPMD 3	SPMD 4	SPMD 5	SPMD 6	SPMD 13
2,3,7,8-TCDF	0.8			7.110	11.622	10.874	2.113	4.733
1,2,3,7,8-PeCDF	2.08			0.873	1.573	0.490	0.261	0.160
2,3,4,7,8-PeCDF	3.13			0.466	0.630	1.025	0.278	1.782
1,2,3,4,7,8-HxCDF	2.59			0.734	0.690	0.495	0.220	0.611
1,2,3,6,7,8-HxCDF	2.46			0.254	0.471	0.187	0.260	0.164
2,3,4,6,7,8-HxCDF	2.88			0.150	0.415	0.175	0.316	0.146
1,2,3,7,8,9-HxCDF	1.68			0.094	0.183	0.035	0.209	0.040
1,2,3,4,6,7,8-HpCDF	2.65			1.765	0.388	1.896	1.022	2.218
1,2,3,4,7,8,9-HpCDF	1.56			0.134	0.067	0.000	0.000	0.023
OCDF	7.18			0.650	0.000	0.000	0.547	0.569
2,3,7,8-TCDD	2.1			0.341	0.343	0.296	0.040	0.503
1,2,3,7,8-PeCDD	2.14			0.000	0.000	0.084	0.000	0.000
1,2,3,4,7,8-HxCDD	3.08			0.076	0.175	0.150	0.318	0.063
1,2,3,6,7,8-HxCDD	1.22			0.193	0.660	0.554	0.522	0.209
1,2,3,7,8,9,-HxCDD	2.84			0.239	0.314	0.318	0.237	0.226
1,2,3,4,6,7,8-HpCDD	2.31			0.948	1.537	0.872	0.522	0.938
OCDD	6.7			5.193	8.310	4.864	3.756	6.087
TEQ		0	0	1.532	2.211	2.224	0.627	2.054

			DOC 7/17	TOC 7/17	Sp. Cond.	Flow 7/13		
			6.0332	6.2299	95.26	2.6		
Congener	MDL*	SPMD 7	SPMD 8	SPMD 9	SPMD 10	SPMD 11	SPMD 12	SPMD 19
2,3,7,8-TCDF	0.8	12.966	9.503	7.640	9.915	7.505	6.803	
1,2,3,7,8-PeCDF	2.08	1.422	1.060	0.606	0.988	0.603	0.145	
2,3,4,7,8-PeCDF	3.13	1.367	0.331	0.924	1.151	2.554	0.000	
1,2,3,4,7,8-HxCDF	2.59	1.068	1.428	0.649	0.703	0.933	0.514	
1,2,3,6,7,8-HxCDF	2.46	0.177	0.342	0.186	0.179	0.245	0.186	
2,3,4,6,7,8-HxCDF	2.88	0.147	0.279	0.102	0.189	0.199	0.156	
1,2,3,7,8,9-HxCDF	1.68	0.038	0.141	0.027	0.115	0.143	0.031	
1,2,3,4,6,7,8-HpCDF	2.65	3.068	2.247	1.408	1.573	2.114	1.707	
1,2,3,4,7,8,9-HpCDF	1.56	0.124	0.250	0.000	0.099	0.000	0.039	
OCDF	7.18	0.000	0.679	0.366	4.036	0.000	0.531	
2,3,7,8-TCDD	2.1	0.253	0.397	0.266	0.390	0.200	0.406	
1,2,3,7,8-PeCDD	2.14	0.000	0.000	0.000	0.000	0.000	0.000	
1,2,3,4,7,8-HxCDD	3.08	0.164	0.161	0.071	0.134	0.287	0.071	
1,2,3,6,7,8-HxCDD	1.22	0.599	0.472	0.167	0.144	0.548	0.259	
1,2,3,7,8,9,-HxCDD	2.84	0.140	0.288	0.057	0.286	0.314	0.176	
1,2,3,4,6,7,8-HpCDD	2.31	0.914	0.957	0.706	0.794	1.453	0.746	
OCDD	6.7	3.014	3.675	4.653	0.414	6.152	4.575	
TEQ		2.579	1.911	1.670	2.207	2.561	1.258	0.000

M/z ion ratio data flags, DPE,co-elution etc.
Surrogate recovery data flags
Both M/z ratio and Surrogate Recovery data flags

Rumford Downstream Data July		TOC 8/10	Sp. Cond.	Flow 8/10		
		6.3	115.3	1.3		
Congener	MDL*	SPMD 14	SPMD 15	SPMD 16	SPMD 17	SPMD 18
2,3,7,8-TCDF	0.8	4.529	7.177	6.874	9.484	8.823
1,2,3,7,8-PeCDF	2.08	0.150	1.234	0.527	0.753	2.429
2,3,4,7,8-PeCDF	3.13	0.000	0.432	0.000	1.322	2.166
1,2,3,4,7,8-HxCDF	2.59	0.505	0.628	0.499	0.847	1.421
1,2,3,6,7,8-HxCDF	2.46	0.169	0.184	0.344	0.266	1.176
2,3,4,6,7,8-HxCDF	2.88	0.138	0.210	0.264	0.194	0.857
1,2,3,7,8,9-HxCDF	1.68	0.055	0.000	0.197	0.092	1.453
1,2,3,4,6,7,8-HpCDF	2.65	2.628	3.448	1.351	1.584	0.708
1,2,3,4,7,8,9-HpCDF	1.56	0.074	0.000	0.189	0.119	0.681
OCDF	7.18	0.415	0.461	0.592	0.363	0.000
2,3,7,8-TCDD	2.1	0.443	0.289	0.372	0.566	0.825
1,2,3,7,8-PeCDD	2.14	0.000	0.000	0.000	0.017	0.864
1,2,3,4,7,8-HxCDD	3.08	0.051	0.220	0.166	0.128	1.207
1,2,3,6,7,8-HxCDD	1.22	0.226	0.508	0.473	0.446	2.083
1,2,3,7,8,9,-HxCDD	2.84	0.167	0.000	0.333	0.246	0.795
1,2,3,4,6,7,8-HpCDD	2.31	0.850	1.323	0.848	0.964	1.208
OCDD	6.7	3.690	6.114	3.790	3.001	3.806
TEQ		1.070	1.507	1.338	2.479	4.701

Congener	MDL*	SPMD 20	Mean	Std. Dev.	%RSD
2,3,7,8-TCDF	0.8	3.987	7.745	2.870	37.057
1,2,3,7,8-PeCDF	2.08	0.187	0.792	0.618	78.062
2,3,4,7,8-PeCDF	3.13	0.000	0.849	0.790	93.039
1,2,3,4,7,8-HxCDF	2.59	0.500	0.732	0.325	44.334
1,2,3,6,7,8-HxCDF	2.46	0.266	0.297	0.241	80.910
2,3,4,6,7,8-HxCDF	2.88	0.235	0.245	0.175	71.453
1,2,3,7,8,9-HxCDF	1.68	0.136	0.189	0.332	176.171
1,2,3,4,6,7,8-HpCDF	2.65	1.863	1.823	0.780	42.814
1,2,3,4,7,8,9-HpCDF	1.56	0.160	0.115	0.164	142.436
OCDF	7.18	1.633	0.638	0.963	150.963
2,3,7,8-TCDD	2.1	0.249	0.363	0.170	46.704
1,2,3,7,8-PeCDD	2.14	0.000	0.057	0.209	368.147
1,2,3,4,7,8-HxCDD	3.08	0.112	0.209	0.268	128.186
1,2,3,6,7,8-HxCDD	1.22	0.504	0.504	0.440	87.316
1,2,3,7,8,9,-HxCDD	2.84	0.302	0.261	0.167	63.886
1,2,3,4,6,7,8-HpCDD	2.31	1.606	1.011	0.307	30.357
OCDD	6.7	14.044	5.008	2.891	57.729
TEQ		0.900	1.931	0.927	48.023

M/z ion ratio data flags, DPE,co-elution etc.
Surrogate recovery data flags
Both M/z ratio and Surrogate Recovery data flags

Jay Upstream Data July 2001 N=8 5 SPMDs per sample <DL=0 (ng/kg) | Temp | DOC 7/17 N/A

Congener	SPMD 49^	SPMD 50^	SPMD 51*	SPMD 52	SPMD 53^	SPMD 54^	SPMD 55^	SPMD 56^
2,3,7,8-TCDF	2.319	2.374	2.849	2.522	2.238	2.124	2.228	2.187
1,2,3,7,8-PeCDF	0.606	1.000	0.941	0.683	0.709	0.610	0.675	0.683
2,3,4,7,8-PeCDF	0.772	1.120	1.027	0.847	0.739	0.732	0.860	0.724
1,2,3,4,7,8-HxCDF	0.399	0.838	0.548	0.459	0.376	0.384	0.455	0.398
1,2,3,6,7,8-HxCDF	0.145	0.469	0.182	0.144	0.156	0.101	0.130	0.146
2,3,4,6,7,8-HxCDF	0.126	0.373	0.225	0.146	0.125	0.094	0.097	0.088
1,2,3,7,8,9-HxCDF	0.057	0.390	0.128	0.043	0.071	0.048	0.045	0.043
1,2,3,4,6,7,8-HpCDF	0.273	0.819	0.363	0.262	0.230	0.184	0.399	0.240
1,2,3,4,7,8,9-HpCDF	0.080	0.422	0.175	0.107	0.134	0.058	0.103	0.066
OCDF	0.206	0.887	0.358	0.256	0.271	0.186	0.255	0.207
2,3,7,8-TCDD	0.115	0.238	0.158	0.141	0.095	0.127	0.131	0.190
1,2,3,7,8-PeCDD	0.098	0.447	0.186	0.079	0.135	0.069	0.113	0.074
1,2,3,4,7,8-HxCDD	0.076	0.368	0.103	0.061	0.109	0.076	0.105	0.071
1,2,3,6,7,8-HxCDD	0.626	1.058	0.321	0.655	0.655	0.472	0.853	0.547
1,2,3,7,8,9,-HxCDD	0.137	0.562	0.310	0.191	0.270	0.172	0.200	0.165
1,2,3,4,6,7,8-HpCDD	0.603	0.921	0.687	0.582	0.553	0.555	0.658	0.522
OCDD	1.444	2.205	1.754	1.528	1.253	1.305	1.446	1.275
TEQ	1.028	1.960	1.384	1.110	1.044	0.947	1.130	1.033

Jay Downstream Data July 2001 N=8 5 SPMDs per sample <DL=0 (ng/kg) | Average Temperature | DOC 9/22 N/A

Congener	SPMD 41	SPMD 42	SPMD 43	SPMD 44	SPMD 45	SPMD 46	SPMD 47	SPMD 48
2,3,7,8-TCDF	0.759	0.711	0.781	0.770	0.640	0.656	0.612	0.613
1,2,3,7,8-PeCDF	0.547	0.350	0.312	0.324	0.265	0.264	0.258	0.201
2,3,4,7,8-PeCDF	0.519	0.304	0.293	0.359	0.297	0.262	0.262	0.266
1,2,3,4,7,8-HxCDF	0.450	0.287	0.241	0.263	0.263	0.231	0.221	0.223
1,2,3,6,7,8-HxCDF	0.276	0.170	0.152	0.125	0.119	0.160	0.100	0.082
2,3,4,6,7,8-HxCDF	0.253	0.104	0.144	0.134	0.088	0.118	0.061	0.055
1,2,3,7,8,9-HxCDF	0.255	0.091	0.104	0.117	0.088	0.101	0.074	0.052
1,2,3,4,6,7,8-HpCDF	0.301	0.293	0.317	0.255	0.229	0.241	0.188	0.165
1,2,3,4,7,8,9-HpCDF	0.232	0.157	0.103	0.114	0.060	0.128	0.060	0.068
OCDF	0.405	0.371	0.344	0.333	0.287	0.368	0.304	0.228
2,3,7,8-TCDD	0.213	0.174	0.116	0.093	0.083	0.086	0.086	0.102
1,2,3,7,8-PeCDD	0.351	0.158	0.142	0.115	0.101	0.148	0.100	0.097
1,2,3,4,7,8-HxCDD	0.193	0.096	0.100	0.097	0.101	0.087	0.074	0.082
1,2,3,6,7,8-HxCDD	0.890	0.499	0.482	0.731	0.535	0.723	0.483	0.541
1,2,3,7,8,9,-HxCDD	0.354	0.198	0.154	0.157	0.152	0.156	0.131	0.099
1,2,3,4,6,7,8-HpCDD	0.453	0.461	0.504	0.415	0.386	0.368	0.343	0.303
OCDD	1.786	1.503	1.602	1.471	1.175	1.137	1.211	0.975
TEQ	1.205	0.726	0.646	0.651	0.552	0.609	0.512	0.522

FLAGS

Yellow	M/z ion ratio
Orange	Surrogate recovery
Green	Both M/z ratio and Surrogate Recovery
Blue	Retention Time

* Loss from GPC Clean Up Run
^ Deployed for 37 days
# All TCDD concentrations should be viewed with trepidation due to existing furan interference

Jay Upstream Data July 2	TOC 7/17	Sp. Cond.	Flow 7/13	Flow 8/10	DOC 8/10	TOC 8/10	Sp. Cond.
	N/A	45.03	0.8	1.4	5.9275	6.3892	95.22
					Without SPMD 50 & 51		
Congener	Mean	Std. Dev.	%RSD		Mean	Std. Dev.	%RSD
2,3,7,8-TCDF	2.355	0.234	9.954		2.270	0.139	6.133
1,2,3,7,8-PeCDF	0.739	0.148	20.099		0.661	0.043	6.451
2,3,4,7,8-PeCDF	0.853	0.148	17.319		0.779	0.060	7.727
1,2,3,4,7,8-HxCDF	0.482	0.155	32.085		0.412	0.036	8.782
1,2,3,6,7,8-HxCDF	0.184	0.117	63.780		0.137	0.020	14.349
2,3,4,6,7,8-HxCDF	0.159	0.097	60.859		0.113	0.023	20.349
1,2,3,7,8,9-HxCDF	0.103	0.119	115.608		0.051	0.011	21.543
1,2,3,4,6,7,8-HpCDF	0.346	0.204	58.801		0.265	0.073	27.513
1,2,3,4,7,8,9-HpCDF	0.143	0.119	83.098		0.091	0.028	31.167
OCDF	0.328	0.232	70.627		0.230	0.035	15.063
2,3,7,8-TCDD	0.149	0.046	30.638		0.133	0.032	24.111
1,2,3,7,8-PeCDD	0.150	0.126	83.997		0.095	0.026	27.239
1,2,3,4,7,8-HxCDD	0.121	0.101	83.577		0.083	0.019	23.283
1,2,3,6,7,8-HxCDD	0.648	0.226	34.925		0.635	0.129	20.262
1,2,3,7,8,9,-HxCDD	0.251	0.138	54.936		0.189	0.045	23.895
1,2,3,4,6,7,8-HpCDD	0.635	0.128	20.158		0.579	0.048	8.249
OCDD	1.526	0.319	20.912		1.375	0.113	8.185
TEQ	1.205	0.332	27.539		1.049	0.065	6.233

Jay Downstream Data Jul	TOC 9/22	Sp. Cond.	Flow 9/27	Flow 10/20	DOC 10/20	TOC 10/20	Sp. Cond.
	N/A	76.94	0.75	0.67	7.7361	7.8293	134.6
					Without SPMD 41		
Congener	Mean	Std. Dev.	%RSD		Mean	Std. Dev.	%RSD
2,3,7,8-TCDF	0.693	0.071	10.289		0.683	0.071	10.439
1,2,3,7,8-PeCDF	0.315	0.105	33.179		0.282	0.050	17.755
2,3,4,7,8-PeCDF	0.320	0.087	27.015		0.292	0.034	11.779
1,2,3,4,7,8-HxCDF	0.273	0.075	27.558		0.247	0.025	9.913
1,2,3,6,7,8-HxCDF	0.148	0.060	40.369		0.130	0.032	25.005
2,3,4,6,7,8-HxCDF	0.119	0.062	52.298		0.100	0.034	34.149
1,2,3,7,8,9-HxCDF	0.110	0.062	55.956		0.090	0.021	23.910
1,2,3,4,6,7,8-HpCDF	0.249	0.054	21.712		0.241	0.054	22.250
1,2,3,4,7,8,9-HpCDF	0.115	0.058	50.768		0.099	0.037	37.993
OCDF	0.330	0.056	16.946		0.319	0.051	15.906
2,3,7,8-TCDD	0.119	0.048	40.459		0.106	0.032	30.446
1,2,3,7,8-PeCDD	0.152	0.084	55.561		0.123	0.026	20.774
1,2,3,4,7,8-HxCDD	0.104	0.037	35.749		0.091	0.010	11.058
1,2,3,6,7,8-HxCDD	0.611	0.151	24.810		0.571	0.109	19.147
1,2,3,7,8,9,-HxCDD	0.175	0.077	44.214		0.150	0.030	19.886
1,2,3,4,6,7,8-HpCDD	0.404	0.067	16.522		0.397	0.069	17.340
OCDD	1.358	0.274	20.218		1.296	0.230	17.739
TEQ	0.678	0.225	33.178		0.603	0.078	12.996

FLAGS

M/z ion ratio

Surrogate recovery

Both M/z ratio and Surrogate Recovery

Retention Time

* Loss from GPC Clean Up Run

^ Deployed for 37 days

All TCDD concentrations should be viewed with trepidation due to existing furan interference

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Huckins J.N., Petty J.D., Lebo J.A., Almeida F.V., Booij K., Alvarez D.A., Cranor W.L., Clark R.C., and Mogensen B.B. 2002. Development of the Permeability/Performance Reference Compound Approach for In Situ Calibration of Semipermeable Membrane Device. *Environmental Science and Technology* 36:85-91.

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4.2

EEL STUDY

EEL STUDY

There are two principle fisheries for adult eels in Maine, a river fishery and a lake fishery. Most of the eels are sold outside Maine in US and international markets, although some are consumed in Maine. People fishing eels need permits from either DMR or DIFW. DMR also funds several eel research projects at the University of Maine. Limited data from previous years show that eels from rivers are often among the species most highly contaminated with a number of contaminants. Contaminant levels in eels from lakes are unknown. In 1998 eels were captured from 3 lakes. Since then we have tried to get eels from 3 rivers as well, but were successful only in collecting eels from the Penobscot River in 2000. Therefore, in 2001, we attempted to collecte 20 eels from each of three rivers to be analyzed as four composites of five fish each for dioxins, coplanar PCBs, total PCBs, and mercury. We were able to collect eels from only the Penobscot River at Orrington which were analyzed for dioxins and coplanar PCBs. Concentrations of both were among the highest of all species and exceeded the Maine Bureau of Health's Fish Tissue Action Level as can be seen in section 3.1 in the Rivers module of this report. Samples of eels have already been collected from the Kennebec River and Penobscot River in 2002 to be analyzed for mercury and total PCBs.

4.3

MINK AND OTTER MERCURY STUDY

Investigation of Mercury Exposure in Maine’s Mink and River Otter

(BRI 2002-10)

Submitted to:

Barry Mower, Maine Department of Environmental Protection
&
Wally Jakubas, Maine Inland Fisheries and Wildlife

Submitted by:

David C. Evers, Dave Yates, and Lucas Savoy

BioDiversity Research Institute
411 North U.S. Rt. 1, Suite 1
Falmouth, Maine 04105

19 April 2002

Please cite this report as: Evers, David C., Dave Yates, and Lucas Savoy. 2002. Investigation of mercury exposure in Maine’s Mink and River Otter. Report BRI 2002-10 submitted to Maine Department of Environmental Protection and Maine Inland Fisheries and Wildlife. BioDiversity Research Institute, Falmouth, Maine

Table of Contents

Summary of Tables

Summary of Figures

Summary of Appendices

Abstract

Anthropogenic releases of mercury into the environment for the past several decades have collected in aquatic ecosystems. The impact of this mercury build-up is of concern to regulators and policy makers. Maine and much of New England are especially at high risk because of local and regional emission sources, prevailing wind patterns, and certain hydrological and biogeochemical features. This study helps establish an exposure profile for mercury in mink and river otter populations in Maine. Although a total of 26 otter and 47 mink carcasses have been collected, parametric statistical analysis of covariables is not yet possible. Mercury levels do tend to be greater in mink vs. otter, interior vs. coastal populations, and females vs. males. Respective mean mercury levels in otter and mink fur, 19.6 and 21.8 ppm, were near concentrations considered to have adverse effects in other studies. The proportion of sampled populations exceeding 20 ppm in the fur was 61% for otter and 47% for mink. Mink fur Hg levels ranged up to 68.5 ppm. Brain and liver Hg levels were well below published lethal levels. The strong relationship among brain, liver, and fur Hg levels indicates great flexibility in using one compartment for determining mercury exposure. Otter and mink mercury levels from western and northern Maine indicate greatest risk. Continued collection of carcasses through our established trapper network will increase sample size and geographic scope. Soon, we will have a suitable mercury exposure profile that can be used to model a wildlife criterion value protective of Maine's mink and river otter population.

The full report is available as a separate file with the 2001 SWAT report at http://www.state.me.us/dep/blwq/monitoring.htm

4.4

MERCURY METHODS STUDY

Optimization of the Methyl Mercury in Ambient Water Method (Distillation, Aqueous Ethylation, Purge and Trap, and CVAFS) for Detection Limits Below 0.05 ng/L.

T. Haines and C. Devoy

Final Report – December 12, 2002

Summary

The analytical method has been improved dramatically resulting in peaks that are taller, sharper, and more reproducible. The system is now composed of a greater number of standard, readily available consumable components, rather than relying on custom-made components. This makes maintenance and repair easier and cheaper.

Some components of the project have not been developed completely, due to resource limitations. Design changes to the gas chromatography and pyrolysis components have been successful. Development of the sparging and distillation components has been partially successful, but further work is required. The ethylation procedure was evaluated and found to be acceptable. An alternate detector was evaluated and found to be more stable and is recommended as a future improvement.

The lowest standard that can be included in a calibration curve has declined from 0.05 to 0.02 ng/L. The calculated method detection limit (MDL) is 0.0397 ng/L, which is higher than expected. Refinement of the distillation method in particular is expected to lower this value.

Part I - Methyl Mercury Detection

Ethylation Efficiency

Ethylation performance was tested, using a range of ethylating agent concentrations (0.25, 0.5, 1.0 and 2.0%), within a completely randomized design. Each concentration was used to produce a standard curve, which could be evaluated in terms of mean calibration factor (CF) size, percent relative standard deviation (%RSD), and low-standard percent recovery. The CF for a standard is the peak height divided by the mass of methyl mercury injected. Percent RSD is the standard deviation of the CF values for the standards, relative to the mean CF.

It is important to note that 24 hours after production of the ethylating agents, all the vials containing the 1% solution had a yellow tinge. This indicates that reaction with air had occurred, most likely in the original vial of sodium tetraethyl borate ($NaBEt_4$). The experimental results support this conclusion, based on reduced response across the entire standard curve.

Ethylating agents contain trace amounts of methyl-, ethyl-mercury that contribute to the response produced by each standard. Small additions may actually be helpful because a quantified value for the blank (rather than a "noise" value) is crucial to the success of the calibration. However, as the size of the blank response increases, it can mask the lower standards. In cases where the blank value is 2 or 3 times the value of the blank-subtracted lowest standard, the validity of blank subtraction may be questioned. However, omitting blank subtraction at the lowest levels of detection prevents successful calibrations because the calibration factors of the lower standards are inflated relative to those of the higher standards.

An addition of 40 µL of 0.5% $NaBEt_4$ is currently used for methyl mercury analysis. Results from this experiment support this choice because the concentration is sufficient to produce a large Mean CF, while yielding a small enough blank response. Low standard recovery consistently lies within the 65-135% range specified in the draft EPA Method.

Sparging system

The initial sparger design is shown in Appendix A and was fabricated by Popper & Sons. Testing confirmed that it was able to sparge multiple sealed samples, and could be connected tightly to the gas lines. However, the machined holes proved to be too large to allow even vertical distribution of gas bubbles. A flow rate of 500-1000 mL/min was required to produce bubbles from each row of holes. This flow rate is too high, driving methyl mercury too far into the trapping material and increasing the risk of thermal decomposition during desorption. During testing, the use of this assembly produced peak heights approximately 0.9 times as large as those from the original glass bubblers. However, the ease of connection, use and cleaning of this system were a significant improvement over the original design. In order to solve this problem, the tip of the original assembly was replaced with a section of porous stainless steel (by Applied Porous Technologies), which resulted in finer bubble formation. While the new design can successfully generate bubbles in a sample at a flow rate of approximately 100-200 mL/min, bubble production is still not vertically uniform. Further development is needed to satisfy the design requirements.

A second aspect of the sparging setup is the ability to stir the sample during the ethylation phase. A miniature stirring assembly was purchased and modified to provide enough power to drive a 3 mm x 12 mm stirbar. During a dye test, complete mixing was achieved within 45 seconds. This indicates that distribution of ethylating agent within the bottle would be uniform during the 15 minute ethylation step.

Chromatography

The original stationary phase of the gas chromatography (GC) column (15% OV-3 on Chromasorb W) is not available in a capillary format. The closest match is 5% phenyl, 95% methylpolysiloxane in a 10 m, 0.53 mm ID column. An Alltech AT-5 column was purchased and installed in a modified HP 5890 Series II gas chromatograph. The modification (Appendix B) involved replumbing the gas flow and sample introduction mechanism. The new design uses a column flow rate of 15 mL/min (at 35 °C and 4.5 psi head pressure), and has operated successfully since installation.

An advantage of switching from packed column to capillary GC is the ability to better control temperatures during the analysis. It was necessary to develop a multistage temperature program (Figure 1) in order to successfully separate the mercury species Hg(0), methyl-, ethyl-mercury and diethyl-mercury. The initial 35 °C is ideal for separation and the first rise is needed to reduce the retention time of the diethyl mercury peak. The temperature is then increased quickly to 115 °C in order to remove residual water from the column. Typical retention times are approximately 1-1.5, 2.25-2.75, and 3.75-4.25 minutes for the three peaks.

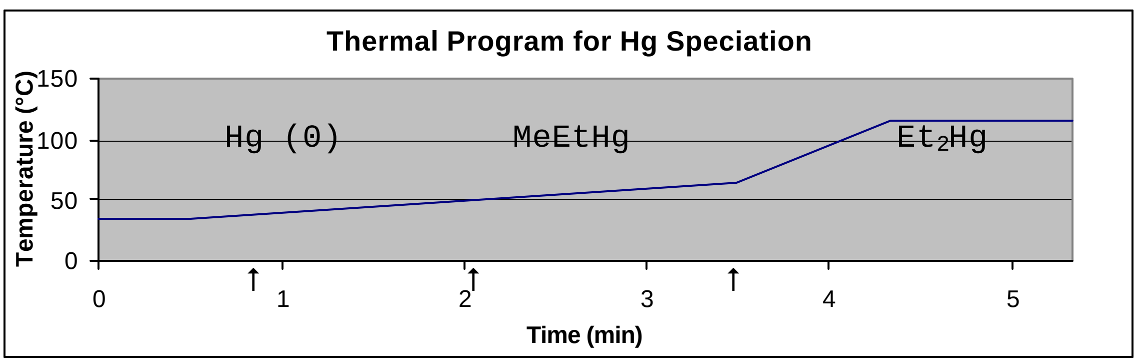


Figure 1. Thermal program and peak elution order.

Thermal Decomposition Furnace and Column

A new pyrolysis furnace has been constructed (Appendix C). Briefly, a ceramic fiber tube heater is connected to a programmable power controller, which monitors temperature via a thermocouple (Omega). Temperature control is very accurate and stable, allowing settings to be maintained over long periods of time. The design of the furnace will allow for the use of a variety of different pyrolytic columns, in order to allow for future development. During testing, the furnace operated well at 500, 700, 800 and 850 °C and maximum variation was ± 0.3 °C (± 0.1 °C typical). An example of the thermal stability of the furnace is given in Figure 2.

The new pyrolytic column design has a reduced internal diameter and a longer, coiled flow path. The quartz wool packing has been eliminated, in order to reduce peak spreading. This column was fabricated by Chemglass. Calibration was very successful during testing, indicating that the coil design is an effective replacement for the packed, wide bore column.

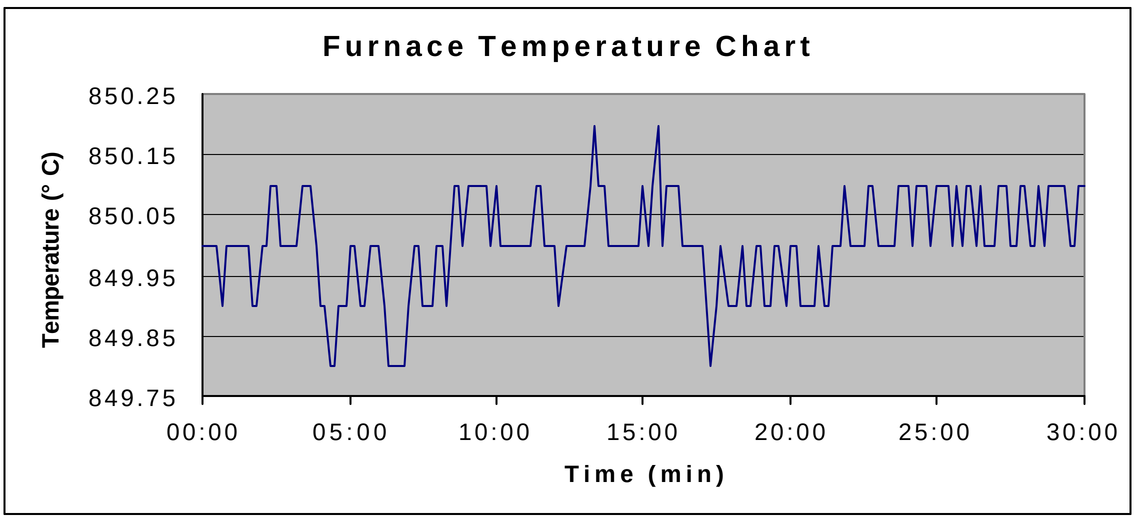


Figure 2. Thermal stability of pyrolysis furnace.

Fluorescence Detector

A comparison of two detector designs (Brooks Rand Model III and Tekran 2600) has been made and example chromatograms are shown in Appendix D. Successful calibration was performed with both detectors, defined as one having a percent RSD <15 % and the low standard having a percent recovery between 65 and 135 %. The Tekran detector yielded the lowest %RSD (8.6 vs 14.1) and a low standard percent recovery closer to 100% (104.2, 94.3 vs 115.4, 111.7).

The limit of detection appears to be controlled by different factors for each of these detectors. The Brooks Rand detector suffers from baseline noise of sufficient magnitude to interfere with peak integration below 0.02 ng/L. The Tekran detector does not exhibit this phenomenon and so the limit of detection could be controlled by factors such as system gas leaks, flow and temperature control, and trap dryness. These factors may yet be improved and so this detector offers the best opportunity for future method improvement.

Part II - Methyl Mercury Distillation Procedure

The new system is composed of a pair of wide-mouth Teflon® 120 mL vessels connected by a 90° elbow. The diameter of the vessels and elbow is 4.7 cm (1.85”), as compared to the 1/16” ID of the transfer tubing in the old system. The results of the initial testing were encouraging, but further work needs to be done before final evaluation. The “hot” side (containing the sample) reached 103 °C on the outside, but only 77 °C on the inside (determined after disassembly). The “cold” side was chilled to 10 °C and the internal temperature reached 15 °C. These conditions resulted in a ΔT of 62 °C and a distillation of approximately 25 mL (of 100 mL) in 4.5 hours. The internal temperatures need to be brought closer to 95 °C and 2 °C respectively, in order to maximize ΔT while preserving the methyl mercury.

Part III - Method Evaluation

Some components of this project could not be fully developed due to resource limitations. These include the sparging components and the distillation system. There are still several ideas which will be explored as time and funding becomes available. The MDL calculation was performed on data produced from the existing distillation method, and the improved analytical equipment. Seven replicates of a 0.02 ng/L standard were distilled and analyzed.

MDL = $s(t \bullet 99)$ for n replicates

where: n = number of replicates analyzed
s = standard deviation of the values
$t \bullet 99$ = students t value for a one-tailed test at the 99% confidence level with n-1 degrees of freedom

MDL = 0.0126 x 3.143 = 0.0397 ng/L

The calculated MDL is not as low as expected, despite several key improvements in the method, which have increased precision and instrument sensitivity. New components have been designed with standard, easily replaceable fittings. The thermal decomposition furnace is very well controlled and the addition of the GC has improved control of the remaining flow and temperature settings. The peak height of a 0.02 ng/L standard is approximately that of a 0.05 ng/L standard one year ago. The system has been successfully calibrated to 0.02 ng/L, with acceptable RSD (<15%) of the standards.

This work has resulted in an improved analytical system, including sparging, trapping/desorption, chromatography and pyrolysis. However, it also highlights the need for the use of a more stable detector, such as a Tekran 2600 and the development of an improved distillation system. Increased detector stability is expected to reduce %RSD in low concentration calibrations. Improvements to the distillation system should focus on precision (consistent distillation conditions) and ease of cleaning. Contamination is extremely hard to control below 0.02 ng/L. A combination of these improvements should lead to a lower calculated MDL, and therefore a lower limit of quantization.

This work has additionally laid the groundwork for automation of the analytical system. Although there are several issues to be resolved, automation could increase both data quality and quantity. In particular, automation could eliminate the need to connect and disconnect traps repeatedly throughout the analysis. This would result in traps being exposed to less air, and enable trap fittings to be more permanent (resulting in fewer leaks). A major component of this development would be to continue and finish development of a sparging probe that can be used in an autosampler. The probe developed in this work suffered from weakness at the tip, and non-uniform bubble production. Resolution of these issues, together with detector – GC – computer interfacing would clear the way for analytical automation.

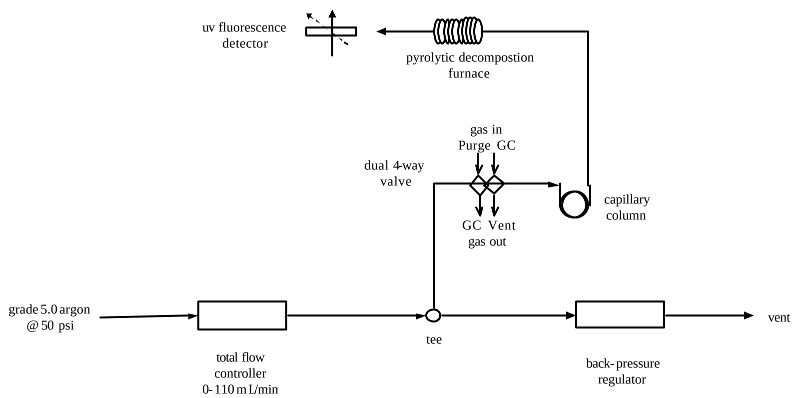
Appendix A – Sparge Assembly

Notes: [a] Gas line in [b] Sparge holes[c] Return holes[d] Gas line out [e] Luer-lok connector

Once the sparger has pierced the septum, the section from about 0-95 mm is within the bottle. Gas return holes are above liquid level. Gas flows down the center tube, bubbles out of the tip section and returns through the outer tube and out of the side arm due to the pressure in the sealed bottle.

Appendix B – Chromatograph Plumbing

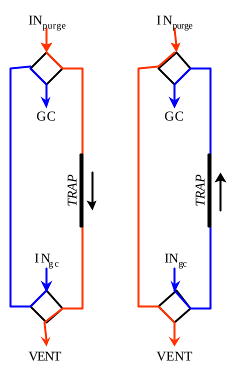
Plumbing Diagram for Methyl Mercury Analysis using Series 5890 GC



Dual 4-way switching valve shown in this figure is given in detail below. Detector flow rate is 15 mL/minute.

Valve arrangement allows loading of trap in one direction and purging in reverse. Gas flow to GC is maintained from the same source.

Plumbing Diagram for Dual 4-way Valve



Trap Purge Trap Inject


a. Front panel   b. Rear panel / cooling fan

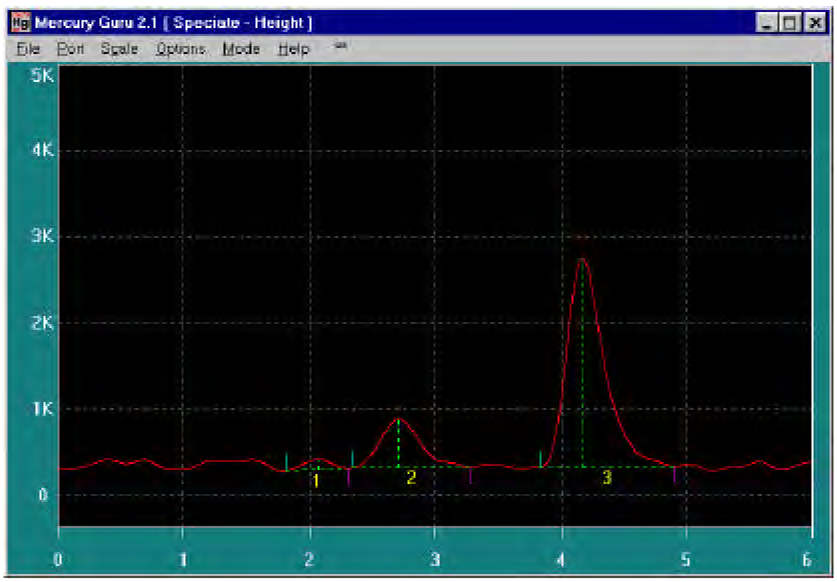

c. Internal organization   d. Temperature control module

e. Furnace and connections   f. Solid state relay and heatsink

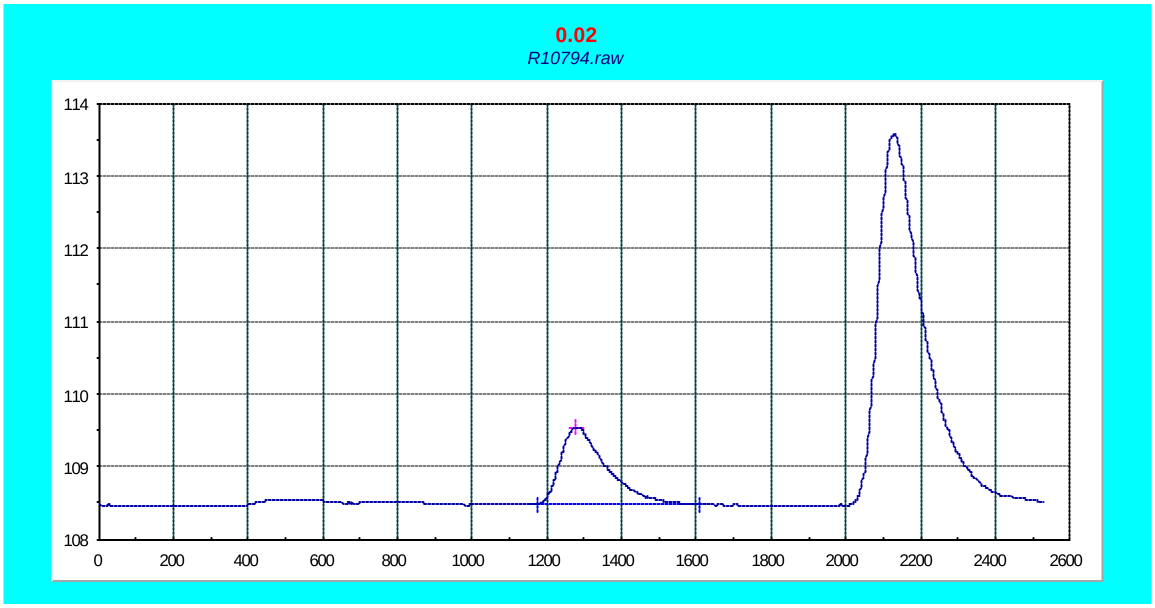
The cooling fan draws cool air in over the solid state relay (SSR) heatsink, maintaining a suitable operating temperature for the switching apparatus. This air also flows around the outer surface of the tube furnace before exiting the enclosure via a row of holes along the top of the left side. The temperature control module is also shielded from radiant heat, while obtaining a temperature signal from a stainless steel thermocouple located in the center of the furnace. Argon gas is fed into the cavity of the tube heater, in order to reduce aging and oxidation of the heater coils and quartz coil.

The furnace is programmable from ambient temperature to 850 °C and will maintain the desired temperature to within ±0.3 °C. The temperature control module operates on a 1 second cycle time during which the SSR is switched on for long enough to maintain the desired temperature. Control is constantly adjusted in order to minimize variations.

Appendix D – Peak Comparison for Two Detectors



Graph of Response vs Time for 0.02 ng/L standard (100 mL), using a Brooks Rand Model III detector. Peak 2 is MeEtHg, derived from MeHg. Peak 3 is Et_2Hg, derived from inorganic Hg. Note symmetrical peak shape, and good spacing of peak 2 and 3. Note also, noisy baseline (approximately 20% of standard) which can influence peak height calculation.



Graph of Response vs Time for 0.02 ng/L standard (100 mL), using a Tekran 2600 CVAFS detector. Peak 1 (centered on 500) is elemental Hg. Peak 2 (centered on 1275) is MeEtHg, derived from MeHg. Peak 3 (centered on 2125) is Et_2Hg, derived from inorganic Hg. Note excellent signal to noise ratio, reasonable peak shape and good spacing of peaks. Note also, very stable baseline.

4.5

BROMINATED ORGANICS
(from 2000)

BROMINATED ORGANICS
SCREENING FOR POLYBROMINATED DIPHENYL ETHERS (PBDE) IN MAINE RIVERS

By Therese Anderson, University of Maine

Polybrominated diphenyl ethers (PBDEs) are a group of 209 congeners that are found as components in flame retardants and plastics. Their structure is similar to dioxins, furans, and PCBs, with bromines substituted instead of chlorines. Because of this similarity, they are named in the same manner. These compounds have been found in increasing concentrations in the environment and initial studies have shown evidence of toxicity.

This project involved an initial screening of fish from Maine rivers by utilizing past dioxin extracts and analyzing them for the presenxe of PBDEs. Since the extraction process is the same for both the dioxins and the PBDEs, these compounds should have been extracted along with the target compounds. The samples analyzed were from the 2000 dioxin project and included original and re-extracted samples. The sample extracts from each site were composited to provide enough sample to analyze. The composites ranged from 3 to 5 extracts per sample. PBDE standards were purchased from Cambridge Isotope Labs and run prior to the analysis of the samples. Since the samples were not originally extracted for PBDEs, surrogates were not added at the beginning of the extraction and the results are not corrected for surrogate recovery.

The results are, therefore, considered qualitative and are used to indicate only the presence or absence of these compounds. The estimated concentrations of the PBDEs ranged from <0.1 to 100s ppb. Station and species codes are shown below. Table 4.5.1 shows estimated average amounts of one of the compounds in each homologue group. These concentrations indicate that PBDEs are present in these watersheds. In order to develop quantitative results, additional fish samples will be collected in the future and extracted and analyzed by a method specific to PBDEs.

SPECIES CODES

BNT brown trout
EEL eel
LMB largemouth bass
RBT rainbow trout
SMB smallmouth bass
WHP white perch
WHS white sucker

STATION CODES

AGL Androscoggin R at Gilead
ARP Androscoggin R at Rumford Point
ARF Androscoggin R at Rumford
ARY Androscoggin R at Riley
AGI Androscoggin R at GIP, Auburn
ALV Androscoggin R at Livermore Falls
ALS Androscoggin R at Lisbon Falls
ALW Androscoggin Lake at Wayne
KRM Kennebec R at Madison
KNW Kennebec R at Norridgewock
KFF Kennebec R at Shawmut, Fairfield
KRS Kennebec R at Sidney
PBW Penobscot R at Woodville
PBM Penobscot R at Winn
PBL Penobscot R at S Lincoln
PBV Penobscot R at Veazie
PBO Penobscot R at Orrington
PWD Presumpscot R at Windham
PWB Presumpscot R at Westbrook
SFS Salmon Falls R at S. Berwick
SEN E Br Sebasticook at Newport
SED E Br Sebasticook at Detroit
SWP W Br Sebasticook at Palmyra

Table 4.5.1 PBDEs in fish samples from Maine Rivers, 2000 (ppb)

STATION	SPECIES	N	P1BDE	P2BDE	P3BDE	P4BDE	P5BDE	P6BDE	P7BDE
AGL	RBT	1	<0.1	1.13	19	1.23	0.63	<0.1	<0.1
ARP	SMB	2	<0.1	1.28	14	4.48	1.15	<0.1	<0.1
ARP	WHS	1	<0.1	0.28	0.51	1.8	1.21	<0.1	<0.1
ARF	SMB	1	0.12	0.57	0.25	6.12	0.41	<0.1	<0.1
ARY	SMB	1	<0.1	2.65	2.2	0.34	1.45	0.1	<0.1
ARY	WHS	1	0.58	9.48	16	0.85	0.63	<0.1	<0.1
ALV	SMB	1	<0.1	26	7.95	3.9	1.44	0.1	<0.1
AGI	SMB	1	<0.1	0.094	5.79	1.89	0.88	<0.1	<0.1
ALS	SMB	1	<0.1	7.24	23	2.19	6.83	0.1	<0.1
KNW		1	<0.1	1.01	<0.1	2.44	1.73	<0.1	<0.1
KNW	SMB	1	<0.1	0.011	<0.1	0.33	<0.1	<0.1	<0.1
KFF	SMB	2	<0.1	0.016	<0.1	0.53	<0.1	<0.1	<0.1
KSD	BNT	1	<0.1	0.64	0.1	0.42	5.73	0.15	<0.1
KSD	SMB	1	<0.1	<0.1	0.38	0.14	0.41	<0.1	<0.1
PBM	SMB	2	<0.1	3.12	1.05	1.05	0.42	<0.1	<0.1
PBM	WHS	1	<0.1	9.62	0.11	2.7	0.3	<0.1	<0.1
PBL	SMB	2	<0.1	1.02	<0.1	0.46	<0.1	<0.1	<0.1
PBL	WHS	1	<0.1	58	4.83	3.36	<0.1	<0.1	<0.1
PBC	SMB	1	<0.1	0.1	<0.1	0.18	<0.1	0.17	<0.1
PBC	WHS	1	<0.1	65	<0.1	0.61	0.49	0.66	<0.1
PBV	SMB	1	<0.1	1.57	0.11	1.92	8.54	0.17	<0.1
PBV	WHS	1	0.1	2.68	1.58	1.74	4.86	0.2	<0.1
PBB	EEL	1	0.13	6.77	13	3.22	17	0.1	<0.1

N= number of samples

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID 2001 list	Date	Length mm	Weight gm.
DMP			
ANDROSCOGGIN RIVER			
Gilead			
AGL-RBT-1	5/24/2001	290	230
AGL-RBT-2	5/24/2001	301	280
AGL-RBT-3	5/24/2001	273	190
AGL-RBT-4	5/24/2001	305	310
AGL-BNT-1	5/24/2001	274	260
Rumford-above			
ARP-SMB-1	9/11/2001	330	480
ARP-SMB-2	9/11/2001	342	600
ARP-SMB-3	9/11/2001	355	690
ARP-SMB-4	9/11/2001	352	700
ARP-SMB-5	9/11/2001	311	445
ARP-WHS-01D	9/11/2001	445	870
ARP-WHS-02D	9/11/2001	410	630
ARP-WHS-03D	9/11/2001	422	750
ARP-WHS-04D	9/11/2001	440	890
ARP-WHS-05D	9/11/2001	441	770
ARP-WHS-06D	9/11/2001	413	640
ARP-WHS-07D	9/11/2001	434	770
ARP-WHS-08D	9/11/2001	432	750
ARP-WHS-09D	9/11/2001	434	780
ARP-WHS-10D	9/11/2001	445	1016
Rumford			
ARF-SMB-1	8/28/2001	320	430
ARF-SMB-2	8/28/2001	322	420
ARF-SMB-3	8/28/2001	345	550
ARF-SMB-4	8/28/2001	350	600
ARF-SMB-5	8/28/2001	355	625
ARF-SMB-6	8/28/2001	321	400
ARF-SMB-7	8/28/2001	320	400
ARF-SMB-8	8/28/2001	325	430
ARF-SMB-9	8/28/2001	343	540
ARF-SMB-10	8/28/2001	332	480

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
ARF-WHS-1	8/28/2001	420	890
ARF-WHS-2	8/28/2001	419	880
ARF-WHS-3	8/28/2001	446	1000
ARF-WHS-4	8/28/2001	430	1040
ARF-WHS-5	8/28/2001	412	740
ARF-WHS-6	8/28/2001	445	930
ARF-WHS-7	8/28/2001	400	700
ARF-WHS-8	8/28/2001	410	820
ARF-WHS-9	8/28/2001	421	910
ARF-WHS-10	8/28/2001	403	680
Riley			
ARY-SMB-1	9/18/2001	380	796
ARY-SMB-2	9/18/2001	360	708
ARY-SMB-3	9/19/2001	385	823.6
ARY-SMB-4	9/19/2001	372	678.1
ARY-SMB-5	9/20/2001	386	853.2
ARY-SMB-6	9/20/2001	370	879.3
ARY-SMB-7	9/20/2001	365	782.1
ARY-SMB-8	9/20/2001	410	948.8
ARY-SMB-9	9/20/2001	350	579.1
ARY-SMB-10	9/20/2001	370	609.4
ARY-SMB-11	9/20/2001	371	649.7
ARY-SMB-12	9/20/2001	381	869.5
ARY-SMB-13	9/20/2001	370	708.3
ARY-SMB-14	9/20/2001	375	763.3
small SMB			
ARY-SSMB-01	9/20/2001	125	
ARY-SSMB-02	9/20/2001	163	
ARY-SSMB-03	9/20/2001	115	
ARY-SSMB-04	9/20/2001	117	
ARY-SSMB-05	9/20/2001	155	
ARY-SSMB-06	9/20/2001	130	
ARY-SSMB-07	9/20/2001	122	
ARY-SSMB-08	9/20/2001	125	
ARY-SSMB-09	9/20/2001	118	
ARY-SSMB-10	9/20/2001	115	

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
ARY-WHS-19	9/18/2001	428	832.4
ARY-WHS-20	9/18/2001	423	883.4
ARY-WHS-22	9/20/2001	426	1050.4
ARY-WHS-29	9/20/2001	409	808.9
ARY-WHS-30	9/20/2001	438	1043.5
ARY-WHS-31	9/20/2001	410	812.8
ARY-WHS-32	9/20/2001	402	927.8
ARY-WHS-35	9/20/2001	442	1066.6
ARY-WHS-50	10/23/01	430	1006
ARY-WHS-51	10/23/01	440	982.8
ARY-WHS-52	10/23/01	424	912.8
ARY-WHS-53	10/23/01	440	1074
ARY-WHS-54	10/23/01	435	963.3
ARY-WHS-55	10/23/01	445	1069.9
ARY-WHS-56	10/23/01	434	976.1
ARY-WHS-57	10/23/01	458	983.1
ARY-WHS-58	10/23/01	430	872.5
ARY-WHS-59	10/23/01	430	922.8
ARY-WHS-60	10/23/01	443	1019.5
ARY-WHS-61	10/23/01	435	1020.1
Livermore Falls Otis			
ALV-SMB-1	9/28/2001	360	548.3
ALV-SMB-2	9/28/2001	375	608.8
ALV-SMB-3	9/28/2001	371	673.2
ALV-SMB-4	9/28/2001	368	638.6
ALV-SMB-5	9/28/2001	382	721.4
ALV-SMB-6	9/28/2001	368	602.1
ALV-SMB-7	9/28/2001	382	772.3
ALV-SMB-8	9/28/2001	355	550.2
ALV-SMB-9	9/28/2001	366	577.4
ALV-SMB-10	9/28/2001	365	538.4
SMB-Yearlings			
ALV-SSMB-11	10/3/2001	117	
ALV-SSMB-12	10/3/2001	114	
ALV-SSMB-13	10/3/2001	111	
ALV-SSMB-14	10/3/2001	105	
ALV-SSMB-15	10/3/2001	114	
ALV-SSMB-16	10/3/2001	102	
ALV-SSMB-17	10/3/2001	105	
ALV-SSMB-18	10/3/2001	98	
ALV-SSMB-19	10/3/2001	95	
ALV-SSMB-20	10/3/2001	92	

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
ALV-WHS-01	9/25/2001	416	625.6
ALV-WHS-02	9/25/2001	435	935.1
ALV-WHS-03	9/25/2001	434	1027.8
ALV-WHS-07	9/26/2001	435	886.1
ALV-WHS-11	9/26/2001	438	968.8
ALV-WHS-14	9/26/2001	435	1120
ALV-WHS-16	9/26/2001	425	985.4
ALV-WHS-18	9/26/2001	445	1098.3
ALV-WHS-19	9/26/2001	440	1191.4
ALV-WHS-20	9/27/2001	439	1234
ALV-WHS-28	9/27/2001	425	997.8
ALV-WHS-29	9/27/2001	439	1046.6
ALV-WHS-30	9/27/2001	446	1074.1
ALV-WHS-32	9/27/2001	418	953.3
ALV-WHS-33	9/27/2001	422	902.7
ALV-WHS-35	9/27/2001	415	1107.8
ALV-WHS-36	9/27/2001	421	1034.4
ALV-WHS-37	9/27/2001	448	1228.2
ALV-WHS-41	9/27/2001	450	1089.9
ALV-WHS-42	9/27/2001	407	831.6
Androscoggin Lake			
ALW-SMB-1	10/18/2001	437	1070
ALW-SMB-2	10/19/2001	400	840
ALW-SMB-3	2/7/2002	417	1080
ALW-SMB-4	2/7/2002	421	1070
ALW-SMB-5	2/7/2002	427	1190
ALW-SMB-6	2/7/2002	467	1600
ALW-SMB-7	2/7/2002	405	920
ALW-SMB-8	2/7/2002	411	920
ALW-SMB-9	2/7/2002	451	1220
ALW-SMB-10	2/7/2002	472	1220
ALW-WHP-1	10/12/2001	280	300
ALW-WHP-2	10/12/2001	297	313
ALW-WHP-3	10/17/2001	352	550
ALW-WHP-4	10/17/2001	298	360
ALW-WHP-5	10/17/2001	302	355
ALW-WHP-6	10/17/2001	276	300
ALW-WHP-7	10/17/2001	284	300
ALW-WHP-8	10/17/2001	282	280
ALW-WHP-9	10/17/2001	257	215
ALW-WHP-10	10/17/2001	266	240

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
ALW-WHS-22 -**1**	10/12/2001	415	723.6
ALW-WHS-24-**2**	10/12/2001	395	661.1
ALW-WHS-27-**3**	10/12/2001	398	594.3
ALW-WHS-28-**4**	10/12/2001	425	801.7
ALW-WHS-29-**5**	10/12/2001	405	690.9
ALW-WHS-37-**6**	10/16/2001	455	760.2
ALW-WHS-38-**7**	10/16/2001	455	765.2
ALW-WHS-42-**8**	10/16/2001	430	765.1
ALW-WHS-43-**9**	10/16/2001	475	953.3
ALW-WHS-44-**10**	10/16/2001	445	925.9
Turner			
AGI-SMB-1	10/4/2001	328	420
AGI-SMB-2	10/4/2001	410	970
AGI-SMB-3	10/4/2001	396	850
AGI-SMB-4	10/4/2001	390	720
AGI-SMB-5	10/4/2001	394	848
AGI-WHS-12-**1**	10/8/2001	380	503
AGI-WHS-13-**2**	10/8/2001	415	653.2
AGI-WHS-14-**3**	10/8/2001	415	734.5
AGI-WHS-15-**4**	10/8/2001	426	737.3
AGI-WHS-16-**5**	10/8/2001	390	535.2
AGI-WHS-18-**6**	10/8/2001	404	688.1
AGI-WHS-22-**7**	10/9/2001	401	632.3
AGI-WHS-24-**8**	10/9/2001	414	701.7
AGI-WHS-25-**9**	10/9/2001	420	770
AGI-WHS-34-**10**	10/10/2001	400	596.2
Lisbon Falls			
ALS-SMB-1	8/20/2001	306	340
ALS-SMB-2	8/20/2001	334	450
ALS-SMB-3	8/20/2001	304	320
ALS-SMB-4	8/20/2001	305	330
ALS-SMB-5	8/20/2001	311	400
KENNEBEC RIVER			
Norridgewock/Madison			
KMD-BNT-01	7/17/2001	378	570
KMD-BNT-02	7/17/2001	347	480
KMD-BNT-03	7/17/2001	375	580
KMD-BNT-04	7/17/2001	368	540
KMD-BNT-05	7/17/2001	373	540

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
KNW-SMB-1	10/15/2001	342	460
KNW-SMB-2	10/15/2001	350	600
KNW-SMB-5	10/16/2001	340	515
KNW-SMB-6	10/16/2001	320	400
KNW-SMB-7	10/16/2001	315	390
KNW-SMB-8	10/31/2001	305	400
KNW-SMB-9	10/31/2001	305	400
KNW-SMB-10	10/31/2001	300	345
KNW-SMB-11	10/31/2001	360	560
KNW-SMB-12	10/31/2001	340	600
KNW-SMB-13	10/31/2001	340	550
KNW-WHS-1	10/15/2001	455	1085
KNW-WHS-2	10/16/2001	500	1360
KNW-WHS-3	10/16/2001	465	1300
KNW-WHS-4	10/16/2001	450	1160
KNW-WHS-5	10/31/2001	470	1300
KNW-WHS-6	10/31/2001	450	1210
KNW-WHS-7	10/31/2001	465	1150
KNW-WHS-8	10/31/2001	465	1200
KNW-WHS-9	10/31/2001	480	1360
KNW-WHS-10	10/31/2001	470	1275
KNW-WHS-11	10/31/2001	485	1550
Fairfield			
KFF-BNT-01	8/2/2001	400	630
KFF-BNT-02	8/2/2001	382	600
KFF-BNT-03	8/2/2001	515	1220
KFF-BNT-04	10/30/2001	346	435
KFF-BNT-05	10/30/2001	495	1040
KFF-SMB-1	10/30/2001	360	580
KFF-SMB-2	10/30/2001	336	505
KFF-SMB-3	10/30/2001	350	540
KFF-SMB-4	10/30/2001	350	560
KFF-SMB-5	10/30/2001	355	600
KFF-SMB-6	10/30/2001	330	470
KFF-SMB-7	10/30/2001	336	490
KFF-SMB-8	10/30/2001	326	410
KFF-SMB-9	10/30/2001	305	330
KFF-SMB-10	10/30/2001	300	300

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
KFF-WHS-01	10/30/2001	460	1250
KFF-WHS-02	10/30/2001	467	1430
KFF-WHS-03	10/30/2001	475	1410
KFF-WHS-04	10/30/2001	483	1570
KFF-WHS-05	10/30/2001	467	1530
KFF-WHS-06	10/30/2001	456	1200
KFF-WHS-07	10/30/2001	459	1280
KFF-WHS-08	10/30/2001	482	1550
KFF-WHS-09	10/30/2001	477	1440
KFF-WHS-10	10/30/2001	485	1570
Winslow			
KWL-BNT-01	7/16/2001	376	470
KWL-BNT-02	7/16/2001	335	325
KWL-BNT-03	7/18/2001	412	700
KWL-BNT-04	11/1/2001	295	220
KWL-BNT-05	11/1/2001	285	200
Sidney			
KSD-SMB-1	8/16/2001	325	450
KSD-SMB-2	8/16/2001	310	380
KSD-SMB-3	8/16/2001	320	420
KSD-SMB-4	8/16/2001	309	330
KSD-SMB-5	8/16/2001	310	360
PENOBSCOT RIVER			
Weldon			
PBW-SMB-01		367	
PBW-SMB-02		357	
PBW-SMB-03		365	
PBW-SMB-04		370	
PBW-SMB-08		370	
PBW-SMB-11		380	
PBW-SMB-12		360	
PBW-SMB-13		357	
PBW-SMB-14		365	
PBW-SMB-15		380	
PBW-WHS-03		460	
PBW-WHS-04		469	
PBW-WHS-07		470	
PBW-WHS-14		455	
PBW-WHS-15		464	
PBW-WHS-18		458	
PBW-WHS-19		469	
PBW-WHS-24		475	
PBW-WHS-27		469	
PBW-WHS-28		462	

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
Mattawamkeag			
PBM-SMB1		392	
PBM-SMB2		357	
PBM-SMB3		363	
PBM-SMB4		360	
PBM-SMB5		375	
PBM-SMB6		355	
PBM-SMB7		374	
PBM-SMB8		353	
PBM-SMB9		372	
PBM-SMB10		345	
PBM-WHS-01		475	
PBM-WHS-02		470	
PBM-WHS-04		476	
PBM-WHS-05		460	
PBM-WHS-10		465	
PBM-WHS-11		451	
PBM-WHS-13		465	
PBM-WHS-14		466	
PBM-WHS-15		464	
PBM-WHS-16		455	
Lincoln			
PBL-SMB-01	8/28/2001	396	800
PBL-SMB-7	8/29/2001	395	875
PBL-SMB-8	8/29/2001	374	725
PBL-SMB-12	9/6/2001	376	809
PBL-SMB-13	9/7/2001	379	725
PBL-SMB-14	9/7/2001	384	
PBL-SMB-15	9/11/2001	379	750
PBL-SMB-16	9/11/2001	386	775
PBL-SMB-18	9/12/2001	389	850
PBL-SMB-19	9/12/2001	375	755
PBL-WHS-3	9/6/2001	467	1020
PBL-WHS-10	9/11/2001	472	1175
PBL-WHS-12	9/11/2001	461	1100
PBL-WHS-13	9/12/2001	466	1220
PBL-WHS-14	9/13/2001	466	1325
PBL-WHS-15	9/13/2001	460	1050
PBL-WHS-20	9/13/2001	475	
PBL-WHS-21	9/13/2001	459	
PBL-WHS-22	9/13/2001	463	
PBL-WHS-23	9/13/2001	460	

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
Costigan			
PBC-SMB-2	8/22/2001	389	875
PBC-SMB-6	8/23/2001	377	800
PBC-SMB-7	8/23/2001	371	775
PBC-SMB-11	9/7/2001	394	900
PBC-SMB-19	9/7/2001	382	850
PBC-WHS-2	8/17/2001	430	920
PBC-WHS-5	8/20/2001	452	1050
PBC-WHS-6	8/22/2001	410	825
PBC-WHS-7	8/22/2001	430	875
PBC-WHS-13	8/30/2001	416	975
PBC-WHS-15	9/6/2001	466	1250
PBC-WHS-17	9/6/2001	355	490
PBC-WHS-21	9/11/2001	458	1200
PBC-WHS-24	9/12/2001	452	1075
PBC-WHS-25	9/12/2001	455	1075
Veazie			
PBV-SMB-9	8/22/2001	371	575
PBV-SMB-12	8/22/2001	390	675
PBV-SMB-17	9/7/2001	388	825
PBV-SMB-18	9/7/2001	375	675
PBV-SMB-19	9/11/2001	378	675
PBV-WHS-01	6/9/2002	460	
PBV-WHS-02		455	
PBV-WHS-03	6/11/2002	365	
PBV-WHS-04	6/12/2002	400	
PBV-WHS-05	6/15/2002	308	
PBV-WHS-06	6/18/2002	300	
PBV-WHS-07	6/20/2002	380	
PBV-WHS-08		320	
PBV-WHS-09		310	
PBV-WHS-10	29-Aug	395	
Orrington			
PBO-EEL-01	Aug-01	474	230
PBO-EEL-02	Aug-01	544	376
PBO-EEL-03	Aug-01	491	278
PBO-EEL-04	Aug-01	528	278
PBO-EEL-05	Aug-01	540	335
PBO-EEL-06	Aug-01	590	330
PBO-EEL-07	Aug-01	576	353
PBO-EEL-08	Aug-01	535	375
PBO-EEL-09	Aug-01	590	430
PBO-EEL-10	Aug-01	525	230
PBO-EEL-11	Aug-01	570	353

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
PRESUMPSCOT RIVER			
Windham			
PWD-SMB-1	7/27/2001	278	280
PWD-SMB-2	7/30/2001	284	290
PWD-SMB-3	7/30/2001	295	300
PWD-SMB-4	7/30/2001	310	365
PWD-SMB-5	7/30/2001	280	280
PWD-WHS-01	7/27/2001	440	1100
PWD-WHS-02	7/31/2001	470	1240
PWD-WHS-03	7/31/2001	490	1180
PWD-WHS-04	7/31/2001	485	1220
PWD-WHS-05	7/31/2001	455	1020
PWD-WHS-06	7/31/2001	440	900
PWD-WHS-07	7/31/2001	445	960
PWD-WHS-08	7/31/2001	456	1040
PWD-WHS-09	7/31/2001	455	1160
PWD-WHS-10	7/31/2001	435	860
PWD-WHS-11	7/31/2001	434	910
Westbrook			
PWB-SMB-1	7/26/2001	290	330
PWB-SMB-2	7/26/2001	285	300
PWB-SMB-3	7/26/2001	295	320
PWB-SMB-4	7/26/2001	280	280
PWB-SMB-5	7/26/2001	270	270
PWB-WHS-01	7/27/2001	425	910
PWB-WHS-02	7/31/2001	415	780
PWB-WHS-03	7/31/2001	405	780
PWB-WHS-04	7/31/2001	430	950
PWB-WHS-05	7/31/2001	455	1060
PWB-WHS-06	7/31/2001	435	940
PWB-WHS-07	8/1/2001	455	1020
PWB-WHS-08	8/2/2001	435	1000
PWB-WHS-09	8/2/2001	420	740
PWB-WHS-10	8/2/2001	390	700
PWB-WHS-11	8/2/2001	460	1100
SALMON FALLS RIVER			
S. Berwick			
SFS-SMB-1	10/24/2001	334	
SFS-SMB-2	10/24/2001	385	
SFS-SMB-3	10/24/2001	264	
SFS-SMB-4	10/24/2001	255	

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
Sebasticook River West Br.-Palmyra			
SWP-SMB-1	8/15/2001	363	680
SWP-SMB-2	8/15/2001	294	300
SWP-SMB-3	8/15/2001	305	380
SWP-SMB-4	8/16/2001	395	860
SWP-SMB-5	8/16/2001	300	340
Sebasticook River East Br.-Newport			
SEN-SMB-01	8/9/2001	436	1120
SEN-SMB-02	8/9/2001	334	510
SEN-SMB-03	8/9/2001	342	490
SEN-SMB-04	8/9/2001	308	380
SEN-SMB-05	8/9/2001	306	390
Sebasticook River East Br.-Detroit			
SED-SMB-01	8/8/2001	340	600
SED-SMB-02	8/8/2001	319	390
SED-SMB-03	8/8/2001	380	745
SED-SMB-04	8/8/2001	343	600
SED-SMB-05	8/8/2001	270	320
SED-SMB-06	8/8/2001	310	400
SWAT			
Kennebec River Bath			
KRP-BLF-01	8/12/2001	30"	
KRP-BLF-02	8/12/2001	30"	
KRP-BLF-03	8/12/2001	30"	
KRP-BLF-04	8/12/2001	32"	
KRP-BLF-05	8/12/2001	33"	
Penobscot River			
PBO-STB-01	6/19/2001	625	
PBO-STB-02	6/19/2001	640	
PBO-STB-03	6/19/2001	620	
PBO-STB-04	6/19/2001	585	
PBO-STB-05	6/19/2001	540	
York River			
YRY-STB-01	6/20/2001	24.5"	
YRY-STB-02	6/20/2001	26"	
YRY-STB-03	6/20/2001	20.75"	
YRY-STB-04	6/20/2001	22.75"	
YRY-STB-05	6/20/2001	22"	

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
LAKES			
Cross Lake			
CRL-LLS-01	6/26/2001	470	1040
CRL-LLS-02	6/26/2001	430	735
CRL-LLS-03	6/26/2001	387	495
CRL-LLS-04	6/26/2001	447	710
CRL-LLS-05	6/26/2001	512	1070
Bradbury/Cochran Ponds			
BPN-SPK-01	6/26/2001	343	495
CPN-SPK-02	7/10/2001	350	470
CPN-SPK-03	7/10/2001	382	600
CPN-SPK-04	7/10/2001	380	600
CPN-SPK-05	7/10/2001	381	605
Monson Pond			
MPM-LKT-01	7/5/2001	486	840
MPM-LKT-02	7/5/2001	480	830
MPM-LKT-03	7/5/2001	415	590
MPM-LKT-04	7/5/2001	399	460
MPM-LKT-05	7/5/2001	443	670
Upper Shin Pd			
USP-LLS-01	7/11/2001	470	1110
USP-LLS-02	7/11/2001	393	540
USP-BKT-01	7/11/2001	296	320
Sabattus P.			
SPS-PKE-01	8/21/2001	558	1060
SPS-PKE-02	8/21/2001	505	730
SPS-PKE-03	8/21/2001	580	930
SPS-PKE-04	8/21/2001	525	830
SPS-PKE-05	8/21/2001	555	900
Alford Lk			
#4798-BNT-01	8/3/2001	445	830
#4798-BNT-02	8/3/2001	421	610
#4798-BNT-03	8/3/2001	449	860
#4798-BNT-04	8/3/2001	411	650
#4798-BNT-05	8/3/2001	460	1050
Spectacle Pd			
#5410-BNT-01	8/7/2001	468	1120
#5410-BNT-02	8/7/2001	459	1120
#5410-BNT-03	8/7/2001	434	1120
#5410-BNT-04	8/7/2001	500	1580
#5410-BNT-05	8/7/2001	502	1490

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
Biscay Pd			
#5710-SPK-01	7/27/2001	325	275
#5710-SPK-02	7/27/2001	400	475
#5710-SPK-03	7/27/2001	336	350
#5710-SPK-04	7/27/2001	441	760
#5710-SPK-05	7/27/2001	315	200
#5710-BNT-01	7/27/2001	361	475
#5710-BNT-02	7/27/2001	435	775
#5710-BNT-03	7/27/2001	396	575
#5710-BNT-04	7/27/2001	436	950
#5710-BNT-05	7/27/2001	476	1125
Minnehonk L			
#5812-SPK-01	8/1/2001	335	350
#5812-SPK-02	8/1/2001	332	325
#5812-SPK-03	8/1/2001	340	350
#5812-SPK-04	8/1/2001	320	275
#5812-SPK-05	8/1/2001	353	350
Chamberlain L			
#2882-LKT-01	10/10/2001	600	1980
#2882-LKT-02	10/11/2001	607	1830
#2882-LKT-03	10/12/2001	528	1380
#2882-LKT-04	10/12/2001	589	720
#2882-LKT-05	10/12/2001	552	1520
Sandy River P	**(Middle)**		
#3566-BKT-01	7/10/2001	362	630
#3566-BKT-02	7/10/2001	346	490
#3566-BKT-03	7/10/2001	309	305
#3566-BKT-04	7/10/2001	318	415
#3566-BKT-05	7/10/2001	293	275
Tufts Pd			
#28-SPK-01	6/28/2001	385	415
#28-SPK-02	6/28/2001	411	580
#28-SPK-03	6/28/2001	370	425
#28-SPK-04	6/28/2001	385	535
#28-SPK-05	6/28/2001	372	430
#28-BKT-01	6/28/2001	300	250
#28-BKT-02	6/28/2001	279	220
#28-BKT-03	6/28/2001	292	245
#28-BKT-04	6/28/2001	300	275
#28-BKT-05	6/28/2001	290	285

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
Cliff Lk			
#2780-LKT-01	FALL 2001	508	1240
#2780-LKT-02	FALL 2001	545	1410
#2780-LKT-03	FALL 2001	559	1850
#2780-LKT-04	FALL 2001	400	540
Big Indian Pd			
LK2866-LKT-01	8/22/2001	470	1060
LK2866-LKT-02	8/22/2001	610	2500
LK2866-LKT-03	8/22/2001	525	1480
LK2866-LKT-04	8/22/2001	618	2550
LK2866-LKT-05	8/22/2001	705	3700
LK2866-BKT-01	8/22/2001	420	890
LK2866-BKT-02	8/22/2001	415	840
LK2866-BKT-03	8/22/2001	368	540
LK2866-BKT-04	8/22/2001	378	640
LK2866-BKT-05	8/22/2001	375	520
LK2866-BKT-06	8/22/2001	378	700
First Roach Pd			
#436-LKT-01	07/17/01	432	630
#436-LKT-02	07/17/01	427	620
#436-LKT-03	07/17/01	449	570
#436-LKT-04	07/17/01	472	740
#436-LKT-05	07/17/01	475	830
Millinocket L			
LK2020-LKT1	7/12/2001	380	500
LK2020-LKT2	7/12/2001	589	2100
LK2020-LKT3	7/12/2001	405	600
LK2020-LKT4	7/12/2001	456	1000
LK2020-LKT5	7/12/2001	476	1050
Webster L			
LK2718-LKT1	6/22/2001	477	930
LK2718-LKT2	6/22/2001	565	1580
LK2718-LKT3	6/22/2001	508	1160
LK2718-LKT4	6/22/2001	552	1200
LK2718-LKT5	6/22/2001	550	1420
LKT2718-BKT1	6/22/2001	405	700
LKT2718-BKT2	6/22/2001	367	470
LKT2718-BKT3	6/22/2001	225	130
LKT2718-BKT4	6/22/2001	235	145
LKT2718-BKT5	6/22/2001	337	380

Fish ID, lengths and weights for the 2001 SWAT monitoring program

field ID	Date	Length mm	Weight gm.
Androscoggin L			
ALWPKL01	2/7/2002	588	1380
ALWPKL02	2/7/2002	540	1050
ALWPKL03	2/7/2002	420	520
ALWPKL04	2/7/2002	552	1000
ALWPKL05	2/7/2002	500	840
Branch P			
PLK01	2/6/2002	370	340
PLK02	2/6/2002	350	290
PLK03	2/6/2002	380	320
PLK04	2/6/2002	335	230
PLK05	2/6/2002	400	400
China L			
PKL01	2/1/2002	552	880
PKL02	2/1/2002	462	500
PKL03	2/1/2002	565	1000
PKL04	2/1/2002	550	1000
PKL05	2/1/2002	580	1220
Givens P			
PKL01	1/30/2002	330	210
PKL02	1/30/2002	330	210
PKL03	1/30/2002	327	230
PKL04	1/30/2002	326	225
PKL05	1/30/2002	380	340
Moosehead L			
LK0390LLS01	7/20/2001	377	440
LK0390LLS02	7/20/2001	363	450
LK0390LLS03	7/20/2001	435	820
LK0390LLS04	7/20/2001	430	720
LK0390LLS05	7/20/2001	386	520