1999 SWAT MONITORING PROGRAM REPORT

PART 2 LAKES

2.1 MERCURY DEPOSITION NETWORK

PRINCIPAL INVESTIGATORS	Barry Mower
	Cathy Richardson
	Bob Breen, ANP
TECHNICAL ASSISTANTS	William Gawley, ANP
	Peter Lowell, LEA
	Richard Mailey
	Don Prince
	John Reynolds

2.2 INDICATOR SPECIES

PRINCIPAL INVESTIGATOR	Barry Mower
	Andrew Smith, DHS
TECHNICAL ASSISTANTS	John Reynolds
	Andrew Merrill
	Charles Penney

2.3 MERCURY DOWNWIND OF MWIs

PRINCIPAL INVESTIGATOR	David Courtemanch
TECHNICAL ASSISTANTS	John Reynolds
	Andrew Merrill

2.4 LOON EFFECTS STUDY

PRINCIPAL INVESTIGATOR	David Evers, BRI

2.5 MERCURY TRENDS

PRINCIPAL INVESTIGATOR	Terry Haines, UM

2.1

MERCURY DEPOSITION NETWORK

MERCURY DEPOSITION NETWORK

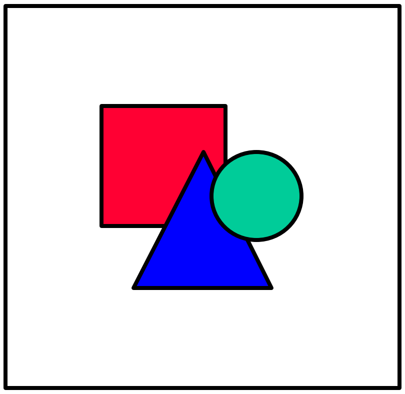
Atmospheric deposition is thought to be a significant source of mercury to Maine surface waters. In order to determine the relative significance of sources throughout Maine and the Northeast region, Maine has joined the Mercury Deposition Network (MDN). The MDN was created as an adjunct to the National 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), Bridgeton (since July 1997), Greenville (since September 1996), and Freeport (since 1998). The ANP station is supported equally by the National Park Service (NPS) and DEP through SWAT ($6000). The Greenville station is funded entirely by SWAT ($16500). The Bridgeton station is funded primarily by an EPA REMAP grant, with DEP providing the station operator and mailing of the samples ($3150 SWAT). The Freeport station is supported entirely by a grant from EPA.

Annual deposition is greatest for the Freeport station followed in decreasing order by Acadia National Park, Bridgton and Greenville for both years (1998 and 1999) where data are available for all four stations. 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.

Mercury Deposition Network: a NADP Network



(.pdf)

MDN Objectives

The objective of the MDN is to develop a national database of weekly concentrations of total mercury in precipitation and the seasonal 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 (>	B	Y

8days)		
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

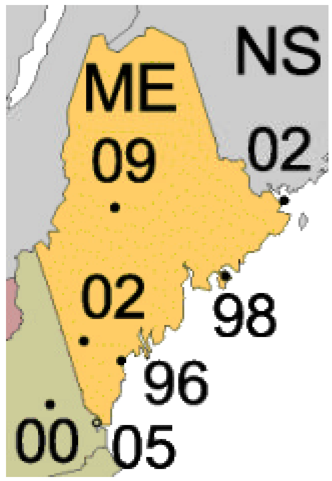
BC used to calculate deposition. These samples are also coded with an “i” in the Notes field and downgraded to a “B” Quality Rating to indicate uncertainty due to low volume. If the BC is > 10 mL, the sample type will be set to “W” (wet) and the BC will be used to calculate deposition.

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.

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				

Table 2.1 ANNUAL MERCURY DEPOSITION AT MAINE MDN STATIONS

TABLE 2.1 ANNUAL MERCURY DEPOSITION AT MAINE MDN STATIONS

		ANNUAL DEPOSITION (ug/m2)			
STATION	ID	1996	1997	1998	1999
Bridgton	MEO2			6.9	6.7
Greenville	ME09	5.5e	5.5	6.8	6.6
Freeport	ME96			11.0e	8.6
ANP	ME98	8.4	7.7	9.0	7.1

		MEAN CONCENTRATION (ng/l)			
STATION	ID	1996	1997	1998	1999
Bridgton	MEO2			6.5	6.6
Greenville	ME09	4.0e	5.9	6.0	5.6
Freeport	ME96			8.6	7.5
ANP	ME98	6.0e	6.8	6.1	6.8

e=estimated since station began during the year

National Atmospheric Deposition Program/MDN

Weekly Mercury Concentrations and Depositions

Bridgton ME02

Site	Date On	Date Off	Subppt	Pptrec	HgConc	HgDep	QR	Sample Type	Notes
			mm	Mm	Ng/L	ng/m²			
ME02	12/29/1998	01/05/1999	24.1	24.1	1.8	43.1	A	W	
ME02	01/05/1999	01/12/1999	19.4	--	1.5	29.6	B	W	m
ME02	01/12/1999	01/19/1999	69.6	69.6	3.8	262.6	B	W	m
ME02	01/19/1999	01/26/1999	22.9	22.9	5.2	117.9	B	W	h
ME02	01/26/1999	02/02/1999	2.3	2.3	--	--	C	W	v
ME02	02/02/1999	02/09/1999	36.1	36.1	3.2	115.4	A	W	
ME02	02/09/1999	02/16/1999	4.8	4.8	14.6	70.4	B	W	d
ME02	02/16/1999	02/23/1999	12.7	12.7	6.5	81.9	A	W	
ME02	02/23/1999	03/02/1999	45.0	45.0	3.7	163.9	B	W	d
ME02	03/02/1999	03/09/1999	36.3	--	6.1	222.3	B	W	dm
ME02	03/09/1999	03/16/1999	8.9	8.9	6.2	55.5	B	W	hd
ME02	03/16/1999	03/23/1999	38.9	38.9	7.2	279.9	B	W	d
ME02	03/23/1999	03/30/1999	10.9	10.9	11.1	120.9	B	W	d
ME02	03/30/1999	04/06/1999	0.8	0.8	22.8	17.4	B	W	di
ME02	04/06/1999	04/13/1999	1.2	1.2	25.2	29.5	B	W	d
ME02	04/13/1999	04/20/1999	1.3	1.3	19.7	25.0	B	W	d
ME02	04/20/1999	04/27/1999	0.0	0.0	--	0.0	B	T	d
ME02	04/27/1999	05/04/1999	0.0	0.0	--	0.0	B	D	d
ME02	05/04/1999	05/11/1999	31.2	31.2	13.2	411.9	B	W	d
ME02	05/11/1999	05/18/1999	0.0	0.0	--	0.0	B	D	d
ME02	05/18/1999	05/25/1999	38.9	38.9	10.3	398.5	A	W	
ME02	05/25/1999	06/01/1999	1.8	1.8	10.8	19.3	B	W	d
ME02	06/01/1999	06/08/1999	12.7	12.7	11.8	150.0	B	W	d
ME02	06/08/1999	06/15/1999	4.2	4.2	8.4	35.4	A	W	
ME02	06/15/1999	06/22/1999	5.6	5.6	20.3	113.5	A	W	
ME02	06/22/1999	06/29/1999	27.4	27.4	17.3	473.8	B	W	d
ME02	06/29/1999	07/06/1999	40.9	40.9	5.4	220.3	B	W	d
ME02	07/06/1999	07/13/1999	17.3	17.3	12.5	215.5	B	W	d
ME02	07/13/1999	07/20/1999	5.6	5.6	12.8	71.5	A	W	
ME02	07/20/1999	07/27/1999	19.3	19.3	10.7	206.7	B	W	d
ME02	07/27/1999	08/03/1999	0.0	0.0	--	0.0	A	T	

ME02	08/03/1999	08/10/1999	34.2	34.2	9.6	327.5	B	W	d
ME02	08/10/1999	08/17/1999	35.6	35.6	8.7	307.5	B	W	d
ME02	08/17/1999	08/24/1999	12.7	12.7	8.5	107.6	B	W	d
ME02	08/24/1999	08/31/1999	1.5	1.5	29.8	45.4	B	W	d
ME02	08/31/1999	09/07/1999	11.4	11.4	7.1	81.2	B	W	d
ME02	09/07/1999	09/14/1999	86.0	86.0	3.0	254.8	B	W	d
ME02	09/14/1999	09/21/1999	141.0	141.0	3.1	434.8	B	W	d
ME02	09/21/1999	09/28/1999	10.8	10.8	12.6	135.5	B	W	d
ME02	09/28/1999	10/05/1999	21.3	21.3	6.1	130.2	A	W	
ME02	10/05/1999	10/12/1999	1.5	1.5	7.4	11.2	A	W	
ME02	10/12/1999	10/19/1999	14.0	14.0	7.0	98.2	A	W	
ME02	10/19/1999	10/26/1999	59.7	--	2.1	123.8	B	W	dm
ME02	10/26/1999	11/02/1999	0.0	0.0	--	0.0	A	T	
ME02	11/02/1999	11/09/1999	25.4	25.4	6.4	161.3	B	W	d
ME02	11/09/1999	11/16/1999	11.8	11.8	8.0	94.9	B	W	d
ME02	11/16/1999	11/23/1999	9.7	9.7	7.5	72.4	B	W	d
ME02	11/23/1999	11/30/1999	23.4	23.4	9.0	210.0	B	W	d
ME02	11/30/1999	12/07/1999	10.4	10.4	6.4	66.6	B	W	dm
ME02	12/07/1999	12/14/1999	5.3	5.3	9.9	52.9	B	W	dm
ME02	12/14/1999	12/21/1999	26.4	26.4	5.9	157.0	B	W	dm
ME02	12/21/1999	12/28/1999	0.0	0.0	--	0.0	B	D	hdm
ME02	12/28/1999	01/04/2000	12.7	12.7	12.1	153.7	B	W	d

National Atmospheric Deposition Program/MDN

Weekly Mercury Concentrations and Depositions

Greenville ME09

Site	Date On	Date Off	Subppt	Pptrec	HgConc	HgDep	QR	Sample Type	Notes
			mm	Mm	ng/L	ng/m²			
ME09	12/29/1998	01/05/1999	31.8	31.8	1.0	30.4	A	W	
ME09	01/05/1999	01/12/1999	18.0	18.0	--	--	C	W	uz
ME09	01/12/1999	01/19/1999	80.8	80.8	2.6	209.6	B	W	z
ME09	01/19/1999	01/26/1999	16.0	16.0	4.9	77.7	A	W	
ME09	01/26/1999	02/02/1999	0.0	0.0	--	0.0	B	D	z
ME09	02/02/1999	02/09/1999	18.3	18.3	2.8	51.7	B	W	z
ME09	02/09/1999	02/16/1999	4.6	4.6	10.2	46.8	A	W	
ME09	02/16/1999	02/23/1999	8.4	8.4	9.2	76.9	B	W	hz
ME09	02/23/1999	03/02/1999	41.1	41.1	2.4	96.7	A	W	
ME09	03/02/1999	03/09/1999	39.1	39.1	3.8	148.7	B	W	hd
ME09	03/09/1999	03/16/1999	39.1	39.1	--	--	C	W	fzdm
ME09	03/16/1999	03/23/1999	36.8	36.8	2.5	93.0	B	W	d
ME09	03/23/1999	03/30/1999	5.3	5.3	6.5	34.8	A	W	
ME09	03/30/1999	04/06/1999	2.8	2.8	10.3	28.8	B	W	d
ME09	04/06/1999	04/13/1999	13.7	13.7	9.1	124.4	B	W	d
ME09	04/13/1999	04/20/1999	0.0	0.0	--	0.0	B	T	d
ME09	04/20/1999	04/27/1999	1.3	1.3	15.8	20.9	A	W	
ME09	04/27/1999	05/04/1999	0.0	0.0	--	0.0	B	D	d
ME09	05/04/1999	05/11/1999	23.1	23.1	4.6	105.7	B	W	hd
ME09	05/11/1999	05/18/1999	0.0	0.0	--	0.0	A	T	
ME09	05/18/1999	05/25/1999	28.0	28.0	12.2	342.1	B	W	hd
ME09	05/25/1999	06/01/1999	20.3	20.3	10.6	214.8	B	W	hd
ME09	06/01/1999	06/08/1999	35.3	35.3	18.5	651.8	B	W	d
ME09	06/08/1999	06/15/1999	67.6	67.6	6.9	466.7	B	W	d
ME09	06/15/1999	06/22/1999	2.0	2.0	7.1	14.4	B	W	d
ME09	06/22/1999	06/29/1999	17.0	17.0	18.2	309.3	B	W	d
ME09	06/29/1999	07/06/1999	38.1	38.1	4.9	184.7	B	W	d
ME09	07/06/1999	07/13/1999	26.7	26.7	6.1	161.6	B	W	d
ME09	07/13/1999	07/20/1999	0.0	0.0	--	0.0	A	T	
ME09	07/20/1999	07/27/1999	3.8	3.8	27.4	104.4	B	W	d
ME09	07/27/1999	08/03/1999	8.1	8.1	17.0	138.4	B	W	d
ME09	08/03/1999	08/10/1999	47.0	47.0	10.1	473.8	B	W	hd
ME09	08/10/1999	08/17/1999	22.4	22.4	5.5	123.8	B	W	d

ME09	08/17/1999	08/24/1999	7.4	7.4	10.1	74.4	B	W	d
ME09	08/24/1999	08/31/1999	1.8	1.8	3.2	5.7	B	W	d
ME09	08/31/1999	09/07/1999	0.0	0.0	--	0.0	B	T	d
ME09	09/07/1999	09/14/1999	77.8	77.8	3.8	295.3	B	W	d
ME09	09/14/1999	09/21/1999	146.3	146.3	3.5	506.5	B	W	d
ME09	09/21/1999	09/28/1999	26.0	26.0	12.7	330.9	B	W	d
ME09	09/28/1999	10/05/1999	40.4	40.4	2.8	113.7	B	W	d
ME09	10/05/1999	10/12/1999	5.8	5.8	8.5	49.7	A	W	
ME09	10/12/1999	10/19/1999	40.9	40.9	2.5	100.3	B	W	hd
ME09	10/19/1999	10/26/1999	43.2	43.2	2.0	87.6	B	W	hd
ME09	10/26/1999	11/02/1999	5.1	5.1	6.0	30.6	A	W	
ME09	11/02/1999	11/09/1999	39.6	39.6	3.7	145.1	B	W	d
ME09	11/09/1999	11/16/1999	18.4	18.4	4.9	89.5	A	W	
ME09	11/16/1999	11/23/1999	10.1	10.1	7.7	77.8	B	W	d
ME09	11/23/1999	11/30/1999	37.3	37.3	3.8	141.0	B	W	hd
ME09	11/30/1999	12/07/1999	2.8	2.8	4.1	11.4	B	W	d
ME09	12/07/1999	12/14/1999	45.1	45.1	3.0	135.8	B	W	hd
ME09	12/14/1999	12/21/1999	21.6	21.6	3.1	65.9	B	W	d
ME09	12/21/1999	12/28/1999	0.0	0.0	--	0.0	A	D	

National Atmospheric Deposition Program/MDN

Weekly Mercury Concentrations and Depositions

Freeport ME96

Site	Date On	Date Off	Subppt	Pptrec	HgConc	HgDep	QR	Sample Type	Notes
			mm	mm	ng/L	ng/m²			
ME96	12/29/1998	01/05/1999	28.9	--	2.0	58.1	B	W	m
ME96	01/05/1999	01/12/1999	33.8	33.8	5.2	174.5	B	W	h
ME96	01/12/1999	01/19/1999	84.8	84.8	5.3	448.0	A	W	
ME96	01/19/1999	01/26/1999	10.9	10.9	6.4	70.2	A	W	
ME96	01/26/1999	02/02/1999	0.0	0.0	--	0.0	A	T	
ME96	02/02/1999	02/08/1999	54.1	54.1	4.3	229.9	B	W	h
ME96	02/08/1999	02/16/1999	0.5	0.5	16.6	8.4	B	T	i
ME96	02/16/1999	02/23/1999	20.8	20.8	4.6	95.9	A	W	
ME96	02/23/1999	03/02/1999	63.8	63.8	3.8	243.8	B	W	d
ME96	03/02/1999	03/09/1999	19.3	19.3	9.9	191.6	B	W	d
ME96	03/09/1999	03/16/1999	18.3	18.3	2.9	53.8	B	W	d
ME96	03/16/1999	03/22/1999	29.2	29.2	12.0	349.3	B	W	d
ME96	03/23/1999	03/30/1999	46.2	--	5.9	271.5	B	W	dm
ME96	03/30/1999	04/06/1999	1.3	1.3	13.4	17.1	B	W	d
ME96	04/06/1999	04/13/1999	0.8	0.8	30.3	23.1	B	W	id
ME96	04/13/1999	04/20/1999	0.7	--	29.0	20.3	B	T	id
ME96	04/20/1999	04/27/1999	3.6	3.6	18.6	67.2	B	W	d
ME96	04/27/1999	05/04/1999	0.0	0.0	--	0.0	B	T	d
ME96	05/04/1999	05/11/1999	45.1	45.1	10.6	476.7	B	W	d
ME96	05/11/1999	05/18/1999	0.0	0.0	--	0.0	B	D	d
ME96	05/18/1999	05/25/1999	80.6	80.6	8.3	667.3	B	W	d
ME96	05/25/1999	06/01/1999	2.5	2.5	17.4	44.2	A	W	
ME96	06/01/1999	06/08/1999	6.9	6.9	18.5	127.0	B	W	d
ME96	06/08/1999	06/15/1999	2.5	2.5	--	--	C	W	fdz
ME96	06/15/1999	06/22/1999	0.1	--	28.2	2.8	B	T	dmi
ME96	06/22/1999	06/29/1999	16.3	16.3	17.4	284.0	B	W	dm
ME96	06/29/1999	07/06/1999	9.9	9.9	15.8	156.9	B	W	hm
ME96	07/06/1999	07/13/1999	13.8	--	--	--	C	W	uhdmz
ME96	07/13/1999	07/20/1999	11.4	11.4	19.0	217.1	A	W	
ME96	07/20/1999	07/27/1999	9.9	9.9	16.3	161.1	B	W	d
ME96	07/27/1999	08/03/1999	0.0	0.0	--	0.0	A	D	
ME96	08/03/1999	08/10/1999	28.2	28.2	9.9	278.1	B	W	d
ME96	08/10/1999	08/17/1999	22.9	22.9	17.2	393.6	B	W	d

ME96	08/17/1999	08/24/1999	8.4	--	9.4	78.9	B	W	dm
ME96	08/24/1999	08/31/1999	4.3	4.3	5.1	22.0	B	W	d
ME96	08/31/1999	09/07/1999	14.6	14.6	6.0	86.9	B	W	d
ME96	09/07/1999	09/14/1999	81.5	81.5	6.5	526.1	B	W	d
ME96	09/14/1999	09/21/1999	120.7	120.7	8.2	993.4	B	W	d
ME96	09/21/1999	09/28/1999	11.3	11.3	8.7	98.0	B	W	d
ME96	09/28/1999	10/05/1999	28.4	28.4	6.8	192.3	A	W	
ME96	10/05/1999	10/12/1999	6.6	6.6	8.7	57.4	A	W	
ME96	10/12/1999	10/19/1999	20.1	20.1	9.6	191.9	B	W	d
ME96	10/19/1999	10/26/1999	79.0	79.0	2.0	157.7	B	W	d
ME96	10/26/1999	11/02/1999	0.0	0.0	--	0.0	A	T	
ME96	11/02/1999	11/09/1999	23.6	23.6	3.4	79.3	B	W	d
ME96	11/09/1999	11/16/1999	17.5	17.5	12.0	210.2	A	W	
ME96	11/16/1999	11/23/1999	7.6	7.6	6.7	50.9	B	W	hd
ME96	11/23/1999	11/30/1999	18.5	18.5	11.6	215.3	B	W	hd
ME96	11/30/1999	12/07/1999	16.3	16.3	4.8	77.8	B	W	dm
ME96	12/07/1999	12/14/1999	7.1	7.1	7.6	54.3	B	W	d
ME96	12/14/1999	12/21/1999	28.2	28.2	3.1	87.7	B	W	d
ME96	12/21/1999	12/28/1999	0.0	0.0	--	0.0	A	D	
ME96	12/28/1999	01/04/2000	3.8	3.8	15.4	58.5	B	W	d

National Atmospheric Deposition Program/MDN

Weekly Mercury Concentrations and Depositions

Acadia National Park

Site	Date On	Date Off	Subppt	Pptrec	HgConc	HgDep	QR	Sample Type	Notes
			mm	mm	ng/L	ng/m²			
ME98	12/29/1998	01/05/1999	37.6	37.6	1.8	68.1	B	W	hm
ME98	01/05/1999	01/12/1999	34.0	34.0	4.6	154.9	A	W	
ME98	01/12/1999	01/19/1999	67.8	67.8	3.6	243.1	B	W	h
ME98	01/19/1999	01/26/1999	16.8	16.8	4.2	69.8	B	W	h
ME98	01/26/1999	02/02/1999	0.0	0.0	--	0.0	A	D	
ME98	02/02/1999	02/09/1999	80.0	80.0	2.7	218.2	A	W	
ME98	02/09/1999	02/16/1999	8.1	8.1	8.0	65.2	B	W	d
ME98	02/16/1999	02/23/1999	20.1	20.1	5.3	106.3	B	W	d
ME98	02/23/1999	03/02/1999	54.1	54.1	4.4	236.0	B	W	dm
ME98	03/02/1999	03/09/1999	19.1	19.1	6.1	115.3	B	W	d
ME98	03/09/1999	03/16/1999	50.8	50.8	2.1	104.2	B	W	d
ME98	03/16/1999	03/23/1999	12.7	12.7	10.1	128.8	B	W	d
ME98	03/23/1999	03/30/1999	43.4	43.4	5.5	240.8	B	W	d
ME98	03/30/1999	04/06/1999	5.1	5.1	8.0	40.5	B	W	d
ME98	04/06/1999	04/13/1999	2.8	2.8	18.1	50.7	B	W	d
ME98	04/13/1999	04/20/1999	0.0	0.0	--	0.0	B	D	d
ME98	04/20/1999	04/27/1999	2.8	2.8	14.5	40.7	B	W	d
ME98	04/27/1999	05/04/1999	0.0	0.0	--	0.0	A	D	
ME98	05/04/1999	05/11/1999	23.4	23.4	15.5	363.3	B	W	d
ME98	05/11/1999	05/18/1999	0.0	0.0	--	0.0	B	D	d
ME98	05/18/1999	05/25/1999	50.8	50.8	6.2	316.4	B	W	d
ME98	05/25/1999	06/01/1999	0.0	0.0	--	0.0	B	T	d
ME98	06/01/1999	06/08/1999	9.9	9.9	27.3	270.1	B	W	d
ME98	06/08/1999	06/15/1999	11.9	11.9	26.4	315.0	B	W	d
ME98	06/15/1999	06/22/1999	0.0	0.0	--	0.0	B	D	d
ME98	06/22/1999	06/29/1999	24.6	24.6	10.6	261.8	B	W	d
ME98	06/29/1999	07/06/1999	14.0	14.0	8.0	111.1	B	W	d
ME98	07/06/1999	07/13/1999	17.8	17.8	15.7	279.4	B	W	d
ME98	07/13/1999	07/20/1999	3.6	3.6	17.0	60.9	A	W	
ME98	07/20/1999	07/27/1999	1.5	1.5	20.2	30.8	A	W	
ME98	07/27/1999	08/03/1999	0.0	0.0	--	0.0	A	D	
ME98	08/03/1999	08/10/1999	20.8	20.8	8.6	179.7	B	W	d
ME98	08/10/1999	08/17/1999	12.4	12.4	9.7	119.6	B	W	d

ME98	08/17/1999	08/24/1999	1.5	1.5	12.0	18.3	B	W	d
ME98	08/24/1999	08/31/1999	1.0	1.0	28.1	28.5	B	W	di
ME98	08/31/1999	09/07/1999	0.0	0.0	--	0.0		T	n
ME98	09/07/1999	09/14/1999	26.3	26.3	4.3	113.8	B	W	d
ME98	09/14/1999	09/21/1999	102.9	102.9	12.5	1287.4	B	W	d
ME98	09/21/1999	09/28/1999	98.3	98.3	4.4	429.8	B	W	d
ME98	09/28/1999	10/05/1999	23.4	23.4	6.9	160.7	A	W	
ME98	10/05/1999	10/12/1999	15.2	15.2	--	--	C	W	f
ME98	10/12/1999	10/19/1999	52.6	52.6	3.8	198.1	A	W	
ME98	10/19/1999	10/26/1999	54.9	54.9	5.3	288.2	B	W	d
ME98	10/26/1999	11/02/1999	0.0	0.0	--	0.0	A	T	
ME98	11/02/1999	11/09/1999	57.2	57.2	3.7	210.1	B	W	d
ME98	11/09/1999	11/16/1999	48.3	48.3	4.4	212.0	B	W	d
ME98	11/16/1999	11/23/1999	17.8	17.8	6.4	114.2	B	W	d
ME98	11/23/1999	11/30/1999	40.0	40.0	4.1	164.7	B	W	hd
ME98	11/30/1999	12/07/1999	44.8	44.8	5.7	253.1	B	W	d
ME98	12/07/1999	12/14/1999	47.0	47.0	2.7	127.2	A	W	
ME98	12/14/1999	12/21/1999	32.8	32.8	4.4	145.0	B	W	d
ME98	12/21/1999	12/28/1999	0.0	0.0	--	0.0		D	hn
ME98	12/28/1999	01/04/2000	14.2	14.2	20.2	286.6	B	W	dh

2.2

INDICATOR SPECIES

INDICATOR SPECIES

The current Statewide FCA for mercury making a distinction between coldwater and warmwater fish is based on limited data. The Maine Bureau of Health (BOH) has requested additional data in order to verify the appropriateness of the current advisories and to enable additional refinements. In addition, BOH would like to be able to provide to the public specific information on as many individual lakes as possible. In addition, a recommendation of the Maine Land and Water Resources Council 1997 annual report, Appendix A titled 'Mercury in Maine', is to expand fish sampling for mercury analysis to meet this need.

In order to make this effort cost-effective, it is necessary identify indicator species of fish, to avoid the need for testing multiple species in the full program in future years. Although previous studies have indicated how mercury concentrations vary among species, those species were collected from different lakes. Since the lakes were numerous and randomly selected, differences in concentrations were ascribed to species, but may have been a result of a lake effect rather than a species effect. Most of these studies also relied on composite samples of a number of fish rather than individuals, which confounds interpretation of the results.

To begin to sort out lake effects from species effects, in 1998 multiple species were collected from the same lakes. Lakes were divided into 2 groups, coldwater and warmwater lakes. Within each group three lakes were selected. A minimum of 2 species, white perch and black bass, were to be collected from the warmwater lakes and a minimum of 4 species, black bass, white perch, lake trout and landlocked salmon, were to be collected from coldwater lakes. Edible filets of 15 fish of each species were to be analyzed individually for mercury.

In 1998 we were able to collect only 2 species from 2 warmwater lakes and 2-3 species from 4 coldwater lakes. Sample sizes ranged from 1-10. These data are insufficient to identify indicator species. Therefore, in 1999 we attempted to conduct the entire study and collect 4 species in 3 lakes and 2 species from 3 lakes in 1999. The target sample sizes were 10 fish from each lake.

In 1999 we were able to collect fish from an additional 2 warmwater lakes and 3 coldwater lakes. Only at Sebago were we able to get all 4 species. We have now collected fish from 11 lakes over the two years combined. From coldwater lakes we have data on 4 species from 1 lake, 3 species from 4 lakes, and 2 species from 2 lakes. We have 2 species from 4 warmwater lakes. Results were highly variable with one species having highest concentrations of all species sampled in some lakes and another species having the highest concentrations in other lakes. No single indicator species was identified for either type of lake.

TABLE 2.2.1 MERCURY LEVELS IN INDICATOR SPECIES FROM SOME MAINE LAKES

SPECIES	Branch L LK4328	Echo L **LK5814**	Moose P LK3134	Panther P LK3694	Pleasant L LK3446	Sebago L **LK5786**	Sheepscot L **LK4896**	Sandy P **LK5174**	Webber P **LK5408**	McCurdy P Lk5712	3-Mile P LK5416
	COLDWATER LAKES							WARMWATER LAKES			
								LMB			LMB
SMB-01	0.62	0.546	0.77	0.75	0.99	0.506	1.12	0.459	0.708	0.28	0.88
SMB-02	0.95	0.425	0.79	0.69	1.45	0.400	1.80	0.528	0.584	0.30	0.48
SMB-03	0.66	0.907	0.54	0.97	0.79	0.280	1.09	0.356	0.664	0.45	0.63
SMB-04	0.77	0.428	0.87	0.68	0.62	0.427	1.13	0.577	0.166	0.30	0.21
SMB-05	1.07	0.530	0.96	0.55	1.23	0.429	1.19	0.322	0.592	0.57	0.70
SMB-06	0.75		0.94	0.92	0.42	0.699	1.20	0.306	0.625	0.35	0.46
SMB-07	0.62		1.47	0.84	0.73	0.501	0.913	0.260	0.519	0.24	0.78
SMB-08	0.36			0.76		0.427	1.59	0.317	0.342		0.86
SMB-09	0.55			0.61		0.348	1.47	0.179	0.683		0.47
SMB-10	1.12			0.41		0.489	1.03	0.333	0.921		0.39
MEAN	**0.74**	**0.57**	**0.90**	**0.72**	**0.89**	**0.45**	**1.25**	**0.36**	**0.58**	**0.36**	**0.58**
WHP-01	0.26	0.711	0.28	0.36	0.79	0.439		0.179	0.301	0.54	1.01
WHP-02		0.470	0.54	0.69	0.58	1.34		0.186	0.236	0.40	0.93
WHP-03		0.739	0.55	0.73	0.80	0.360		0.344	0.183	0.52	0.38
WHP-04		1.74	0.49	0.51	0.92	0.420		0.222	0.253	0.54	0.30
WHP-05		0.862	0.48	0.72	0.91	0.877		0.171	0.238	0.45	0.40
WHP-06		0.448	0.21	0.78	0.75	0.714		0.120	0.253	0.31	0.51
WHP-07		0.638		0.80	0.97	0.593		0.154	0.174	0.44	0.54
WHP-08		1.19		0.41	1.06	0.808		0.445	0.378	0.47	0.74
WHP-09		0.657			0.79	0.502		0.160	0.171	0.56	0.37
WHP-10					0.77	0.446		0.261	0.187	0.47	0.61
								0.186			
MEAN		**0.83**	**0.43**	**0.62**	**0.83**	**0.65**		**0.22**	**0.24**	**0.47**	**0.58**
LKT-01	0.88	0.550				0.391	0.966				
LKT-02	0.61	0.629				0.429	1.01				
LKT-03	0.53	0.473				0.402	0.989				
LKT-04	0.73	0.298				0.460	0.447				
LKT-05	0.52	0.653				0.405	0.735				
LKT-06	0.50	0.423				0.405	0.967				
LKT-07	0.78					0.262					
LKT-08	0.56					0.386					
LKT-09	0.61					0.449					
LKT-10	0.49					0.475					
MEAN	**0.62**	**0.50**				**0.41**	**0.85**				
LLS-01	0.39		0.51	0.32	0.65	0.657	0.762				
LLS-02	0.28		0.40	0.28	0.24	0.419	0.505				
LLS-03			0.36	0.20	0.32	0.318	0.206				
LLS-04			0.33	0.12	0.13	0.379					
LLS-05			0.37	0.32	0.22	0.289					
LLS-06			0.30	0.25	0.17	0.245					
LLS-07			0.31	0.35	0.27	0.411					
LLS-08			0.51	0.34	0.27	0.396					
LLS-09			0.41	0.30	0.16	0.398					
LLS-10			0.43	0.29	0.29	0.224					
MEAN	**0.34**		**0.39**	**0.28**	**0.27**	**0.37**	**0.49**				

2.3

MERCURY IN FISH DOWNWIND OF MUNICIPAL WASTE INCINERATORS

MERCURY IN FISH DOWNWIND OF MUNICIPAL WASTE INCINERATORS

This study is a continuation of the work conducted on the Orrington-Bucksport area lakes to determine differential mercury content in tissue and sediments from lakes associated with local emission sources. Lakes presumed to receive mercury depositions from the RWS and MMWC waste incinerators will be selected for study. Methods similar to the Orrington study will be employed. This effort began in 1998, but fish were successfully captured at only 2 lakes and sediments were collected from only 4 lakes. In 1999 fish and sediments were collected from 3 lakes, making the total of 5 lakes where both fish and sediments were collected.

TABLE 2.3 MERCURY CONCENTRATIONS (mg/kg) IN FISH (ww) AND SEDIMENT (dw) FROM LAKES DOWNWIND OF MUNICIPAL WASTE INCINERATORS

SPECIES	**Taylor Pond** LK-3750	**Sabattus Pond** LK-3796	**Forest L** LK-3712	**Highland L** LK-3734	**L Sebago L** LK-3714
WHP-01	0.731	0.136	0.535	0.661	0.226
WHP-02	0.515	0.323	0.507	0.849	0.176
WHP-03	0.706	0.110	0.360	0.731	0.191
WHP-04	0.525	0.100	0.633	0.565	0.188
WHP-05		0.090	0.430	0.764	0.114
WHP-06		0.092	0.355	0.665	0.113
WHP-07			0.519	0.584	0.086
WHP-08			0.462	0.735	0.105
WHP-09				0.539	0.176
WHP-10				0.598	0.122
MEAN	**0.619**	**0.142**	**0.475**	**0.669**	**0.150**
SEDIMENT	**0.199**	**0.103**	**0.310**	**0.252**	**0.252**

2.4

LOON EFFECTS STUDY

LOON EFFECTS STUDY

Beginning in 1994, studies of exposure of common loons in Maine lakes to mercury by BioDiversity Research Institute (BRI) and collaborators indicate that 40% of eggs are potentially impacted. From mercury concentrations in blood and feather samples, BRI estimates that 28% of the adult breeding population is also at risk based on risk categories developed from their studies and the literature.

In 1999 a study was initiated to look for actual impacts on individuals and the population by measuring (1) overall productivity, (2) adult incubating behavior (3) egg development (4) chick behavior (5) juvenile survival and (6) overall health. Results documented that eggs from high-risk pairs were significantly smaller and hatched 50% fewer chicks than those from low-risk pairs. One extra high-risk male spent significantly less time incubating eggs and significantly more time brooding instead of searching for food than low-risk birds, similar to findings from other studies. There was greater asymmetry in feather mercury concentrations in high-risk loons than in low-risk loons indicating developmental instability. The stress hormone, corticosterone, was highly correlated with mercury concentrations. Mercury concentrations seem to be increasing approximately 9% in males and 5.6% in females each year. Additional work is needed to increase the sample size and valid these findings.

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, 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 sampling efforts from 1994-99 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, 28% of the breeding loon population in Maine is estimated to be at risk, while 40% of the eggs laid are potentially impacted.

This is a summary of the full report available from the Department of Environmental Protection, Augusta, Maine, as listed below.

BRI, 2000. Assessing the impacts of methylmercury on the piscivorous wildlife as indicated by the common loon. BioDiversity Research Institute, Falmouth, Maine. 41pp

2.5

MERCURY TRENDS

MERCURY TRENDS

Temporal Changes in Fish Mercury Concentration in Maine Lakes. Terry A. Haines, Department of Biological Sciences University of Maine, 5751 Murray Hall, Orono, ME 04469-5751

Notification that funding was approved for this project was received on 22 October, 1999, which was too late to schedule any field sampling for 1999. The winter was spent locating and organizing records of previous fish collections that were analyzed for mercury. There were 12 lakes for which data were collected between 1978 and 1986 (see attached spreadsheet). East Chairback Pond was acidic (pH about 5) and had a sparse population of large brook trout when initially sampled. This lake was netted by Paul Johnson in 1999, unknown to me, and seems to be unchanged. Paul requested that the lake not be netted again because of the small fish population. St. Froid Lake was surveyed by Dave Basley in August 2000 from which we collected fish samples. The best candidate lake for sediment coring with the presently-available equipment is Cliff Lake. A coring trip occurred mid-July. Sampling trips to net selected trout and sucker lakes occurred during June. Data will be reported in the 2000 SWAT report.