Development of a Preliminary Remediation Goal (PRG) for Dioxin in Sediment for the Passaic River/Newark Bay and Raritan Bay Complex, New Jersey, Using a Reproductive End-Point in the Eastern Oyster

Session on Assessment and Remediation of Chemical Contamination in Tidal Estuary Sediments
SETAC 28th Annual Meeting, Milwaukee

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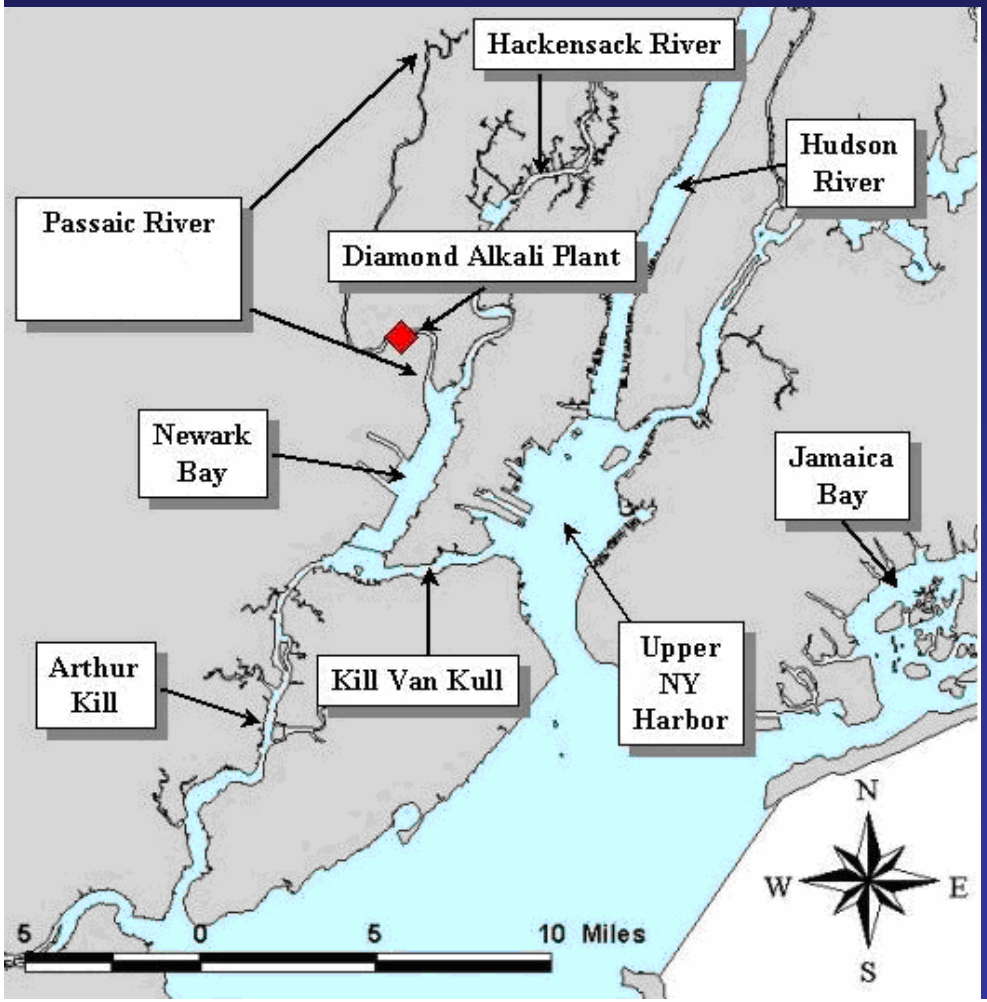


Lower Passaic River

Newark Bay

Kill van Kull

Arthur Kill

Hackensack River

Raritan Bay

New York Harbor

Objectives

- Review Information Available To Develop Invertebrate-based PRG For TCDD
- Review Data Adequacy
- Use Site Specific Data To Populate Model
- Compare PRGs Developed For Bedded Sediments and Suspended Solids

Eastern Oyster – (*Crassostrea virginica, Gmelin*)

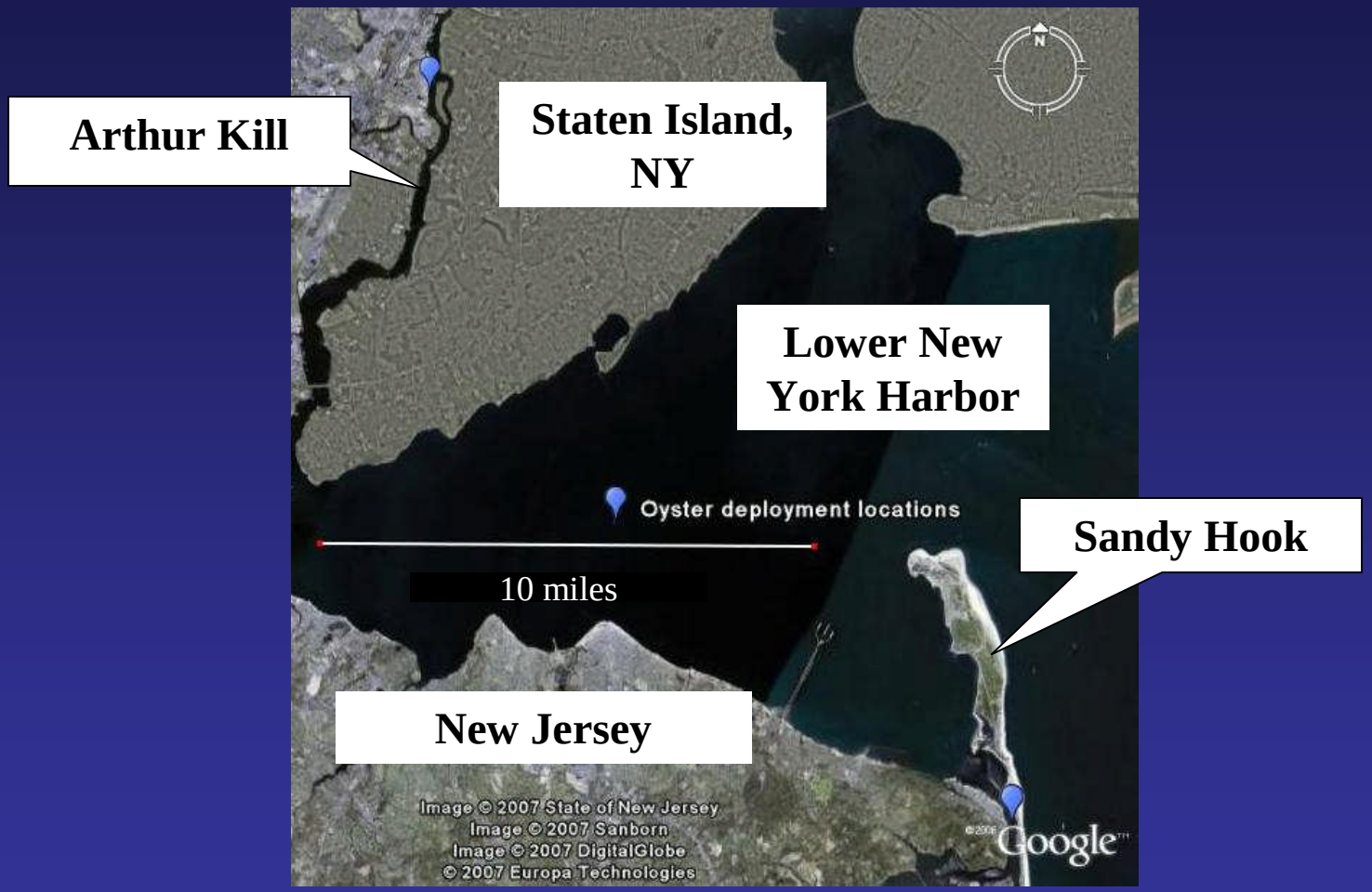
One of the Most Sensitive Receptors to Dioxin Exposure

Wintermeyer and Cooper (2003)

- Field study: Deployed oysters in Newark Bay, Arthur Kill, and Sandy Hook and evaluated:
  - Bioaccumulation
  - Effects on reproduction
  - Effects on histology

Objective 1

Oyster Deployment Locations



Data collected 9/2000 to 6/2001

(Wintermyer and Cooper 2003)

Eastern Oyster – Field Study

Location	Actual TCDD Bioaccumulation (pg/g)	Fertilization (%)	Survival (%)
Arthur Kill	1.3	23.3	0.04
Sandy Hook	0.15	53.7	84

Data from Wintermeyer and Cooper (2003)

Bedded Sediment Data

The New York New Jersey Harbor Estuary Program

Contamination Assessment & Reduction Project

Data collected for:

Harbor Ambient Sediment Sampling Project

Harbor Sediment Trackdown Project

Sediment Sampling Locations In The Complex

Data collected 7/1999 to 7/2001 by NYSDEC (CARP)

Accessed via OurPassaic.org

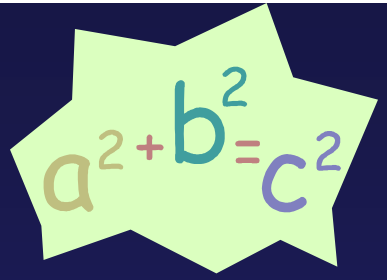
Evaluation of Data Adequacy

Available data include:

- Effects concentrations (critical body residues) and lipid concentrations in oysters
- Collocated TCDD and organic carbon in sediment
- Spatially and temporally consistent sediment and oyster data

3 for 3 !!!

The Formula



$$PRGsed_{dw} = \frac{(C\ oyst\text{-}lip\ [t] \times fsoc)}{BSAF}$$

Where:

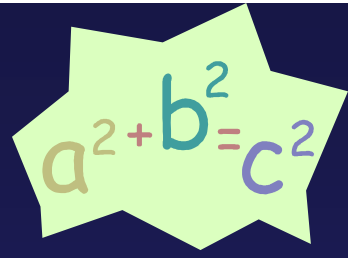
$PRGsed_{dw}$ = remediation goal for TCDD in sediment (PRG)

C oyst-lip [t] = lipid-normalized threshold TCDD concentration in oyster tissue

fsoc = fraction organic carbon in sediment

BSAF = biota-sediment accumulation factor

The Inputs (1) – Coyst-lip [t]



C oyst-lip [t] =Lipid-normalized threshold TCDD concentration in oysters (pg/g ww)

Coyst-lip [t] = Ct / Lt

Where:

Ct = TCDD tissue effects threshold (0.44* pg/g)

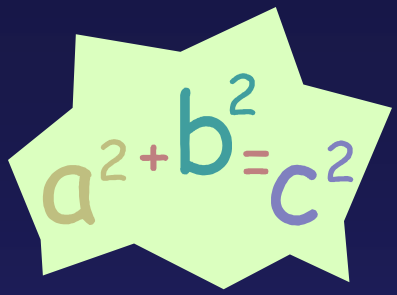
Lt = oyster lipid content (max.) = 0.6*%

$$\text{C oyst-lip [t]} = \frac{0.44 \text{ pg/g}}{0.006}$$

C oyst-lip [t] = 73.3 pg/g

*Data from Wintermyer and Cooper 2003

The Inputs (2) - fsoc



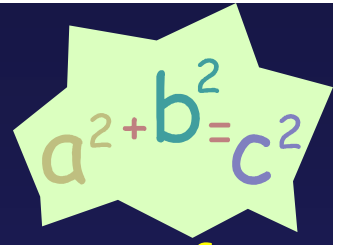
Fsoc = fraction organic carbon in sediment

fsoc = 0.0394* (g OC/g sed)

(Average for all 4 sediment sampling locations)

***Data collected by NYSDEC (CARP)**
Accessed via OurPassaic.org

The Inputs (3) - BSAF



Step 1: Derive the lipid normalized concentration of TCDD measured in oyster tissue = C oyst-lip (m) (pg/g)

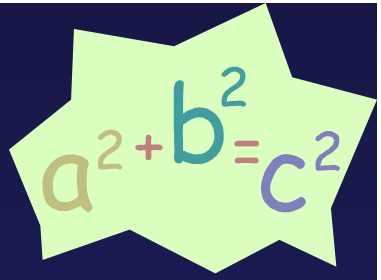
$$\text{Coyst-lip (m) (pg/g)} = \frac{\text{TCDD (pg/g)}}{\text{lipid content (g/g)}}$$

$$\text{Coyst-lip (m) (pg/g)} = \frac{1.3^{*}\ \text{pg/g}}{0.002^{*}\ \text{g/g}}$$

Coyst-lip (m) = 650 pg/g

***Data from Wintermyer and Cooper 2003**

The Inputs (3) – BSAF, cont'd.



Step 2: For each sediment sample, calculate organic carbon normalized TCDD in sediment (Csoc)

$$Csoc = \frac{TCDDsed\ (pg/g\ dw)}{Coc\ (g/g)}$$

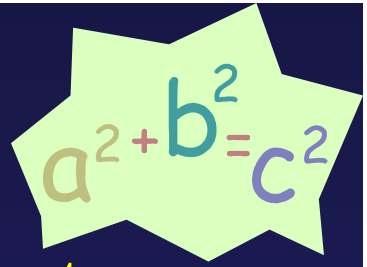
$$Csoc\ (ARK07\_14 - 8/30/00) = \frac{39.0^*\ (pg/g\ dw)}{0.0259^*\ (g/g)}$$

Csoc (ARK07_14 - 8/30/00) = 1506 (pg/g)

***Data collected by NYSDEC (CARP)**

Accessed via OurPassaic.org

The Inputs (3) – BSAF, cont'd.



Step 3: Calculate the BSAF for each sediment sample location

$$BSAF = \frac{\text{C oyst-lip (m) (pg/g)}}{\text{Csoc (pg/g)}}$$

Sample location ARK07_14 - 8/30/00:

$$BSAF = \frac{\text{650 pg/g}}{\text{1506 pg/g}}$$

BSAF =0.4317

Putting It Together

The Formula, revisited:

$$PRGsed_{dw} = \frac{(C\ oyst\text{-}lip\ [t] \times fsoc)}{BSAF}$$

The Inputs, revisted:

C oyst-lip [t] = 73.3 pg/g

fsoc (average) = 0.0394 g/g

BSAF (average) = 0.91

The Final Result

$$PRGsed_{dw} = \frac{(C\ oyst\text{-}lip\ [t] \times fsoc)}{BSAF}$$

$$PRGsed_{dw} = \frac{73.3\ pg/g \times 0.0394\ g/g}{0.91}$$

$PRGsed_{dw}$ = 3.17 pg/g

Suspended Solids

Data for the Arthur Kill collected through CARP:

- Collocated TCDD and organic carbon in suspended solids
- Spatially and temporally consistent with oyster data

Along with oyster CBR and lipid values:

3 for 3 !!!

Dimou and Pecchioli (2006) and Pecchioli, NJDEP, (pers. comm.)

Objective 4

Suspended Solids Sampling Locations in the Complex

(Dimou and Pecchioli 2006; Pecchioli pers. comm)

Suspended Solids

$$PRGsed_{dw} = \frac{(C\ oyst\text{-}lip\ [t] \times fsoc)}{BSAF}$$

$$PRGsed_{dw} = \frac{73.3\ pg/g \times 0.0525^{*}\ g/g}{1.05}$$

$PRGsed_{dw} = 3.67\ pg/g$

***Data from Dimou and Pecchioli (2006) and Pecchioli, NJDEP, (pers. comm.).**

Oyster Restoration in the Complex

>5 PPT Salinity Zone

Arthur Kill

- Reproductive failure, mortality;
- No restoration potential without remediation

Sandy Hook Bay

- Restoration potential NOW

Based on data from Wintermyer and Cooper 2003

Conclusions, cont'd.

- This approach used literature-based effects concentrations to develop site-specific goals for remediation based on site-specific data.
- Remediation is needed to have successful restoration of oysters in the Complex.

Conclusions, cont'd.

- Threshold concentrations derived for bedded sediments and suspended solids are very similar. This strengthens the value of the PRG and reflects the strong hydrological interaction of bedded sediment and suspended solids in the Complex.
- This approach can be revisited as clean up efforts continue and more data become available.
- The approach can be applied to other areas or taxa as well.