HydroQual
Environmental Engineers & Scientists
HydroQual, Inc. 1200 MacArthur Blvd., Mahwah, NJ 07430 T: 201-529-5151 F: 201-529-5728

SUBJECT	PAGE: OF: 1	BY: CHECKED:	DATE:	PROJECT NUMBER:

Lecture #11

$C_L^* = K_{LW} C_W^*$

$C^*_{L|CMC} = K_{LW}$ CMC

$C^*_{L|FAV} = K_{LW}$ FAV (mmol/L)

35.3 mmol(g lipid) = mmol/kg lipid

$\log K_{LW} = -0.945 \log K_{OW}$

CMC = FAV/2 ⇐ FAV (LC50 of 5th percentile)

CMC ≅ LC10 " " "

Sediment Toxicity. (TLM)

"LC50" $C_L^* = K_{LW} C_W^*$

C_L^* = 12.2 mmol/kg lipid

C_W^* ↑ calculate

mmol/L water

Equilibrium Partition ing (EqP)

"LC50" $C^*_{S,OC} = K_{OC} C_W^*$

mmol/kg OC

$\log K_{OC} = \log K_{OW}$

$\frac{L\ water}{kg\ OC}$

HydroQual
Environmental Engineers & Scientists
HydroQual, Inc. 1200 MacArthur Blvd., Mahwah, NJ 07430 T: 201-529-5151 F: 201-529-5728

SUBJECT	PAGE: OF: -2-	BY: CHECKED:	DATE:	PROJECT NUMBER:

$C^*_{s,oc}$ = 5 mmol / kg OC

Mixture Model – Toxic units Add
(concentration addition)

$$TU_i = \frac{C_{s,oc_i}}{C^*_{s,oc_i}}$$

Calculate $TU_{naphthalene}$ ⇐

" $TU_{C1-Naphthalenol}$

:

$\sum TU$

% Mortality	50%
$\sum TU$	1.0

"Molar Sum Approx"

$\log C^*_L = \log K_{Lw} + \log C_w$ TLM (*)

$\log C^*_{s,oc} = \log K_{ow} + \log C_w$ Eq P ($K_{oc} \sim K_{ow}$)
(Org C ~ octanol)

$\log C_w = \log C^*_L - \log K_{Lw}$ (*)

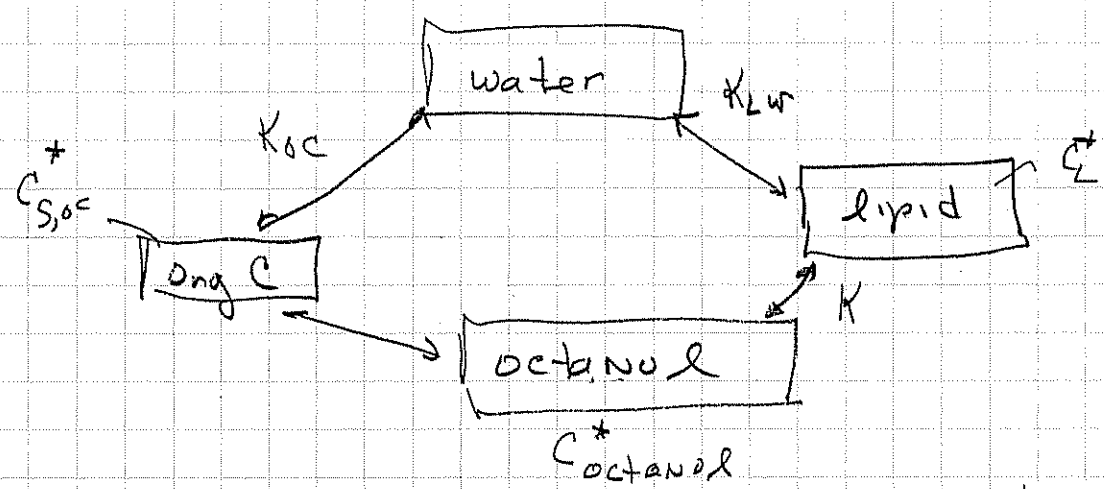
$\log C^*_{s,oc} = \log K_{ow} - \log K_{Lw} + \log C^*_L$

$\log K_{Lw} = 0.945 \log K_{ow}$ (Target Lipid ~ Octanol

($\log C^*_{s,oc} = 0.055 \log K_{ow} + \log C^*_L$)

HydroQual
Environmental Engineers & Scientists
HydroQual, Inc. 1200 MacArthur Blvd., Mahwah, NJ 07430 T: 201-529-5151 F: 201-529-5728

SUBJECT	PAGE: OF: -3-	BY: CHECKED:	DATE:	PROJECT NUMBER:



$C^*_{S,OC} \sim C^*_L$ ($C^*_{S,OC}$ indep of chemical)

So: $\sum_{i=1}^{N} C_{S,OC_i}$ Compare to C^*_L

Approximate $TU = \dfrac{\sum C_{S,OC_i}}{C^*_L}$

Molar Sum

$TU_i = \dfrac{C_{S,OC_i}}{C^*_{S,OC_i}} = \dfrac{C_{S,OC_i}}{C^*_{S,OC}}$

$\sum TU_i = \sum_{i=1}^{N} \dfrac{C_{S,OC_i}}{C^*_{S,OC}} = \dfrac{1}{C^*_{S,OC}} \underbrace{\sum_{i=1}^{N} C_{S,OC_i}}$

Molar Sum of All PAHs

SEDIMENT QUALITY CRITERIA FOR TOXIC METALS

Lecture # 11

* What are they?

  Chemical concentration in the sediment that are protective of aquatic life.

  Applicable to all sediments.

* What metals?

  Copper (Cu), Cadmium (Cd), Nickel (Ni), Lead (Pb), Zinc (Zn)

* What is the problem?

  Need to demonstrate that concentration of metals in sediment correlates to biological effects

WHAT UNIT OF MEASUREMENT SHOULD BE USED ?

* Sediment

  Total metal (ug Cu/L)

  Total metal (ug Cu/g dry weight)

  Dissolved metal (ug Cu/L)

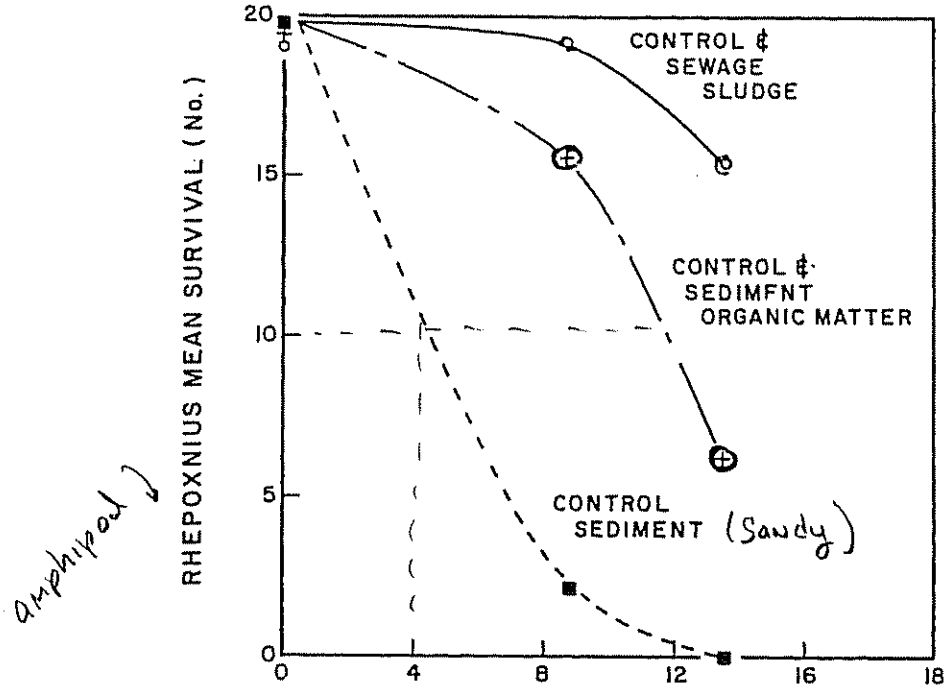
* The issue is:

  What concentration correlates to biological effects?

* Total concentration DOES NOT !

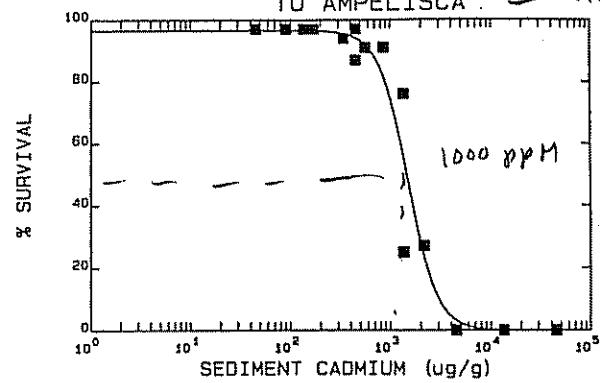
ACUTE TOXICITY OF CADMIUM TO AN AMPHIPOD EFFECT OF SEDIMENT PROPERTIES

(AFTER R.C. SWARTZ et al., 1985)

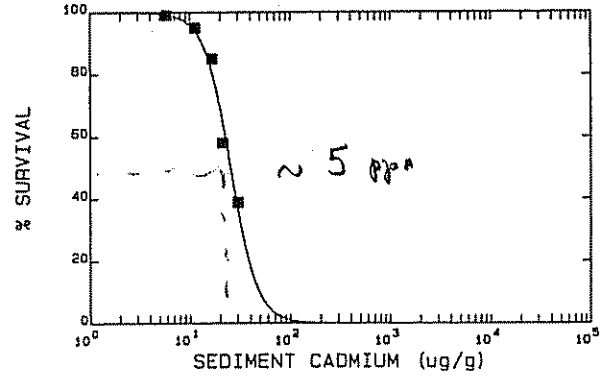


amphipod

ACUTE TOXICITY OF CADMIUM TO AMPELISCA — amphipod



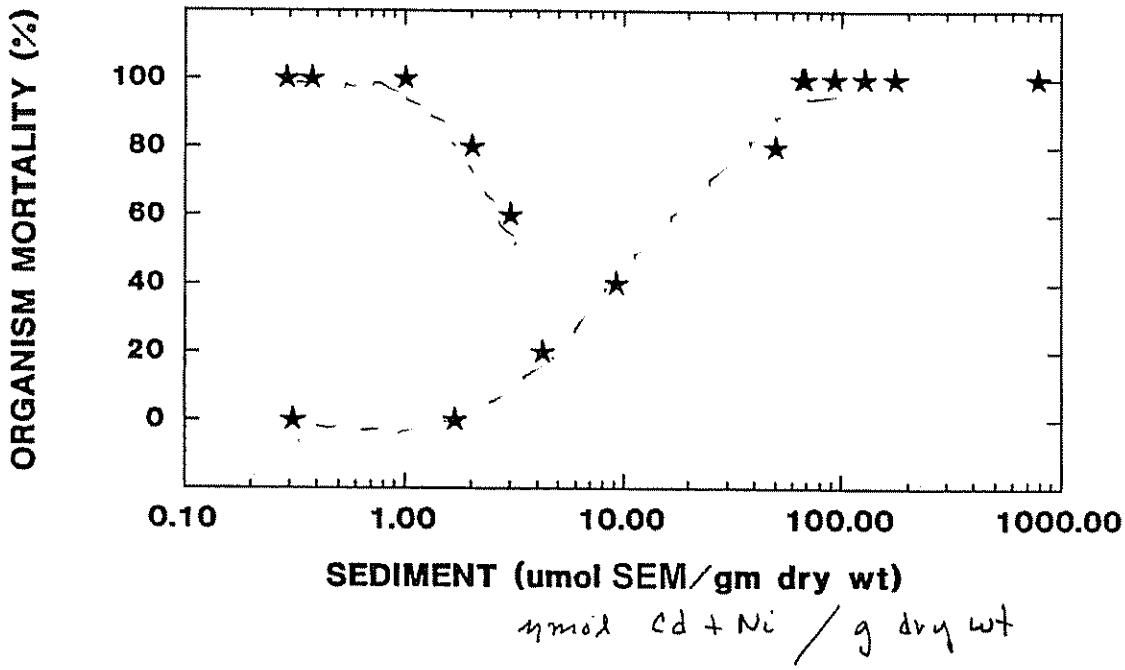
ACUTE TOXICITY OF CADMIUM TO RHEPOXYNIUS



FOUNDRY COVE / Hudson River

AMPHIPOD MORTALITY - Cd + Ni - FRESH WATER

DRY WEIGHT NORMALIZATION



THE CRUCIAL DISCOVERY

Biological Effects Correlate to Chemical Activity

* **Chemical Activity:**

  The concentration of Me^{2+}

  $pMe = - \log_{10} [Me_2^{+}]$

  Me = Cu, Cd, ...

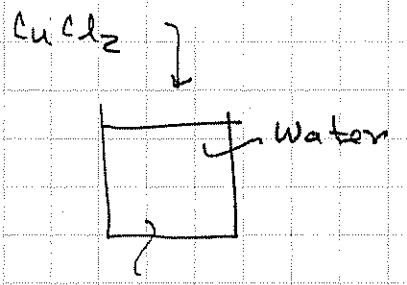
* **Data from Water Column experiments**

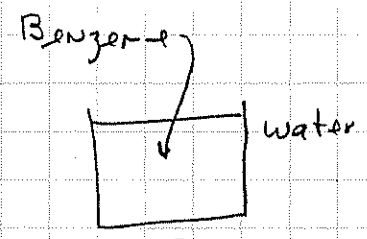
* **Data from Sediment experiments**

HydroQual
Environmental Engineers & Scientists
HydroQual, Inc. 1200 MacArthur Blvd., Mahwah, NJ 07430 T: 201-529-5151 F: 201-529-5728

SUBJECT	PAGE: OF: -4-	BY: CHECKED:	DATE:	PROJECT NUMBER:

Metal Bioavailability in Water

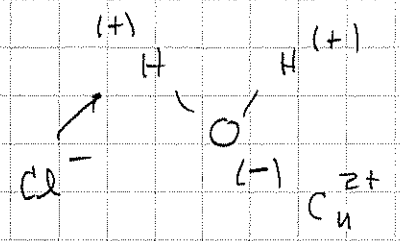




Benzene → 6C + 6H

$CuCl_2 \rightarrow Cu + Cl_2$

$Cu^{2+} + 2Cl^-$



$+ H_2O$

$H_2O \rightleftharpoons H^+ + OH^-$

$CuOH^+ + H^+$

1st hydrolysis product

Cu in water : Cu^{2+} $CuOH^+$ $Cu(OH)_2$

TRIS (organic acid) = L

$Cu^{2+} + L = CuL^+$

$Cu^{2+} + 2L = CuL_2$

Cadmium

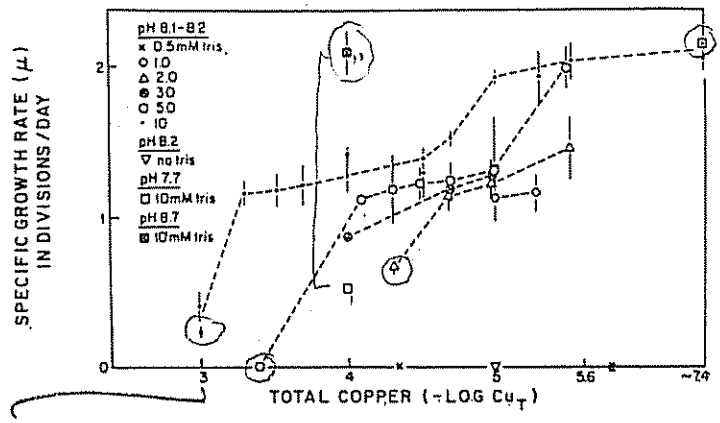
$Cd^{2+} + Cl^- \rightarrow CdCl^+ + Cl \rightarrow CdCl_2$

Chloro complex

CHRONIC TOXICITY OF COPPER TO A DIATOM

TRIS

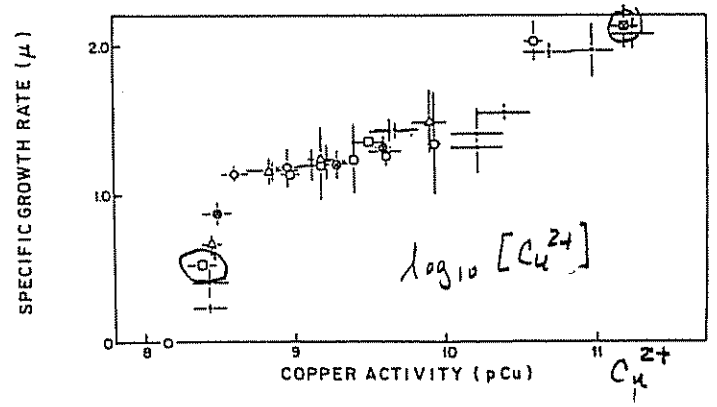
(FROM SUNDA AND GUILLARD, 1976)



fine

$pH = -\log_{10} H^+$

mixed



"FIAM" free ion activity model

ACUTE TOXICITY OF CADMIUM TO GRASS SHRIMP (Palaemonetes) EFFECT OF SALINITY

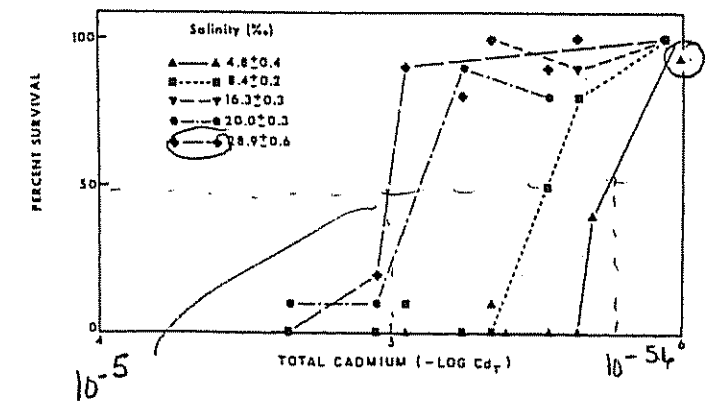
(AFTER W.G. SUNDA et al., 1978)

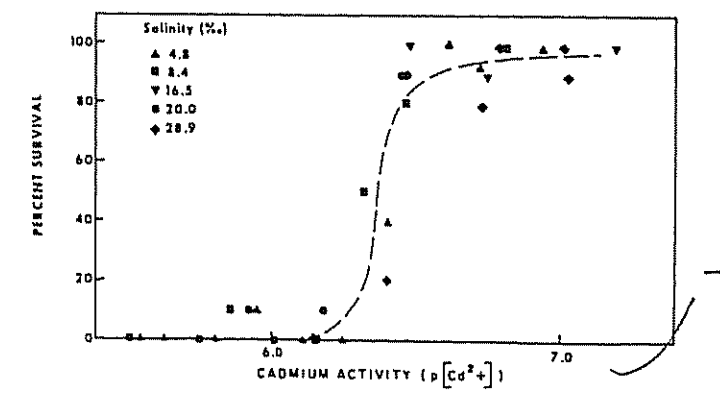
‰ = g/kg - g salt/kg seawater

35 ‰

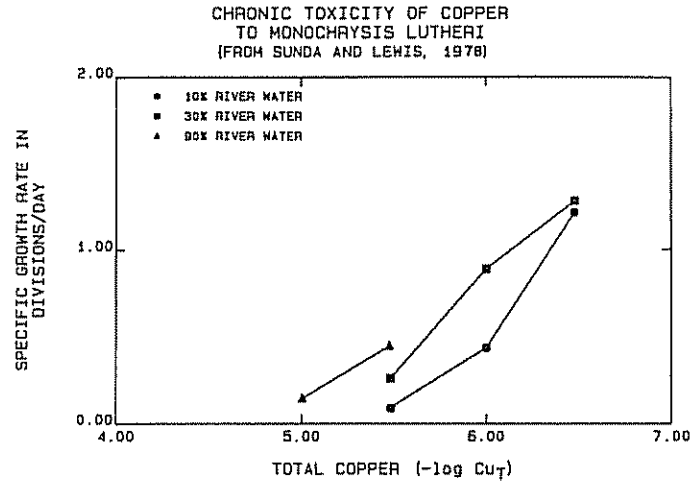
↑

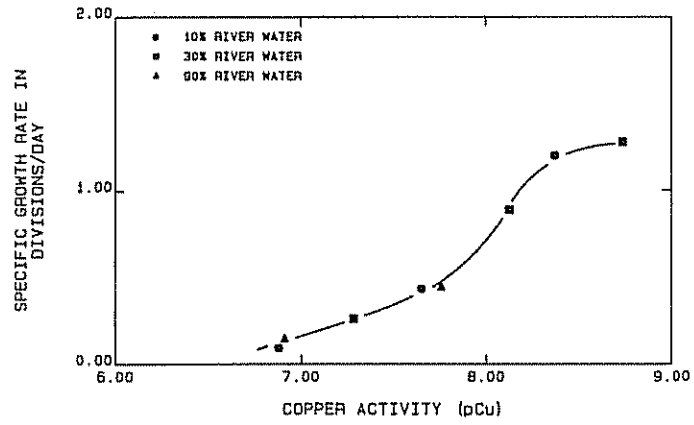
parts/thousand

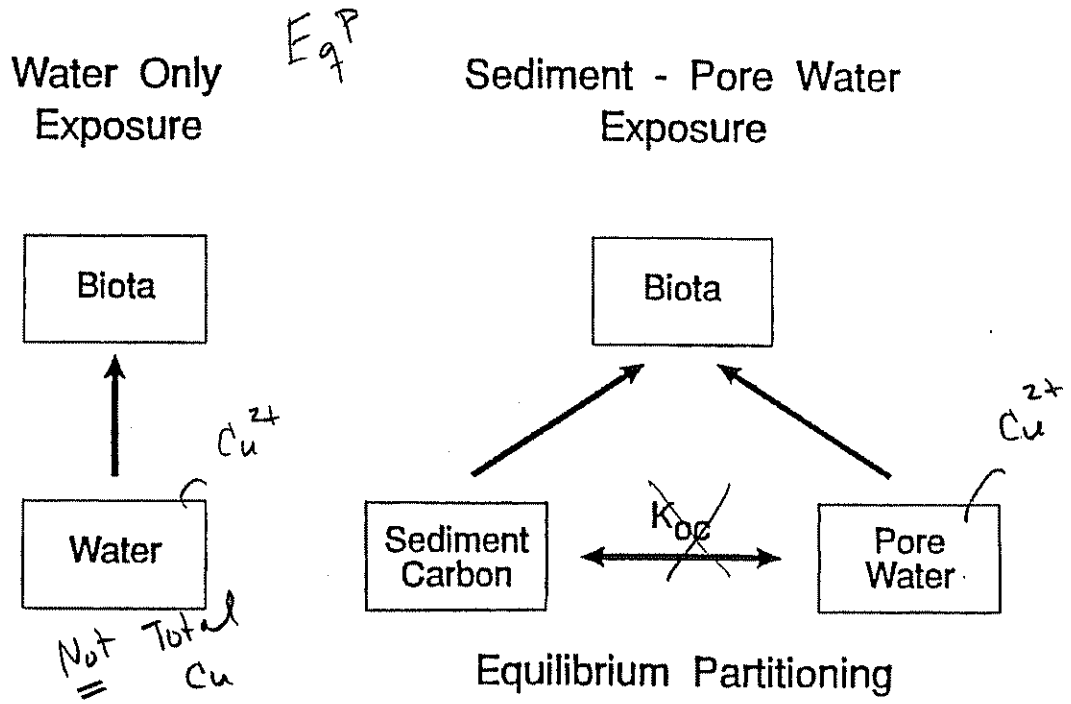




$-\log_{10}[Cd^{2+}]$

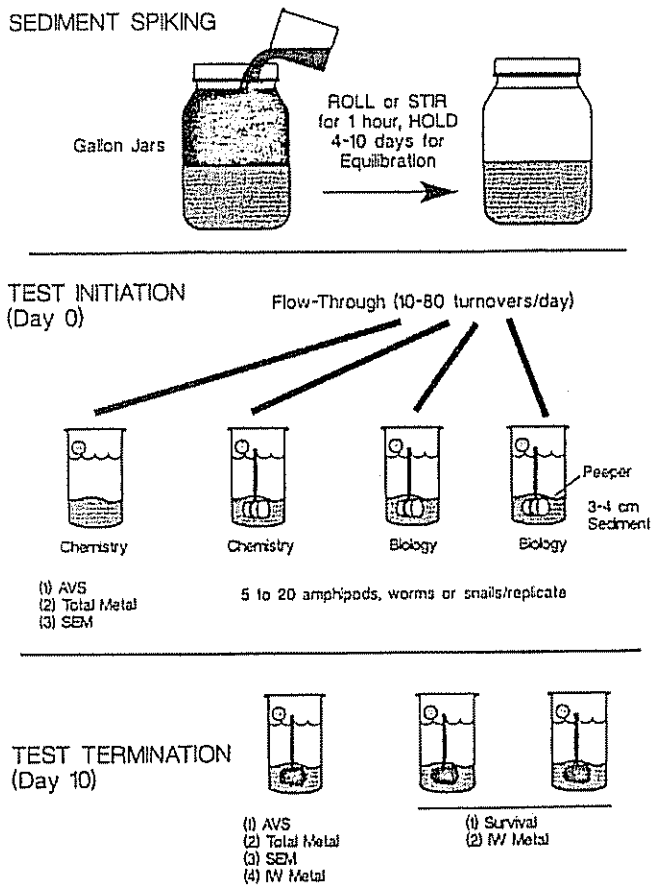






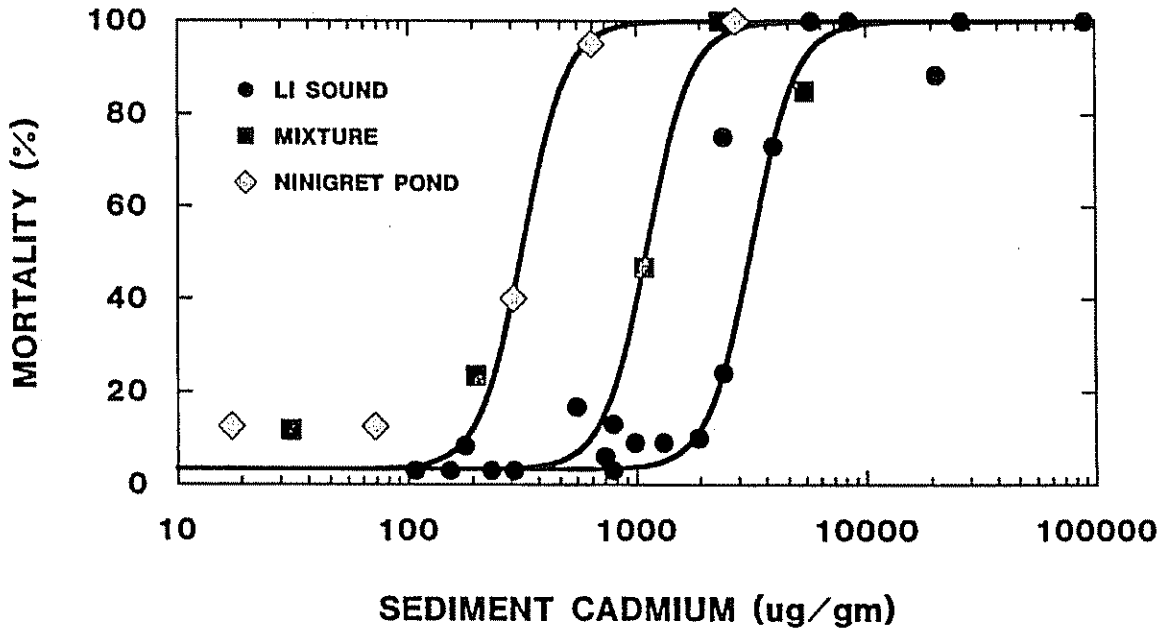
(From Di Toro et. al., 1991)

EXPERIMENTAL DESIGN

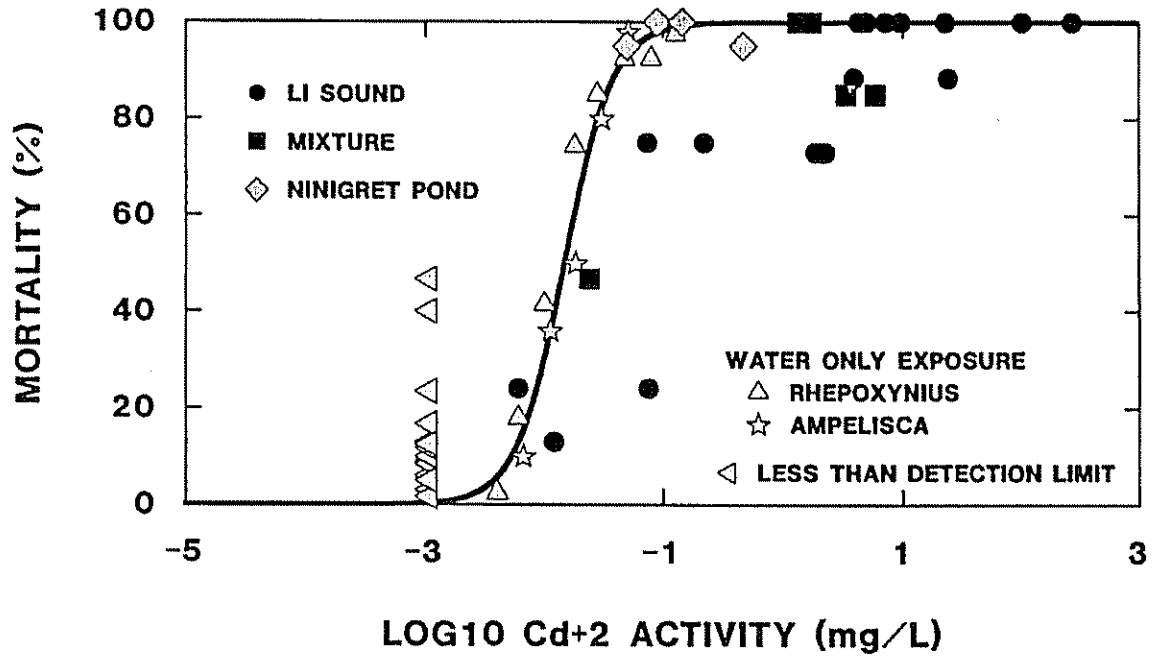


MORTALITY vs SEDIMENT CADMIUM

DRY WEIGHT NORMALIZATION



MORTALITY vs INTERSTITIAL WATER CADMIUM



MORTALITY vs INTERSTITIAL WATER CADMIUM