

Concept and Demonstration of a Water Contamination Index for the San Francisco Estuary

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BACKGROUND

- SFEP is developing indicators for the condition of SF Estuary
- The recommended Estuary Contamination Index includes indicators for:
 - Water and sediment quality (contaminants, nutrients, etc.)
 - Toxicity
 - Biological effects
 - Fish Bioaccumulation
- State Sediment Quality Objectives are being developed which include indicators for all of above except water quality.

PURPOSE

- Provide assessments of the condition of aquatic life in the Estuary related to to contaminants in water.
- The Water Contamination Index is one component of the SF Estuary Contamination Index.

**ESTUARY
CONTAMINATION
INDEX**

**WATER
CONTAMINATION
INDEX**

**SEDIMENT QUALITY
INDEX
(SQO)**

**BENEFICIAL
USE:**

Aquatic Life:

Human Health:

Aquatic Life:

Human Health:

INDICATORS:

**Water Conc.
Aquatic Tox.
Bio. Effects**

**Water Conc.
Tissue Conc.
Advisories**

**Sed. Conc.
Sed. Tox.
Benthos**

**Sed. Conc.
Tissue Conc.
Advisories**

**CURRENT
STATUS:**

Draft WCI Rept.

Needs to be Devel.

Draft SQO

Draft SQO

SQO PRINCIPLES

- Assessments use multiple lines of evidence.
 - No single line of evidence is adequate due of limitations in interpreting any single line of evidence (e.g. bioeffects may be influenced by more than just contaminants; toxicity may be due to unmeasured contaminants, etc.)
- Lines of evidence include indicators of exposure and biological effects.
- Each LOE includes several levels of 'impact'.
- Biological effects LOEs are weighted.
- Assessments are for a site, but waterbody assessments may be made using sites as replicates.

WATER CONTAMINANT INDEX LINES OF EVIDENCE

1. Water Contamination – assessed using CTR values as a basis for thresholds.
2. Aquatic Toxicity – assessed using lab toxicity test results.
3. Potential Biological Effects - uses biological effects thresholds from literature.

WATER CONTAMINATION LINE OF EVIDENCE

- Includes 15 water contaminants measured by RMP
 - Option: use CTR quotients to account for additivity
- NOT regulatory, but used to describe the level of exposure to water contaminants as one LOE.

WATER CONTAMINANTS

Ag

As

Cd

Cu

Diazinon

Dieldrin

Hg

Ni

Pb

Se

Sum of Chlordanes

Sum of DDTs

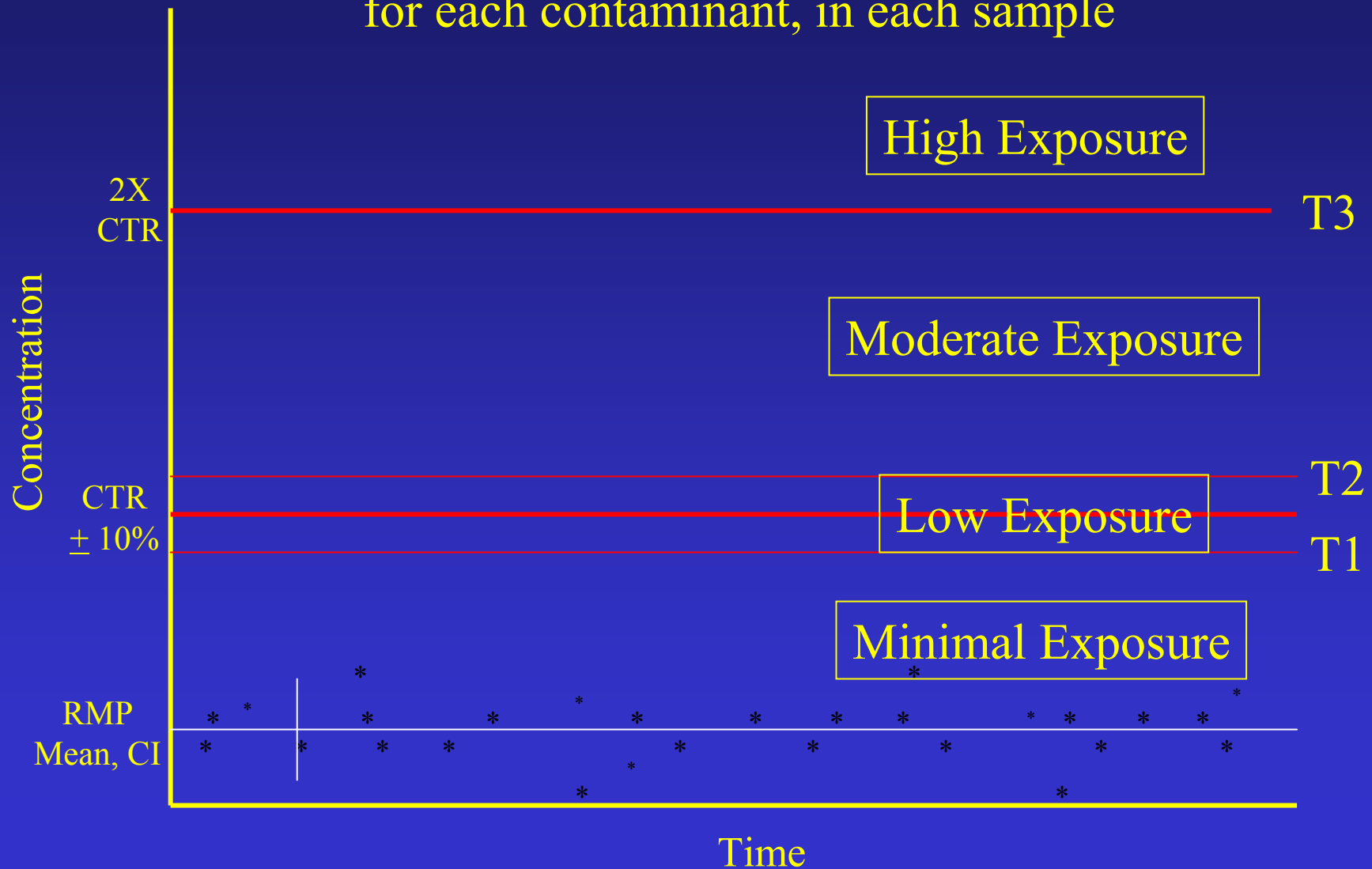
Sum of PAHs

Sum of PCBs

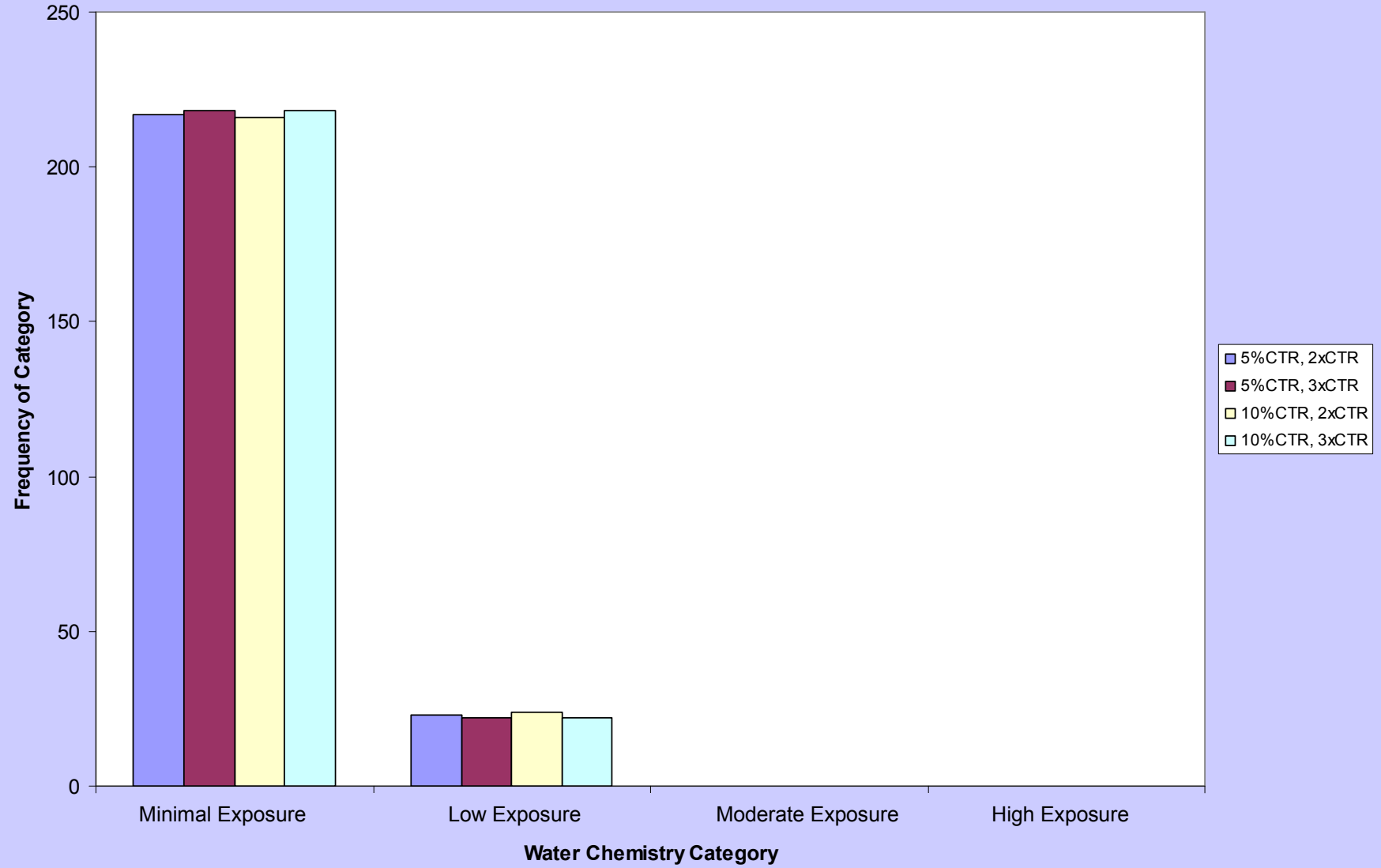
Zn

WATER CONTAMINATION CATEGORIES AND THRESHOLDS

for each contaminant, in each sample



Site Contamination Scores - Comparison of Calculation Method - Summer Data Only



AQUATIC TOXICITY LINE OF EVIDENCE

- RMP toxicity tests:
 - *Mytilus* or *Crassostrea*, 48 hour development
 - *Thalassiosira* 96 h growth
 - *Americamysis*, 7 day survival
- Variable testing in space and time, currently only every 5 years, and episodic sampling at selected inflows.
- Only 7.6 % of tests 1993 – 2002 were toxic (mysids or mussels).

AQUATIC TOXICITY CATEGORIES AND THRESHOLDS

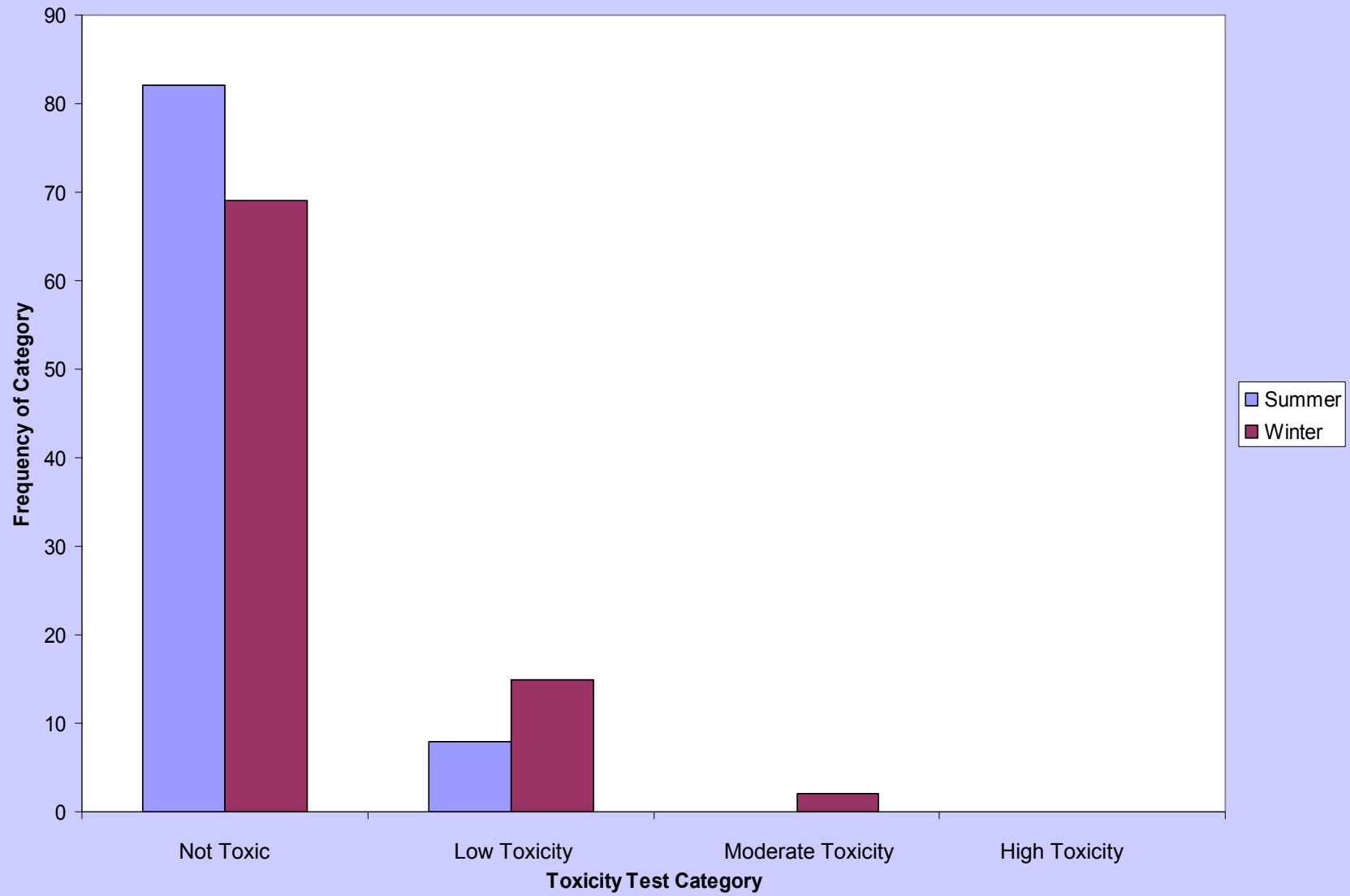
Not Toxic. Not significantly different from controls AND above the lowest control value (70% for bivalves, 80% for mysid).

Low Toxicity. Not significantly different from control AND below the lowest control value, OR significantly different from control and above the lowest control.

Moderate Toxicity. Significantly different from controls AND below the lowest control value, and above 50% endpoint.

High Toxicity. Highest toxic responses reported. 50% endpoint (normal development, survival, or half of control median for *Thalassiosira*).

Aquatic Toxicity LOE



BIOLOGICAL EFFECTS LINE OF EVIDENCE

- Used to assess the potential for biological effects from contamination exposure.
- Water bioeffects data from the EcoTox website, will eventually add other threshold data.
- Selected only data for bioeffects in 21 common and abundant organisms that inhabit SF Estuary, and for 25 of the water contaminants monitored by RMP, where available.
- Biochemical, enzyme, growth, histology, mortality, and reproduction effects thresholds were used. No accumulation measures were used.
- Where there was a choice, the minimum effects level and /or maximum test duration data was selected.
- Freshwater species were used for river sites and saltwater species for all other sites.

BIOEFFECTS DATA FOR THESE CONTAMINANTS

Trace Organics

Acenaphthene
Anthracene
Benzo(a)pyrene
Fluoranthene
Pyrene
alpha-HCH
beta-HCH
gamma-HCH
Chlorpyrifos
Diazinon
Dieldrin
Endrin
p,p'-DDD
p,p'-DDE
p,p'-DDT

Trace Elements

Ag
As
Cd
Cr
Cu
Hg
Ni
Pb
Se
Zn

SPECIES WITH BIOEFFECTS DATA

Salt Water

Americamysis bahia
Cancer magister
Clupeidae
Cymatogaster aggregata
Engraulidae
Eurytemora affinis
Menidia beryllina
Mytilus edulis
Mytilus galloprovincialis
Mytilus sp.
Oncorhynchus tshawytscha
Oryzias latipes
Palaemon elegans
Palaemon serratus
Paralichthys olivaceus
Platichthys flesus
Pseudodiaptomus coronatus

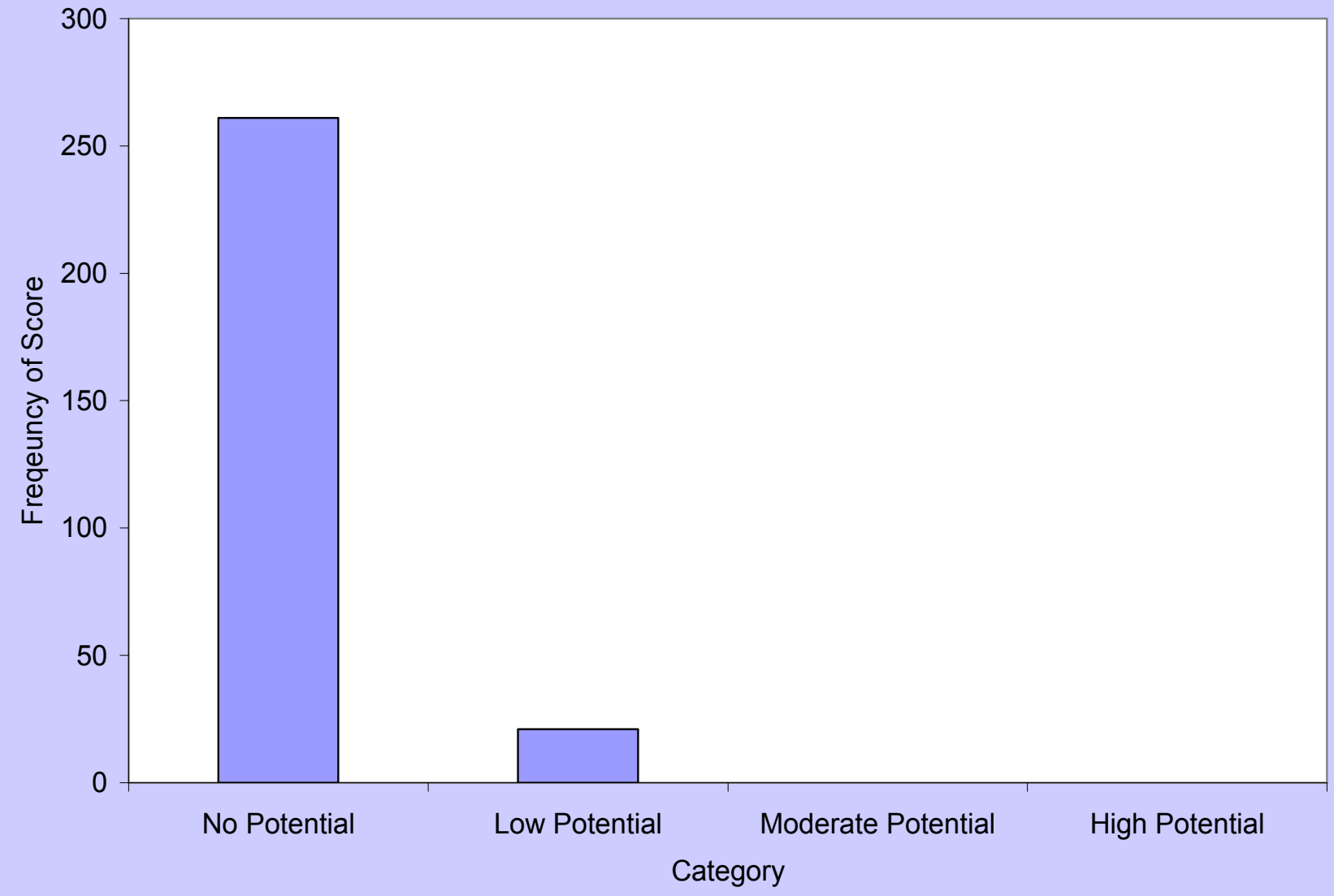
Fresh Water

Ceriodaphnia dubia
Hyalella azteca
Morone saxatilis
Oncorhynchus tshawytscha
Oryzias latipes
Palaemon adspersus
Platichthys stellatus

BIOLOGICAL EFFECTS CATEGORIES AND THRESHOLDS

- **Minimal Potential.** No biological effect thresholds exceeded. The term “minimal” is used in preference to “no effect” because of the incomplete nature of the effects database and to acknowledge possible impacts due to additive or cumulative effects from mixtures of contaminants.
- **Low Potential.** One biological effect threshold was exceeded.
- **Moderate Potential.** More than one biological effects threshold was exceeded. However, none of the RMP samples were in this category using the bioeffects database information.
- **High Potential.** More than five biological effect thresholds were exceeded. The threshold limits for this category must be reconsidered using more extensive effects information.

RMP SAMPLES IN EACH BIOLOGICAL EFFECTS CATEGORY



SEVERITY OF EFFECT

Toxicity

**B
i
o
e
f
f
e
c
t
s**

	Nontoxic	Low Toxicity	Moderate Toxicity	High Toxicity
No Effect	Unaffected	Unaffected	Unaffected	Low Effect
Low Effects	Unaffected	Low Effect	Low Effect	Low Effect
Moderate Effects	Low Effect	Moderate Effect	Moderate Effect	Moderate Effect
High Effect	Moderate Effect	High Effect	High Effect	High Effect

POTENTIAL THAT EFFECTS ARE CHEMICALLY MEDIATED

Bioeffects

C
h
e
m
i
s
t
r
y

	No Effects	Low Effects	Moderate Effects	High Effects
Minimal Exposure	Minimal Potential	Minimal Potential	Low Potential	Low Potential
Low Exposure	Minimal Potential	Low Potential	Low Potential	Moderate Potential
Moderate Exposure	Low Potential	Moderate Potential	Moderate Potential	Moderate Potential
High Exposure	Moderate Potential	Moderate Potential	High Potential	High Potential

STATION ASSESSMENT

Severity of Effect

**Potential
that Effects
are
Chemically
Mediated**

	Unaffected	Low Effect	Moderate Effect	High Effect
Minimal Potential	Unimpacted	Likely Unimpacted	Likely Unimpacted	Likely Unimpacted
Low Potential	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
Moderate Potential	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
High Potential	Likely Unimpacted	Likely Impacted	Clearly Impacted	Clearly Impacted

EXAMPLE

WATER CONTAMINANT ASSESSMENT

Sample	Water Contaminants				Aquatic Toxicity			Biological Effects	Level of Effect	Potential for Contam. Effect	Site Ass'mt
	X	Y	Z	Score	Test XX	Test YY	Score				
A	Min	Min	Mod	Low	Not	Low	Low	None	Un	Min	Unimpacted
B	Min	Low	High*	Low	Mod	Not	Low	Low	Low	Low	Likely Unimpacted
C	Mod	Low	High	Mod	-	-	-	High	High	Mod	Clearly Impacted

* will require text / graphic

ADDENDUM: ADDITIONAL BIOLOGICAL EFFECTS INFORMATION

- Cursory literature search located 49 articles.

93 threshold values:

27 for lethal effects (LC50s, LD50s, etc.)

60 for sublethal effects

6 for sublethal effects on cell cultures

- Effects thresholds for:

lesions caused by PAH

selenium induced deformities

olfactory inhibition by copper

reduced locomotion growth inhibition

reproductive success