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COA Sediment Assessment Decision Making Framework

(Thunder Bay, Peninsula Harbours)

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October 30, 2007
Duluth, Minnesota

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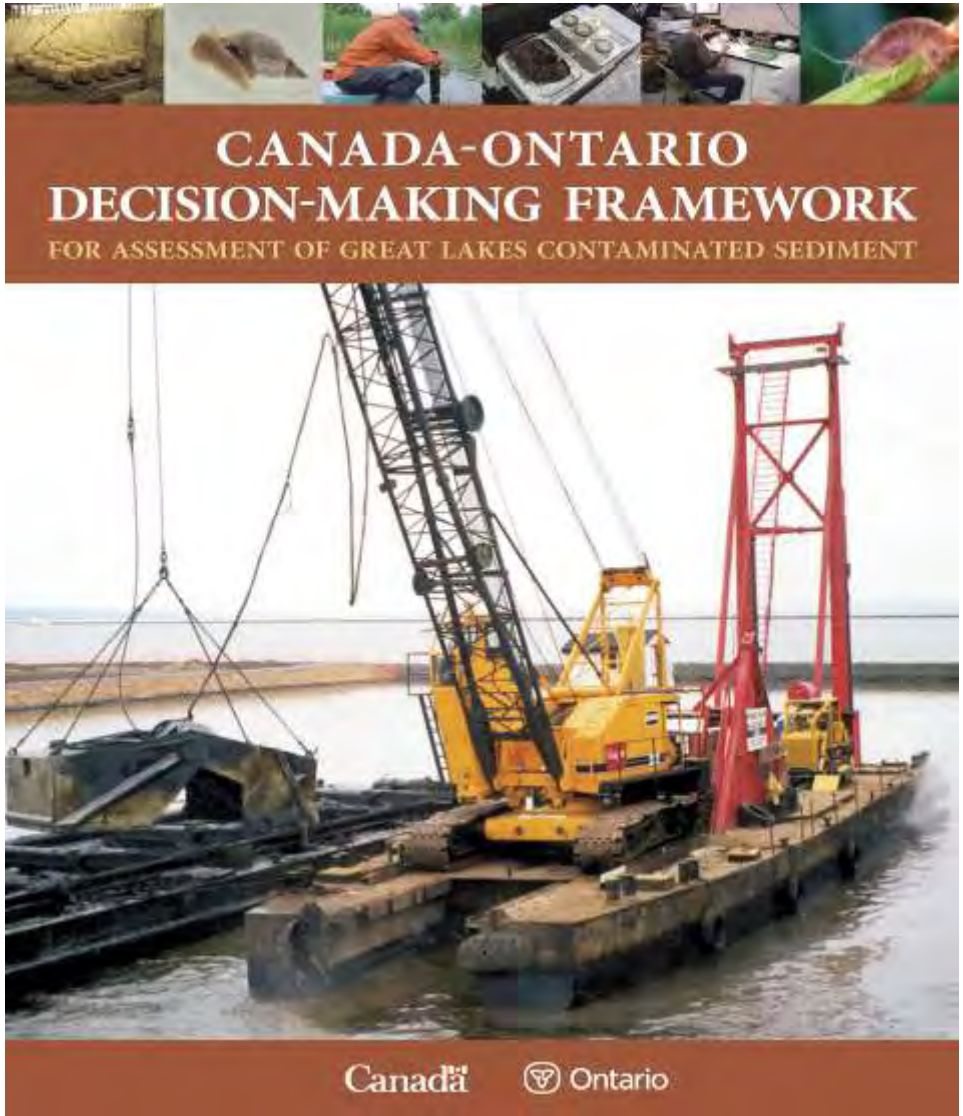
Overview

- COA Contaminated Sediment Assessment Decision Making Framework
- NWRI **BE**nthic **A**ssessment of **S**ediment**T** (**BEAST**) methodology
- Thunder Bay Harbour North Assessment
- Peninsula Harbour (Jellicoe Cove) Assessment

Managing Contaminated Sediment

- CANADA-ONTARIO AGREEMENT (COA) SEDIMENT COMMITTEE
  - To identify the nature and extent of sediment contamination in the Great Lakes
  - To develop methods to evaluate the impact of sediment contamination on the ecosystem.
  - To develop Sediment Management Options
- Creation of the REMEDIATION TECHNOLOGIES PROGRAM
  - Three full-scale sediment remediation projects
  - Eleven pilot-scale technology demonstrations
  - Twenty-nine bench-scale tests
- Creation of the COA Sediment Assessment Decision Making Framework
  - Rule-based, weight of evidence approach to assess contaminated sediment sites

COA Sediment Assessment Decision Making Framework



OVERVIEW

- **Need for consensus on conduct of scientific assessments of contaminated sediments**
- **Need for a framework that is consistent, transparent, scientifically rigorous, technically defensible, understandable by laypersons**
- **Acknowledges and fits with existing guidance/criteria and clearly articulates decision rules and outcomes based on science.**
- **Extensive review within EC nation wide, internationally (US, Spain & Australia) and scientific journal peer review (i.e. SETAC)**

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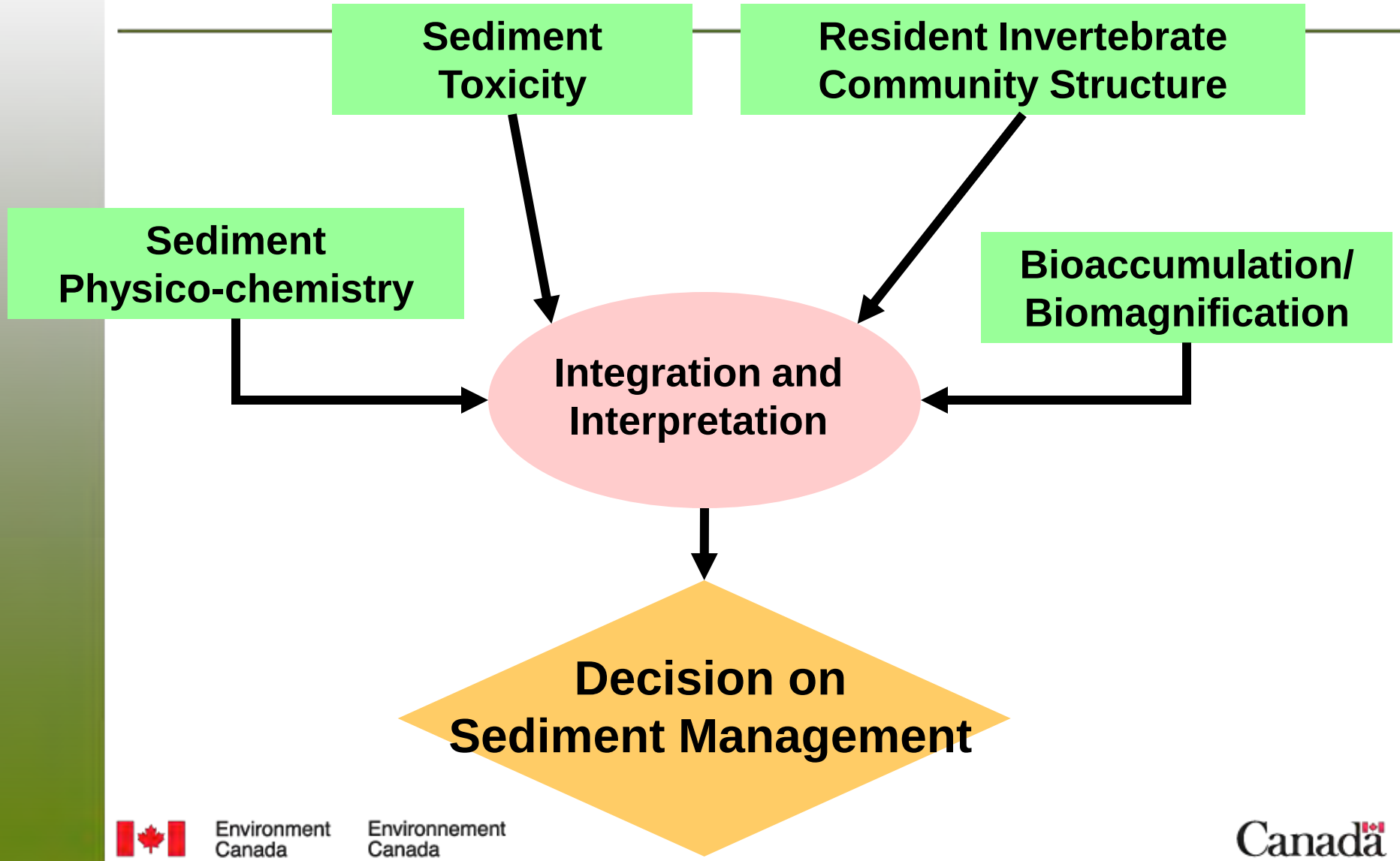
Sediment Assessment Components



Decision Matrix

	■	▣	□
Chemistry	Adverse effects likely	Adverse effects may or may not occur	Adverse effects unlikely
Toxicity endpoints	Major	Minor	Negligible
Overall toxicity	Significant	Potential	Negligible
Benthos alteration	“different” or “very different”	“possibly different”	“equivalent”
Biomagnification potential	Significant	Possible	Negligible
Overall WOE assessment	Significant adverse effects	Potential adverse effects	No significant adverse effects

COA Framework - Decision Matrix Examples

Scenario	Bulk Sediment Chemistry	Toxicity	Benthos Alteration	Biomagnifica-tion Potential	Assessment
1	□	□	□	□	**No further actions needed**
2	■	□	□	□	**No further actions needed**
6	■	■	□	□	**Determine reason(s) for sediment toxicity**
8	■	□	■	□	**Determine reason(s) for benthos alteration**
12	□	■	□	■	**Determine reason(s) for sediment toxicity & fully assess risk of biomagnification**
14	□	■	■	■	**Determine reason(s) for sediment toxicity & benthos alteration & fully assess biomagnification**
16	■	■	■	■	**Management actions required.**

□ Adverse effects unlikely ■ Adverse effects likely

BEAST - Overlying Water/Sediment Chemistry

Overlying water (0.5 m from bottom)

- YSI field measurements
  - •temp, pH, D.O., conductivity
- Van Dorn sampler
  - •nutrients, alkalinity

Sediment

- •Collected with mini-box core or ponar
  - •trace metals (incl. Hg), methyl Hg, PCBs, nutrients, grain size

Benthic Community/Toxicity

- 5 cores collected for identification and enumeration of invertebrate taxa.

4 toxicity tests performed:

- midge (*C. riparius*)
- mayfly (*Hexagenia* spp.)
- amphipod (*H. azteca*)
- worm (*T. tubifex*)
- Measurement of survival, growth, reproduction

Comparisons of test samples to environmental criteria or reference conditions

Sediment/tissue mercury:

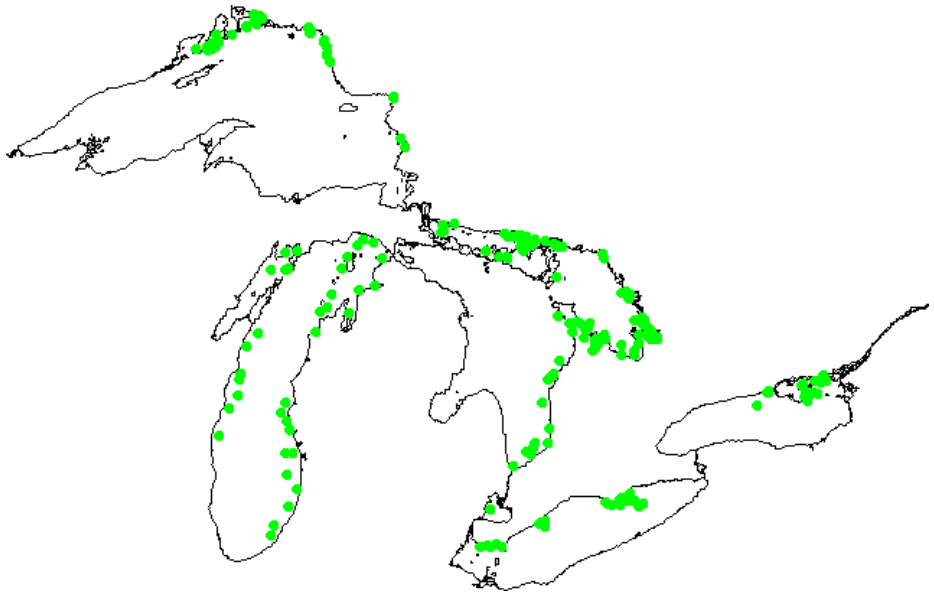
- MOE Sediment Quality Guidelines (Lowest and Severe Effect Levels)
- Lake Superior reference sites (99th percentile)

Sediment toxicity:

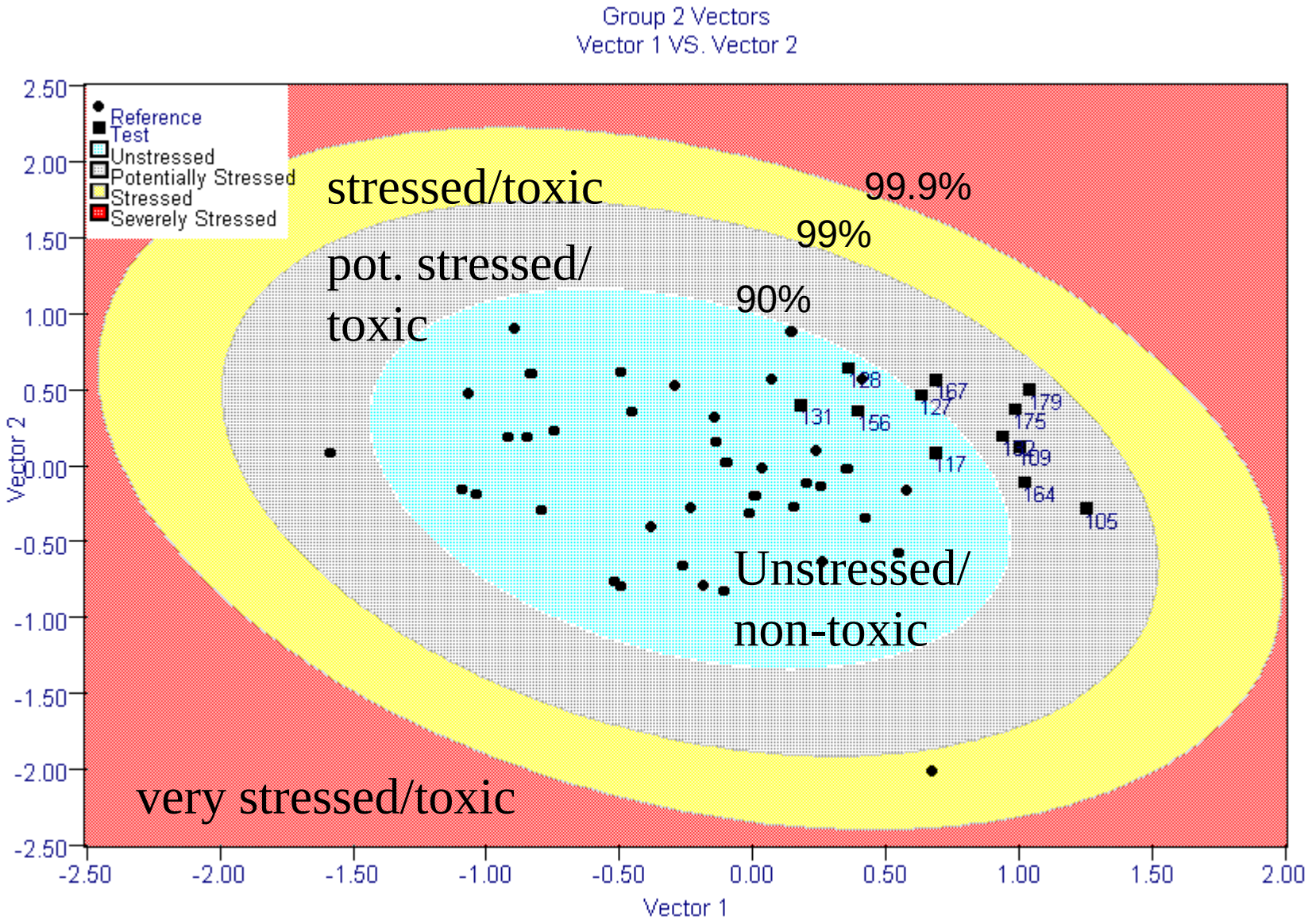
- Range of endpoint responses for GL reference sites

Benthic community:

- Range of conditions in subset of GL reference sites matched to test sites based on habitat conditions



nearshore, depositional sites, stratified by ecodistrict, >10 km from known sources of contaminants


Group 2 Vectors
Vector 1 VS. Vector 2
Reference
Test
Unstressed
Potentially Stressed
Stressed
Severely Stressed
stressed/toxic
99.9%
99%
pot. stressed/
toxic
90%
Unstressed/
non-toxic
very stressed/toxic
Vector 2
Vector 1
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-2.50
-2.00
-1.50
-1.00
-0.50
0.00
0.50
1.00
1.50
2.00
128
167
179
31
156
127
175
17
169
164
105

Bioaccumulation/Biomagnification Potential

Tissue Analysis

- Oligochaetes, chironomids, amphipods, caged mussels
- Total and methyl Hg

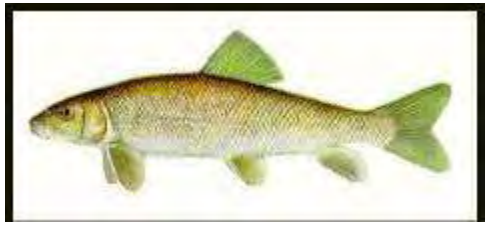
Oligochaetes

Chironomids

Screening Level Prediction of Mercury Biomagnification

1. **Identify receptors of concern.**
2. **Select biomagnification factors (from literature).**
3. **Predict receptor species tissue concentrations using trophic-transfer models.**
4. **Potential risk of adverse effects to receptor was concluded if there were exceedences of the CCME TRG and predicted 99th percentile for reference sites.**

$[contam.]_{invert.}$



$[contam.]_{receptor\ 1}$

$[contam.]_{receptor\ 2}$


Thunder Bay Harbour North
Current River
Cascades Fine Paper
3.6
7.6
5.0
39.7
34.3
2.5
3.0
Investigative
0.1
0.1
0.4
0.6
0.2
0.2
0.2
Assessment
Biomagnification
Toxicity
Toxicity and Biomagnification
0
0.4
0.8
km

Outcomes and Management Recommendation

Scenario	Sediment Chemistry	Toxicity	Benthos Alteration	Biomagnification Potential	Assessment
15, 16	■	■	■	⊙-□	Management Actions

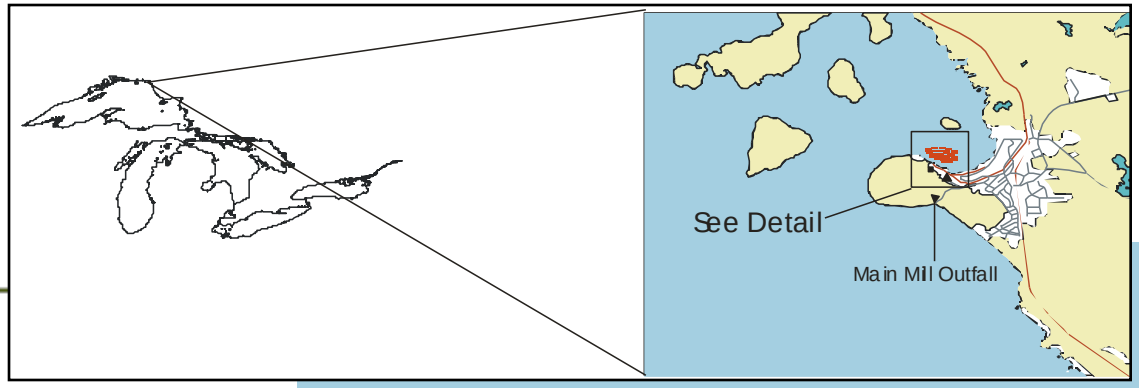
- Currently, sediment management options are being investigated for the nearshore area of Thunder Bay North Harbour, which includes **6** impacted sites.

Outcomes and Management Recommendation

Scenario	Sediment Chemistry	Toxicity	Benthos Alteration*	Biomagnification Potential	Assessment
11	■	o	■	o	**Fully Assess Risk of Biomagnification**

*Benthic communities – in area of pulp fibre/pulp silt accumulation and high TOC – already determined reasons for benthos alteration

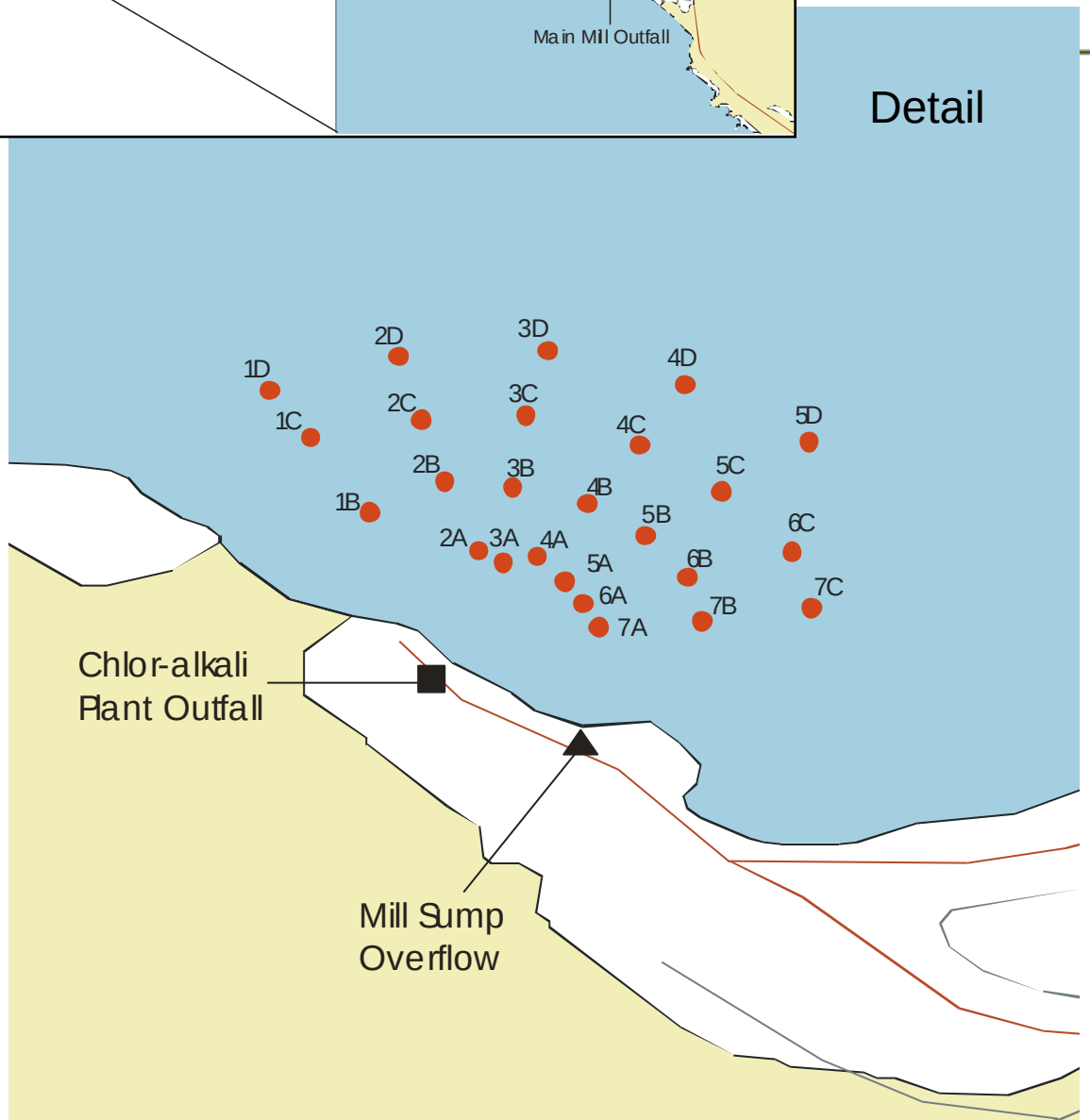
- Currently, fully assessing the need for biomagnification for 1 site in the nearshore area.



Peninsula Harbour Assessment

Exposed Sites: Jellicoe Cove

Total of 46 sites sampled in Cove, 25 sites in multiple gradient (grid)



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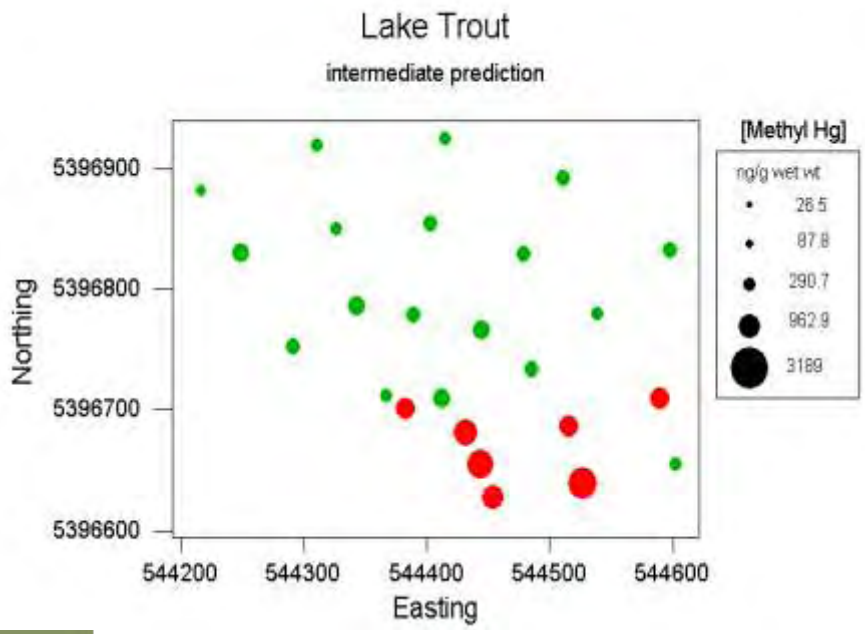
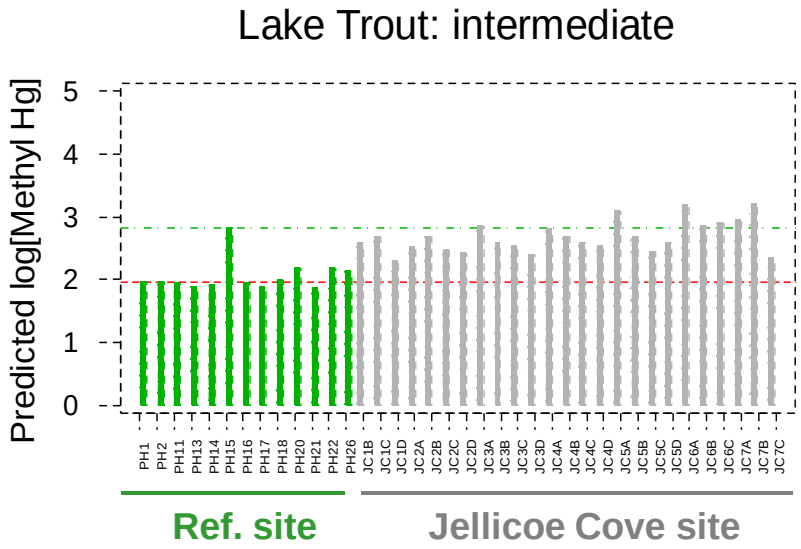
Predicted Hg in receptors (e.g., [MeHg] in Lake Trout: intermediate scenario)



Jellicoe Cove sites



= $[MeHg]_{rec}$ < max. for ref. sites, > TRG

= $[MeHg]_{rec}$ > max. for ref. sites, > TRG

max. for reference sites

tissue residue guideline

Outcomes and Management Recommendation

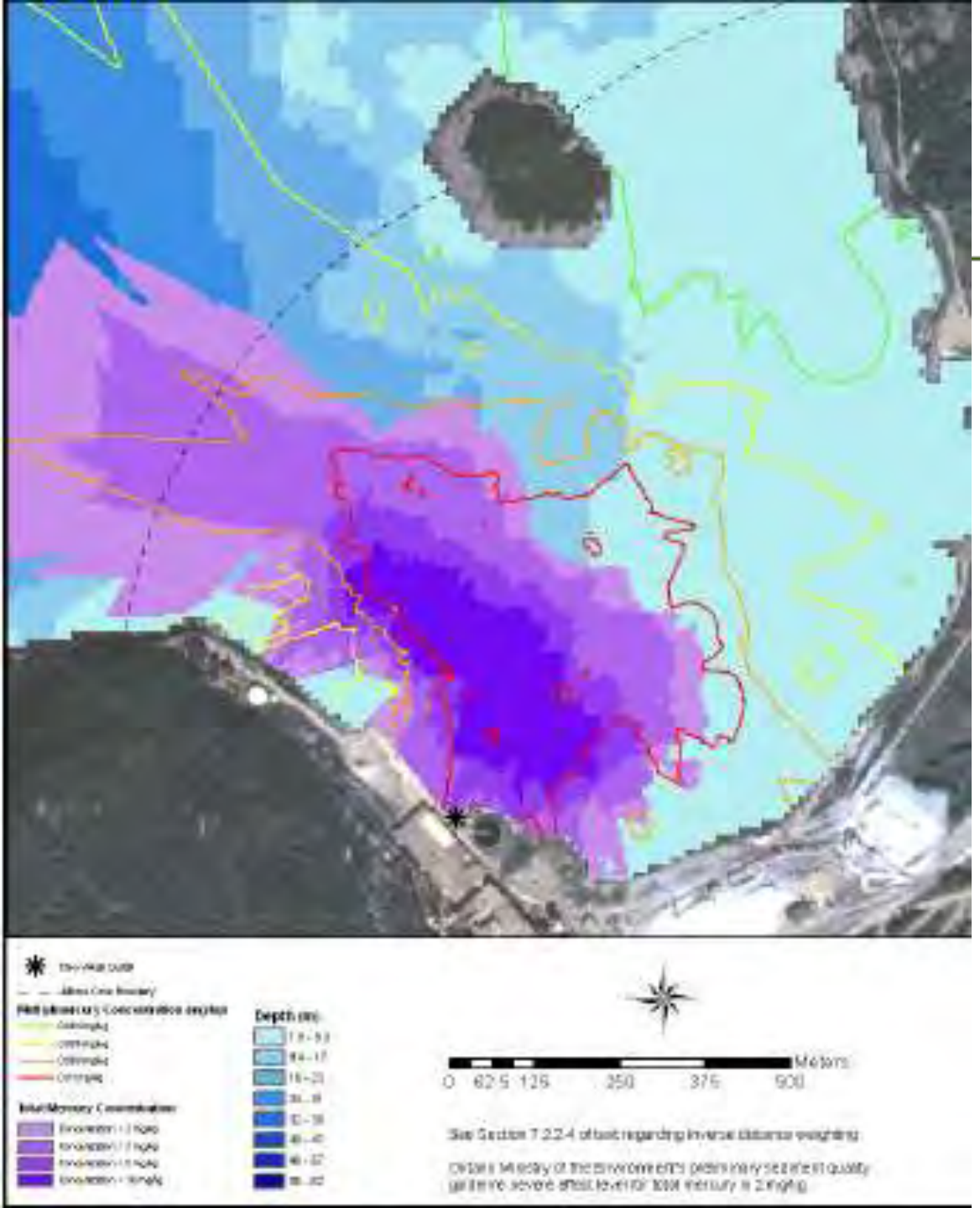
Scenario	Sediment Chemistry	Toxicity	Benthos Alteration*	Biomagnification Potential	Assessment
11	■	○	■	□	Fully assess risk of biomagnification

*Jellicoe Cove Benthic communities – in area of wood accumulation and high TOC – already determined reasons for benthos alteration

- Work completed to date has involved components of detailed quantitative assessment of ecological risk of mercury **and PCB** biomagnification.

Peninsula Harbour ERA Objectives

- Estimate ecological risk posed by Hg
- Evaluate potential risks to human health from consumption of fish caught in Peninsula Harbour
- Develop risk-based site-specific sediment management goals
- Estimate area and volume of sediment warranting management



Mercury Hot Spot-Based Management Areas

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Preliminary Management Volumes

Hot Spot-Based Sediment Management Goal (Total Mercury, mg/kg)	Area of Jellicoe Cove with Concentrations Above Goal (m^2)	Average Depth of Sediment in Area[a] (cm)	Volume of Sediment Associated with Area (m^3)[b]	Residual Hazard Quotients		
				Longnose Sucker[c]	Mink[d]	Sport Angler[e]
2	250,000	17	42,500	1	3	0.5
3	182,000	18	32,760	1	4	0.7
6	83,000	18	14,940	1	4	1.0
10	39,000	20	7,800	1	4	1.1

a. Average sediment depth data based on Beak (2000).

b. Dredging costs estimated to range from $2.3 million to $13 million, based on rule-of-thumb estimate of $300/cubic meter (NRC 2001).

c. Assumes longnose sucker inhabit Jellicoe Cove 25% of the time and the rest of Peninsula Harbour 75% of the time.

d. Assumes mink forage within Jellicoe Cove 25% of the time and the rest of Peninsula Harbout 75% of the time.

e. Sport anglers assumed to target lake trout and to derive 50% of their catch from Peninsula Harbour.

Thank you.

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