Penobscot River Mercury Study

Results of 2012 monitoring of mercury in Penobscot River and Bay
With comparisons to previous years

December 2013

TABLES (1 – 17)

Table 1. Monitoring schedule for all samples collected in 2012 in the Penobscot study area. Each cell lists the month and sample number collected at each site. Co-located or adjacent sites are grouped in rows.

2012 PENOBSCOT MONITORING SCHEDULE FOR BIOTA, SEDIMENT, AND WATER																							
	Fish					Shellfish		Sediment			Water	Birds					Invertebrates						
Aquatic + Wetland Sites (ordered N to S)	Eel	Mummichog	Rainbow smelt	Tomcod	Winter flounder	Blue mussels	Lobster	Intertidal sediment	Subtidal sediment	Wetland sediment	Penobscot Surface Water	Black duck	Red-winged blackbird	Nelson's sparrow (AHY)	Swamp sparrow (AHY)	Double-crested cormorant	Crangon shrimp	Aquatic snail spp.	Littorina snail	Freshwater and brackish mussels	Amphipod	Wetland snail spp.	Tadpole
OV4	Jun n=21							Aug n=5										Jul n=6		Jul n=3			
OV1								Aug n=5															
OV2 / Veazie Dam	Jun n=20							Aug n=5			Jun-Sep n=2/mo							Jul n=3		Jul n=4			
BO5 marsh / BO5		Jul n=15						Aug n=5															
BO4	Jul n=20																	Jul n=6		Jul n=1			
WQ1b-C / W63 / OB5	Jul n=20		Sep n=3	Sep n=15	Sep n=15			Aug n=5		Aug n=4x4 elev.	Jul n=2						Sep n=6	Jul n=3					
OB4	Jul n=4																						
Winterport / W17N / OB2										Aug n=4x4 elev.	Jun-Sep n=2/mo		Jul n=6	Jul n=10	Jul n=8					Jul n=5	Jun n=2	Jun n=1	
OB1E4 / OB1	Jul n=18		Sep n=15	Sep n=15				Aug n=5									Sep n=6						
W65 / Mendall Marsh SE										Aug n=4x4 elev.			Jul n=2	Jul n=5	Jul n=6					Jun n=2; Jul n=3	Jul n=3	
W21 / W21UM / Mendall Marsh SW		Jul n=15								Aug n=4x4 elev.; n=4x4 sites		Jan n=8	Jul n=4	Jul n=5	Jul n=5						Jun n=2	Jun n=4	Jun n=2
WQ3-C											Jul n=2												
ES02			Sep n=10	Sep n=15	Sep n=14			Aug n=5									Sep n=5		Sep n=5				
ES15 / Odom Ledge / Sandy Point					Sep n=15	Sep n=15	Sep n=15									Jun n=7							
W61 / ES13 / South Verona			Sep n=9	Sep n=15	Sep n=12	Mar n=15; Sep n=15	Sep n=15	Aug n=5		Aug n=4x4 elev.		Jan n=8					Sep n=6		Sep n=6				
E01 transect / ESFP / Fort Point			Sep n=15	Sep n=15	Sep n=15	Sep n=15	Sep n=15		Aug n=3x3 sites								Sep n=6		Sep n=6				
Turner Point							Sep n=15																
Parker Cove							Sep n=15																
Harborside							Sep n=15																
Thrumcap Island																Jul n=7							
ES04 / SW Sears Island			Sep n=1		Sep n=16	Mar n=15 Sep n=15	Sep n=16	Aug n=5									Sep n=5		Sep n=5				
ES07			Sep n=16		Sep n=6																		
Frenchman Bay												Jan n=6											
St. George River								Aug n=5															
Pleasant River N													Jul n=3	Jul n=10	Jul n=10						Jul n=2	Jul n=3	

Table 2. Values used to estimate trophic position in aquatic biota, using formulas given in Chapter 16, Phase II Report.

FISH + SHELLFISH TARGET SPECIES				$\delta^{15}N_{base1}$ BENTHIC			$\delta^{15}N_{base2}$ PELAGIC		
AQUATIC SITE	TAXA	2° Consumers in 1 Food Web	2° Consumers in 2 Food Webs	TAXA	$\delta^{15}N$ ‰	α	TAXA	$\delta^{15}N$ ‰	1- α
BO4	American eel	B		snail	7.36	100			0
OB1	American eel		B/P	snail ES02	8.88	80	mussel OB2	7.96	20
OB5	American eel		B/P	snail BO4	7.36	80	mussel BO4	3.56	20
OV2	American eel	B		snail	5.61	100			0
OV4	American eel	B		snail	4.83	100			0
W21	Mummichog	B		snail MMSW-C	3.90	50	snail-aq. benthic	8.88	50
BO5	Mummichog	B		snail BO4	7.36	100			
ES04	Lobster		B/P	Littorina snail	7.70	53	blue mussel	6.87	47
ES13	Lobster		B/P	Littorina snail	8.85	53	blue mussel	7.39	47
ES15	Lobster		B/P	use ES13					
ESFP	Lobster		B/P	Littorina snail	8.36	53	blue mussel	7.38	47
TP	Lobster		B/P	use ESFP					
H	Lobster		B/P	use ESFP					
PC	Lobster		B/P	use ESFP					
ES02	Rainbow smelt	P					use ES13		100
ES04	Rainbow smelt	P					blue mussel	6.87	100
ES07	Rainbow smelt	P					use ES04		100
ES13	Rainbow smelt	P					blue mussel	7.39	100
ESFP	Rainbow smelt	P					blue mussel	7.38	100
OB1	Rainbow smelt	P	B/P	snail ES02	8.88	10	mussel OB2	7.96	90
OB5	Rainbow smelt	P	B/P	snail BO4	7.36	50	mussel BO4	3.56	50
ES02	Tomcod		B/P	Littorina snail	8.88	35	use ES13		65
ES13	Tomcod		B/P	Littorina snail	8.85	35	blue mussel	7.39	65
ESFP	Tomcod		B/P	Littorina snail	8.36	35	blue mussel	7.38	65
OB1	Tomcod		B/P	snail ES02	8.88	50	mussel OB2	7.96	50
OB5	Tomcod		B/P	snail BO4	7.36	80	mussel BO4	3.56	20
ES02	Winter flounder	B		Littorina snail	8.88	100			
ES04	Winter flounder	B		Littorina snail	7.70	100			
ES07	Winter flounder	B		use ES04					
ES13	Winter flounder	B		Littorina snail	8.85	100			
ESFP	Winter flounder	B		Littorina snail	8.36	100			
OB1	Winter flounder	B		snail ES02	8.88				
OB5	Winter flounder	B		snail BO4	7.36	100			
ES13	American black duck	B		Littorina snail	8.85	50	blue mussel	7.39	50
Mendall Marsh	American black duck	B		Littorina snail	8.88	50	w etland snail	3.19	50
Frenchman Bay	American black duck	B		use ES13		100			
Sandy Point	Double-crested cormorant	P		blue mussel	7.46	100			
Thrumcap Island	Double-crested cormorant	P		blue mussel ESFP	7.38	100			

Table 3. Values used to estimate trophic position in wetland birds, using formulas given in Chapter 16, Phase II Report.

	WETLAND BIRD - $\delta^{15}N_{base}$ values for TROPHIC LEVEL ESTIMATION					
	2° consumer in wetland food web			2° consumer in wetland food web		
WETLAND SITE	N_{base} TAXA	$\delta^{15}N_{base}$	λ	N_{base} TAXA	$\delta^{15}N_{base}$	λ
MMSE1	SNAIL	0.83	0.50	AMPHIPOD	1.48	0.50
MMSE2	SNAIL	4.13	0.50	AMPHIPOD	2.29	0.50
MMSW	SNAIL	3.19	0.50	AMPHIPOD	3.20	0.50
PRN	SNAIL	0.34	0.50	AMPHIPOD	3.10	0.50
W17N	SNAIL	0.47	0.50	AMPHIPOD	2.86	0.50

Table 4. Significant findings from temporal trend analyses of total Hg in fish from two monitoring periods, 2006 – 2010 and 2006 – 2012.

		Total Hg, adj for size		Total Hg, adj for size	
			2006-2010		2006-2012
FISH SPECIES	SITE	n	significant change?	n	significant change?
American Eel	OV4	4	no Δ	5	decrease in THg
	OV5	3	no Δ		
	OV2	1	—	2	—
	BO67	4	no Δ		
	BO66	3	no Δ		
	BO3	4	no Δ		
	BO4	4	no Δ	5	no Δ
	OB5	4	no Δ	5	no Δ
	OB73	4	no Δ		
	OB4	2	—	3	no Δ
	OB1	4	no Δ	5	no Δ
Tomcod	OB5	2	—	3	no Δ
	OB1E-4	4	no Δ	5	no Δ
	OB1S-1	3	decrease in THg		
	ES11N	4	no Δ		
	ES02E	4	no Δ	5	decrease in THg
	ES05S	3	no Δ		
	ES06S	3	no Δ		
	ES13	1	—	2	—
Rainbow Smelt	OB5	1	—	2	—
	OB1NE	3	no Δ	4	decrease in THg
	OB1S-1	3	decrease in THg		
	ES11N	4	decrease in THg		
	ES02E	4	no Δ	5	decrease in THg
	ES05S	3	no Δ		
	ES06S	3	decrease in THg		
	ES13	2	—	3	decrease in THg
	ES13S	4	decrease in THg		
	ES14N	3	no Δ		
	ESFP	2	—	3	no Δ
	ES04W	3	decrease in THg		
	ES07S	1	—	2	—
Winter Flounder	OB5	1	—	2	—
	OB1E4	3	increase in THg	4	no Δ
	ES11N	3	no Δ		
	ES02E	3	no Δ	4	no Δ
	ES15S	4	no Δ		
	ES13	2	—	3	no Δ
	ES13S	4	no Δ		
	ES14N	3	no Δ		
	ESFP	2	—	3	no Δ
	ES04W	3	no Δ	4	no Δ
	ES07S	2	—	3	no Δ
Mummichog	BO5	2	—	3	decrease in THg
	OBINE	3	decrease in THg		
	W21	1	—	2	—

Table 5. Significant findings from temporal trend analyses of total Hg in birds from two monitoring periods, 2006 – 2010 and 2006 – 2012.

		Total Hg, adj for sample date		Total Hg, adj for sample date	
			2006-2010		**2006-2012**
BIRD SPECIES	SITE	n	significant change?	n	significant change?
Nelson's Sparrow	W-17-N	3	no Δ	4	no Δ
(blood)	W-17-S	3	increase in THg		
	MM-CAR DEALER	3	no Δ		
	MM-NORTHEAST	4	decrease in THg		
	MM-SOUTHEAST	3	increase in THg	4	increase in THg
	MM-JETTI	4	no Δ		
	MM-SOUTHWEST	4	decrease in THg	5	no Δ
	MM-SOUTH-174	3	no Δ		
	Pleasant River			1	—
Swamp Sparrow	W-17-N	3	no Δ	4	no Δ
(blood)	MM-SOUTHEAST	2	—	3	no Δ
	MM-JETTI	3	no Δ		
	MM-SOUTHWEST	4	no Δ	5	no Δ
	MM-SOUTH-174	4	decrease in THg		
	Pleasant River			1	—
Red-winged Blackbird	W-17-N	1	—	2	—
(blood)	MM-NORTHEAST	3	no Δ		
	MM-SOUTHEAST	2	—	3	increase in THg
	MM-SOUTHWEST	4	no Δ	5	no Δ
	MM-SOUTH-174	4	no Δ		
	Pleasant River			1	—
Double-crested Cormorant	Luce Cove	2	—		
(egg)	Sandy Point	4	no Δ	5	no Δ
	Thrumcap	4	no Δ	5	no Δ
American Black Duck	Mendall Marsh	1	—	2	—
(blood)	Verona Island	1	—	2	—
	Frenchman Bay	1	—	2	—

Table 6. Significant findings from temporal trend analyses of total Hg and methyl Hg in shellfish from two monitoring periods, 2006 – 2010 and 2006 – 2012.

		Total Hg		Total Hg		Methyl Hg		Methyl Hg	
		2006-2010		2006-2012		2006-2010		2006-2012	
SHELLFISH	SITE	n	significant change?	n	significant change?	n	significant change?	n	significant change?
Blue Mussel	ES15	4	decrease in THg	5	decrease in THg	4	increase in MeHg	5	no Δ
	ES13	4	decrease in THg	5	decrease in THg	4	decrease in MeHg	5	decrease in MeHg
	ES03	4	decrease in THg			3	decrease in MeHg		
	ESFP	2	—	3	no Δ	2	—	3	decrease in MeHg
	ES14	3	decrease in THg			3	no Δ		
	ES10	4	no Δ			3	no Δ		
	ES04	4	no Δ	5	increase in THg	3	no Δ	5	no Δ
	ES07	4	no Δ			3	no Δ		
	ES13-SPRING	1	—	2	—	1	—	2	—
	ES04-SPRING	1	—	2	—	1	—	2	—

		Total Hg, adj for size		Total Hg, adj for size	
		2006-2010		2006-2012	
		n	significant change?	n	significant change?
Lobster tail	Odom Ledge	3	no Δ	4	decrease in THg
	S. Verona	3	no Δ	4	no Δ
	Ft. Point	3	decrease in THg	4	no Δ
	Turner Point	4	no Δ	5	no Δ
	SW Sears Island	4	no Δ	5	no Δ
	Harborside	4	decrease in THg	5	decrease in THg
	Parker Cove	3	no Δ	4	decrease in THg
	Kellys Cove	2	—		

Table 7. Significant findings from temporal trend analyses of total Hg in sediment from two monitoring periods, 2006 – 2010 and 2006 – 2012.

			Total Hg		Total Hg	Total Hg adjusted for TOC
			2006-2010		2006-2012	2006-2012
SAMPLE	SITE	n	significant change?	n	significant change?	significant change?
Intertidal Sediment	OV4	3	no Δ	4	no Δ	no Δ
	OV1	3	no Δ	4	no Δ	no Δ
	OV2	2	—	3	decrease in THg	no Δ
	BO5	2	—	3	decrease in THg	decrease in THg
	OB5	3	no Δ	4	no Δ	no Δ
	OB1	3	no Δ	4	no Δ	no Δ
	ES02	3	no Δ	4	no Δ	no Δ
	ES13	3	increase in THg	4	no Δ	no Δ
	ES04	3	no Δ	4	no Δ	no Δ
	SG1	1	—	2	—	no Δ
Subtidal Sediment	E01-1	3	no Δ	4	no Δ	
	E01-2	3	no Δ			
	E01-3	3	no Δ	4	no Δ	
	E01-4	3	no Δ	4	no Δ	
	E01-5	3	no Δ			
Wetland Sediment - High	W63	3	no Δ	4	decrease in THg	
	W10	3	no Δ			
	W17	4	no Δ	5	no Δ	
	W65	1	—	2	—	
	W21	4	no Δ	5	no Δ	
	W25	4	no Δ			
	W26	3	no Δ			
	W61	1	—	2	—	
Wetland Sediment - Medium	W63	3	no Δ	4	no Δ	
	W10	3	no Δ			
	W17	4	no Δ	5	no Δ	
	W65	1	—	2	—	
	W21	4	no Δ	5	decrease in THg	
	W25	4	no Δ			
	W26	3	no Δ			
	W61	1	—	2	—	
Wetland Sediment - Low	W63	3	no Δ	4	decrease in THg	
	W10	3	no Δ			
	W17	4	no Δ	5	no Δ	
	W65	1	—	2	—	
	W21	4	no Δ	5	no Δ	
	W25	4	no Δ			
	W26	3	no Δ			
	W61	1	—	2	—	
Wetland Sediment - Mudflat	W63	3	no Δ	4	no Δ	
	W10	3	no Δ			
	W17	4	no Δ	5	decrease in THg	
	W65	1	—	2	—	
	W21	4	decrease in THg	5	decrease in THg	
	W25	4	decrease in THg			
	W26	3	no Δ			
	W61	1	—	2	—	

Table 8. . Significant findings from temporal trend analyses of methyl Hg in sediment from two monitoring periods, 2006 – 2010 and 2006 – 2012.

			Methyl Hg		Methyl Hg	Methyl Hg adjusted for TOC
			2006-2010		2006-2012	2006-2012
SAMPLE	SITE	n	significant change?	n	significant change?	significant change?
Intertidal Sediment	OV4	3	no Δ	4	no Δ	no Δ
	OV1	3	decrease in MeHg	4	no Δ	no Δ
	OV2	2	—	3	decrease in MeHg	decrease in MeHg
	BO5	2	—	3	decrease in MeHg	no Δ
	OB5	3	no Δ	4	decrease in MeHg	no Δ
	OB1	3	no Δ	4	no Δ	no Δ
	ES02	3	no Δ	4	no Δ	no Δ
	ES13	3	no Δ	4	no Δ	no Δ
	ES04	3	decrease in MeHg	4	no Δ	no Δ
	SG1	1	—	2	—	—
Subtidal Sediment	E01-1	3	decrease in MeHg	4	no Δ	
	E01-2	3	no Δ			
	E01-3	3	no Δ	4	no Δ	
	E01-4	3	decrease in MeHg	4	no Δ	
	E01-5	3	no Δ			
Wetland Sediment - High	W63	3	0.04	4	decrease in MeHg	
	W10	3	increase in MeHg			
	W17	4	no Δ	5	no Δ	
	W65	1	—	2	—	
	W21	4	no Δ	5	no Δ	
	W25	4	increase in MeHg			
	W26	3	increase in MeHg			
	W61	1	—	2	—	
Wetland Sediment - Medium	W63	3	no Δ	4	no Δ	
	W10	3	no Δ			
	W17	4	no Δ	5	decrease in MeHg	
	W65	1	—	2	—	
	W21	4	decrease in MeHg	5	no Δ	
	W25	4	no Δ			
	W26	3	no Δ			
	W61	1	—	2	—	
Wetland Sediment - Low	W63	3	no Δ	4	no Δ	
	W10	3	no Δ			
	W17	4	no Δ	5	no Δ	
	W65	1	—	2	—	
	W21	4	no Δ	5	no Δ	
	W25	4	decrease in MeHg			
	W26	3	no Δ			
	W61	1	—	2	—	
Wetland Sediment - Mudflat	W63	3	no Δ	4	no Δ	
	W10	3	no Δ			
	W17	4	no Δ	5	no Δ	
	W65	1	—	2	—	
	W21	4	decrease in MeHg	5	decrease in MeHg	
	W25	4	decrease in MeHg			
	W26	3	no Δ			
	W61	1	—	2	—	

Table 9. Power analysis results for American eel and winter flounder - the sample sizes needed at each site listed for various sampling frequencies and minimum sampling periods, assuming a minimum power of 0.80.

American Eel + Winter Flounder								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Species	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
31	eel	OV4	1	>60	40	20	10	10
31	eel	OV2	1	>60	50	30	10	10
31	eel	BO4	1	60	20	10	10	10
31	eel	OB5	1	>60	40	20	10	10
31	eel	OB4	1	60	30	10	10	10
31	eel	OB1	1	30	10	10	10	10
31	eel	OV4	2	>60	60	30	15	10
31	eel	OV2	2	>60	>60	40	20	10
31	eel	BO4	2	>60	40	15	10	10
31	eel	OB5	2	>60	>60	30	15	10
31	eel	OB4	2	>60	40	20	10	10
31	eel	OB1	2	40	20	10	10	10
31	eel	OV4	3	>60	>60	40	20	10
31	eel	OV2	3	>60	>60	50	30	15
31	eel	BO4	3	>60	40	20	10	10
31	eel	OB5	3	>60	>60	40	20	15
31	eel	OB4	3	>60	40	20	10	10
31	eel	OB1	3	50	20	10	10	10
31	flounder	OB5	1	30	10	10	10	10
31	flounder	OB1E4	1	>60	30	15	10	10
78	flounder	ES02E	1	>60	50	20	10	10
78	flounder	ES13	1	>60	>60	30	15	10
78	flounder	ESFP	1	>60	>60	>60	30	15
78	flounder	ES04W	1	>60	>60	>60	40	20
31	flounder	OB5	2	40	15	10	10	10
31	flounder	OB1E4	2	>60	50	30	10	10
78	flounder	ES02E	2	>60	>60	40	15	10
78	flounder	ES13	2	>60	>60	50	30	15
78	flounder	ESFP	2	>60	>60	>60	50	30
78	flounder	ES04W	2	>60	>60	>60	60	30
31	flounder	OB5	3	40	15	10	10	10
31	flounder	OB1E4	3	>60	60	30	15	10
78	flounder	ES02E	3	>60	>60	40	20	15
78	flounder	ES13	3	>60	>60	50	40	20
78	flounder	ESFP	3	>60	>60	>60	>60	40
78	flounder	ES04W	3	>60	>60	>60	>60	50

Table10. Power analysis results for Atlantic tomcod, rainbow smelt and mummichog - the sample sizes needed at each site listed for various sampling frequencies and minimum sampling periods, assuming a minimum power of 0.80.

Atlantic Tomcod + Rainbow Smelt + Mummichog								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Species	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
78	tomcod	ES02	1	>60	50	30	10	10
78	tomcod	ES13	1	>60	>60	>60	40	20
78	tomcod	ESFP	1	>60	>60	>60	40	20
31	tomcod	OB1E4	1	>60	30	15	10	10
31	tomcod	OB5	1	50	15	10	10	10
78	tomcod	ES02	2	>60	>60	40	20	10
78	tomcod	ES13	2	>60	>60	>60	60	30
78	tomcod	ESFP	2	>60	>60	>60	60	40
31	tomcod	OB1E4	2	>60	50	20	10	10
31	tomcod	OB5	2	60	30	15	10	10
78	tomcod	ES02	3	>60	>60	50	30	15
78	tomcod	ES13	3	>60	>60	>60	>60	50
78	tomcod	ESFP	3	>60	>60	>60	>60	50
31	tomcod	OB1E4	3	>60	50	30	15	10
31	tomcod	OB5	3	>60	30	15	10	10
31	smelt	OB5	1	>60	50	20	10	10
31	smelt	OB1E4	1	>60	60	30	15	10
78	smelt	ES02	1	>60	>60	>60	50	30
78	smelt	ES13	1	>60	>60	>60	40	20
78	smelt	ESFP	1	>60	>60	40	15	10
78	smelt	ES07	1	50	20	10	10	10
31	smelt	OB5	2	>60	>60	40	20	10
31	smelt	OB1E4	2	>60	>60	50	30	15
78	smelt	ES02	2	>60	>60	>60	>60	40
78	smelt	ES13	2	>60	>60	>60	60	40
78	smelt	ESFP	2	>60	>60	60	30	15
78	smelt	ES07	2	>60	30	15	10	10
31	smelt	OB5	3	>60	>60	40	20	15
31	smelt	OB1E4	3	>60	>60	60	30	20
78	smelt	ES02	3	>60	>60	>60	>60	60
78	smelt	ES13	3	>60	>60	>60	>60	50
78	smelt	ESFP	3	>60	>60	>60	40	20
78	smelt	ES07	3	>60	30	20	10	10
31	mummichog	BO5	1	60	30	15	10	10
22	mummichog	W21	1	40	15	10	10	10
31	mummichog	BO5	2	>60	40	20	10	10
22	mummichog	W21	2	60	20	10	10	10
31	mummichog	BO5	3	>60	40	20	10	10
22	mummichog	W21	3	60	30	15	10	10

Table 11. Power analysis results for marsh birds - the sample sizes needed at each site listed for various sampling frequencies and minimum sampling periods, assuming a minimum power of 0.80.

Nelson's Sparrow + Swamp Sparrow + Red-winged Blackbird								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Species	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
31	NESP	NESP-W17N	1	15	7	5	5	5
22	**NESP**	**NESP-MM (SE+SW)**	**1**	**15**	**7**	**5**	**5**	**5**
22	NESP	NESP-SE1	1	5	5	5	5	5
22	NESP	NESP-SW1	1	20	7	5	5	5
31	NESP	NESP-PRN1	1	40	20	10	5	5
31	NESP	NESP-W17N	2	30	10	5	5	5
22	**NESP**	**NESP-MM (SE+SW)**	**2**	**30**	**10**	**5**	**5**	**5**
22	NESP	NESP-SE1	2	5	5	5	5	5
22	NESP	NESP-SW1	2	30	10	5	5	5
31	NESP	NESP-PRN1	2	>60	30	15	7	5
31	NESP	NESP-W17N	3	30	10	5	5	5
22	**NESP**	**NESP-MM (SE+SW)**	**3**	**30**	**10**	**5**	**5**	**5**
22	NESP	NESP-SE1	3	7	5	5	5	5
22	NESP	NESP-SW1	3	30	15	7	5	5
31	NESP	NESP-PRN1	3	>60	40	15	10	5
31	SWSP	SWSP-W17N	1	>60	30	15	5	5
22	**SWSP**	**SWSP-MM (SE+SW)**	**1**	**>60**	**30**	**15**	**7**	**5**
22	SWSP	SWSP-SE	1	>60	30	15	7	5
22	SWSP	SWSP-SW1	1	40	15	7	5	5
31	SWSP	SWSP-PRN1	1	10	5	5	5	5
31	SWSP	SWSP-W17N	2	>60	40	20	10	5
22	**SWSP**	**SWSP-MM (SE+SW)**	**2**	**>60**	**50**	**20**	**10**	**5**
22	SWSP	SWSP-SE	2	>60	50	30	15	7
22	SWSP	SWSP-SW1	2	40	20	10	5	5
31	SWSP	SWSP-PRN1	2	15	5	5	5	5
31	SWSP	SWSP-W17N	3	>60	50	30	15	7
22	**SWSP**	**SWSP-MM (SE+SW)**	**3**	**>60**	**50**	**30**	**15**	**10**
22	SWSP	SWSP-SE	3	>60	60	30	15	10
22	SWSP	SWSP-SW1	3	60	20	15	7	5
31	SWSP	SWSP-PRN1	3	15	5	5	5	5
31	RWBL	RWBL-W17N	1	>60	>60	40	15	7
22	**RWBL**	**RWBL-MM (SE+SW)**	**1**	**10**	**5**	**5**	**5**	**5**
22	RWBL	RWBL-SE2	1	5	5	5	5	5
22	RWBL	RWBL-SW1	1	5	5	5	5	5
31	RWBL	RWBL-PRN1	1	>60	>60	40	15	10
31	RWBL	RWBL-W17N	2	>60	>60	50	30	15
22	**RWBL**	**RWBL-MM (SE+SW)**	**2**	**15**	**7**	**5**	**5**	**5**
22	RWBL	RWBL-SE2	2	5	5	5	5	5
22	RWBL	RWBL-SW1	2	7	5	5	5	5
31	RWBL	RWBL-PRN1	2	>60	>60	60	30	15
31	RWBL	RWBL-W17N	3	>60	>60	>60	30	20
22	**RWBL**	**RWBL-MM (SE+SW)**	**3**	**15**	**7**	**5**	**5**	**5**
22	RWBL	RWBL-SE2	3	5	5	5	5	5
22	RWBL	RWBL-SW1	3	7	5	5	5	5
31	RWBL	RWBL-PRN1	3	>60	>60	>60	40	20

Table 12. Power analysis results for American black duck and double-crested cormorant - the sample sizes needed at each site listed for various sampling frequencies and minimum sampling periods, assuming a minimum power of 0.80.

American Black Duck + Double-crested Cormorant								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Species	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
22	ABDU	ABDU-MUSCLE-MM	1	20	7	5	5	5
22	ABDU	ABDU-BLOOD-MM	1	>60	50	30	10	7
78	ABDU	ABDU-BLOOD-ES13	1	>60	60	30	15	7
78	ABDU	ABDU-BLOOD-FRBAY	1	>60	>60	40	20	10
31	ABDU	ABDU-BLOOD-ES13	1	30	10	5	5	5
31	ABDU	ABDU-BLOOD-FRBAY	1	40	15	7	5	5
22	ABDU	ABDU-MUSCLE-MM	2	30	15	5	5	5
22	ABDU	ABDU-BLOOD-MM	2	>60	>60	40	20	10
78	ABDU	ABDU-BLOOD-ES13	2	>60	>60	40	20	15
78	ABDU	ABDU-BLOOD-FRBAY	2	>60	>60	>60	30	20
31	ABDU	ABDU-BLOOD-ES13	2	40	15	7	5	5
31	ABDU	ABDU-BLOOD-FRBAY	2	60	30	15	5	5
22	ABDU	ABDU-MUSCLE-MM	3	30	15	7	5	5
22	ABDU	ABDU-BLOOD-MM	3	>60	>60	50	30	15
78	ABDU	ABDU-BLOOD-ES13	3	>60	>60	50	30	15
78	ABDU	ABDU-BLOOD-FRBAY	3	>60	>60	>60	50	30
31	ABDU	ABDU-BLOOD-ES13	3	40	20	10	5	5
31	ABDU	ABDU-BLOOD-FRBAY	3	>60	30	15	7	5
31	DCCO	SANDY POINT	1	>60	>60	40	15	10
31	DCCO	THRUMCAP	1	40	15	7	5	5
31	DCCO	SANDY POINT	2	>60	>60	60	30	15
31	DCCO	THRUMCAP	2	50	20	10	5	5
31	DCCO	SANDY POINT	3	>60	>60	>60	40	20
31	DCCO	THRUMCAP	3	60	30	15	7	5

Table 13. Power analysis results for American lobster and blue mussel - the sample sizes needed at each site listed for various sampling frequencies and minimum sampling periods, assuming a minimum power of 0.80.

American Lobster + Blue Mussel								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Species	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
78	lobster	Odom Ledge	1	>90	>90	>90	70	40
78	lobster	South Verona	1	>90	>90	>90	60	30
78	lobster	Fort Point	1	>90	>90	90	40	30
78	lobster	Turner Point	1	>90	>90	>90	50	30
78	lobster	SW Sears Island	1	>90	>90	>90	90	50
78	lobster	Harborside	1	>90	>90	90	40	30
78	lobster	Parker Cove	1	>90	>90	>90	90	50
78	lobster	Odom Ledge	2	>90	>90	>90	>90	60
78	lobster	South Verona	2	>90	>90	>90	>90	60
78	lobster	Fort Point	2	>90	>90	>90	70	40
78	lobster	Turner Point	2	>90	>90	>90	80	50
78	lobster	SW Sears Island	2	>90	>90	>90	>90	80
78	lobster	Harborside	2	>90	>90	>90	70	40
78	lobster	Parker Cove	2	>90	>90	>90	>90	90
78	lobster	Odom Ledge	3	>90	>90	>90	>90	80
78	lobster	South Verona	3	>90	>90	>90	>90	80
78	lobster	Fort Point	3	>90	>90	>90	90	60
78	lobster	Turner Point	3	>90	>90	>90	>90	70
78	lobster	SW Sears Island	3	>90	>90	>90	>90	>90
78	lobster	Harborside	3	>90	>90	>90	90	60
78	lobster	Parker Cove	3	>90	>90	>90	>90	>90
78	mussel	ES15	1	>80	80	40	15	10
78	mussel	ES13	1	>80	50	30	10	10
78	mussel	ES13Spring	1	>80	>80	60	30	15
78	mussel	ESFP	1	80	30	15	10	10
78	mussel	ES04	1	>80	40	20	10	10
78	mussel	ES04Spring	1	>80	60	30	15	10
78	mussel	ES15	2	>80	>80	50	30	15
78	mussel	ES13	2	>80	80	40	20	10
78	mussel	ES13Spring	2	>80	>80	>80	50	30
78	mussel	ESFP	2	>80	50	30	10	10
78	mussel	ES04	2	>80	70	30	15	10
78	mussel	ES04Spring	2	>80	>80	50	20	15
78	mussel	ES15	3	>80	>80	70	40	20
78	mussel	ES13	3	>80	>80	50	20	15
78	mussel	ES13Spring	3	>80	>80	>80	60	40
78	mussel	ESFP	3	>80	60	30	15	10
78	mussel	ES04	3	>80	70	40	20	15
78	mussel	ES04Spring	3	>80	>80	50	30	20

Table 14. Power analysis results for subtidal and intertidal sediment - the sample sizes needed at each site listed for various sampling frequencies and minimum sampling periods, assuming a minimum power of 0.80.

Subtidal + Intertidal Sediment								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Sediment type	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
78	SUBTIDAL	E01-1	1	>50	30	10	5	3
78	SUBTIDAL	E01-3	1	30	10	5	3	3
78	SUBTIDAL	E01-4	1	30	15	5	3	3
78	SUBTIDAL	E01-1	2	>50	40	20	8	5
78	SUBTIDAL	E01-3	2	30	15	10	3	3
78	SUBTIDAL	E01-4	2	50	20	10	5	3
78	SUBTIDAL	E01-1	3	>50	40	20	10	10
78	SUBTIDAL	E01-3	3	40	15	10	5	3
78	SUBTIDAL	E01-4	3	50	20	10	10	3
31	INTERTIDAL	OV4	1	50	15	10	5	3
31	INTERTIDAL	OV2	1	30	10	5	3	3
31	INTERTIDAL	BO5	1	>50	>50	40	20	10
31	INTERTIDAL	OB5	1	30	10	5	3	3
31	INTERTIDAL	OB1	1	10	3	3	3	3
78	INTERTIDAL	ES02	1	>50	30	15	10	3
78	INTERTIDAL	ES13	1	>50	30	15	10	3
78	INTERTIDAL	ES04	1	50	15	10	5	3
78	INTERTIDAL	SG1	1	50	15	10	5	3
31	INTERTIDAL	OV4	2	>50	30	15	10	3
31	INTERTIDAL	OV2	2	40	15	10	5	3
31	INTERTIDAL	BO5	2	>50	>50	>50	30	20
31	INTERTIDAL	OB5	2	40	15	10	3	3
31	INTERTIDAL	OB1	2	10	3	3	3	3
78	INTERTIDAL	ES02	2	>50	50	30	10	10
78	INTERTIDAL	ES13	2	>50	50	30	10	10
78	INTERTIDAL	ES04	2	>50	30	15	10	3
78	INTERTIDAL	SG1	2	>50	5	15	7	3
31	INTERTIDAL	OV4	3	>50	30	15	10	5
31	INTERTIDAL	OV2	3	40	20	10	5	3
31	INTERTIDAL	BO5	3	>50	>50	>50	40	30
31	INTERTIDAL	OB5	3	40	15	10	5	3
31	INTERTIDAL	OB1	3	10	5	3	3	3
78	INTERTIDAL	ES02	3	>50	50	30	15	10
78	INTERTIDAL	ES13	3	>50	>50	30	15	10
78	INTERTIDAL	ES04	3	>50	30	15	10	5
78	INTERTIDAL	SG1	3	>50	30	15	10	5

Table 15. Power analysis results for wetland sediment - the sample sizes needed at each site listed for annual sampling and various minimum sampling periods, assuming a minimum power of 0.80.

Wetland Sediment								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Sediment Type	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
31	wet sed	W63H	1	>50	30	10	5	3
31	wet sed	W63M	1	5	3	3	3	3
31	wet sed	W63L	1	3	3	3	3	3
31	wet sed	W63MUD	1	40	15	10	3	3
31	wet sed	W17H	1	15	10	3	3	3
31	wet sed	W17M	1	20	10	3	3	3
31	wet sed	W17L	1	10	3	3	3	3
31	wet sed	W17MUD	1	10	3	3	3	3
22	wet sed	W65H	1	50	20	10	5	3
22	wet sed	W65M	1	10	3	3	3	3
22	wet sed	W65L	1	20	10	3	3	3
22	wet sed	W65MUD	1	30	10	5	3	3
22	wet sed	W21H	1	10	3	3	3	3
22	wet sed	W21M	1	5	3	3	3	3
22	wet sed	W21L	1	3	3	3	3	3
22	wet sed	W21MUD	1	3	3	3	3	3
22	wet sed	W21UM-CC	1	20	10	5	3	3
22	wet sed	W21UM-EC	1	3	3	3	3	3
22	wet sed	W21UM-S	1	20	10	3	3	3
22	wet sed	W21UM-WA	1	5	3	3	3	3
78	wet sed	W61H	1	>50	>50	>50	>50	>50
78	wet sed	W61M	1	>50	>50	50	20	10
78	wet sed	W61L	1	>50	40	20	10	5
78	wet sed	W61MUD	1	50	20	10	5	3

Table 16. Power analysis results for wetland sediment - the sample sizes needed at each site listed for bi-annual sampling and various minimum sampling periods, assuming a minimum power of 0.80.

Wetland Sediment								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Sediment Type	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
31	wet sed	W63H	2	>50	40	20	10	5
31	wet sed	W63M	2	10	3	3	3	3
31	wet sed	W63L	2	3	3	3	3	3
31	wet sed	W63MUD	2	50	20	10	5	3
31	wet sed	W17H	2	30	10	5	3	3
31	wet sed	W17M	2	30	10	5	3	3
31	wet sed	W17L	2	10	5	3	3	3
31	wet sed	W17MUD	2	15	5	3	3	3
22	wet sed	W65H	2	>50	30	15	10	5
22	wet sed	W65M	2	10	5	3	3	3
22	wet sed	W65L	2	30	15	5	3	3
22	wet sed	W65MUD	2	50	20	10	5	3
22	wet sed	W21H	2	10	5	3	3	3
22	wet sed	W21M	2	10	3	3	3	3
22	wet sed	W21L	2	5	3	3	3	3
22	wet sed	W21MUD	2	5	3	3	3	3
22	wet sed	W21UM-CC	2	30	15	10	3	3
22	wet sed	W21UM-EC	2	5	3	3	3	3
22	wet sed	W21UM-S	2	30	10	5	3	3
22	wet sed	W21UM-WA	2	10	3	3	3	3
78	wet sed	W61H	2	>50	>50	>50	>50	>50
78	wet sed	W61M	2	>50	>50	>50	40	20
78	wet sed	W61L	2	>50	>50	30	15	10
78	wet sed	W61MUD	2	>50	30	15	10	5

Table 17. Power analysis results for wetland sediment - the sample sizes needed at each site listed for a sampling frequency of every three years and various minimum sampling periods, assuming a minimum power of 0.80.

Wetland Sediment								
Sample Sizes (needed to confirm the absence of a significant change in Total Hg concentrations)								
$T_{1/2}$ Estimated Rate of Hg Reduction (years)	Sediment Type	Site	Sampling Frequency (every X year/s)	Minimum Sampling Period				
				6 years	9 years	12 years	16 years	20 years
31	wet sed	W63H	3	>50	40	20	10	10
31	wet sed	W63M	3	10	3	3	3	3
31	wet sed	W63L	3	5	3	3	3	3
31	wet sed	W63MUD	3	>50	30	15	10	5
31	wet sed	W17H	3	30	10	5	3	3
31	wet sed	W17M	3	30	10	5	3	3
31	wet sed	W17L	3	10	5	3	3	3
31	wet sed	W17MUD	3	15	5	3	3	3
22	wet sed	W65H	3	>50	40	15	10	5
22	wet sed	W65M	3	15	5	3	3	3
22	wet sed	W65L	3	40	15	10	5	3
22	wet sed	W65MUD	3	50	20	10	5	3
22	wet sed	W21H	3	15	5	3	3	3
22	wet sed	W21M	3	10	3	3	3	3
22	wet sed	W21L	3	5	3	3	3	3
22	wet sed	W21MUD	3	5	3	3	3	3
22	wet sed	W21UM-CC	3	40	15	10	5	3
22	wet sed	W21UM-EC	3	5	3	3	3	3
22	wet sed	W21UM-S	3	30	10	10	3	3
22	wet sed	W21UM-WA	3	10	3	3	3	3
78	wet sed	W61H	3	>50	>50	>50	>50	>50
78	wet sed	W61M	3	>50	>50	>50	50	30
78	wet sed	W61L	3	>50	>50	40	20	10
78	wet sed	W61MUD	3	>50	30	20	10	5