The Use of *In Vitro* Soil Metal Bioavailability Methodologies to Adjust Human and Ecological Risk Assessment Workshop

Metal Bioavailability in the USEPA Terrestrial Ecological Risk Assessment Framework

Dr. Mark Sprenger

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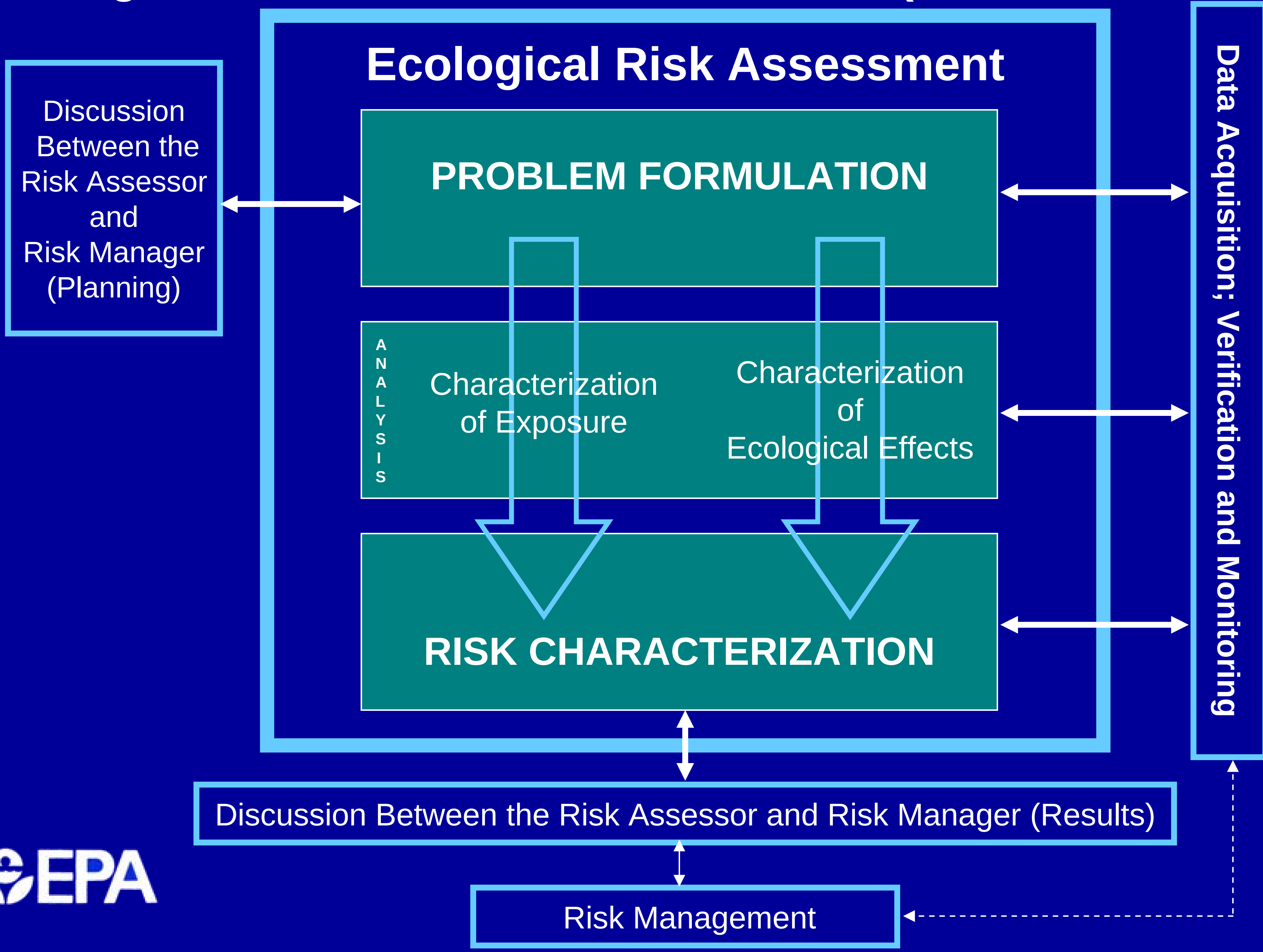
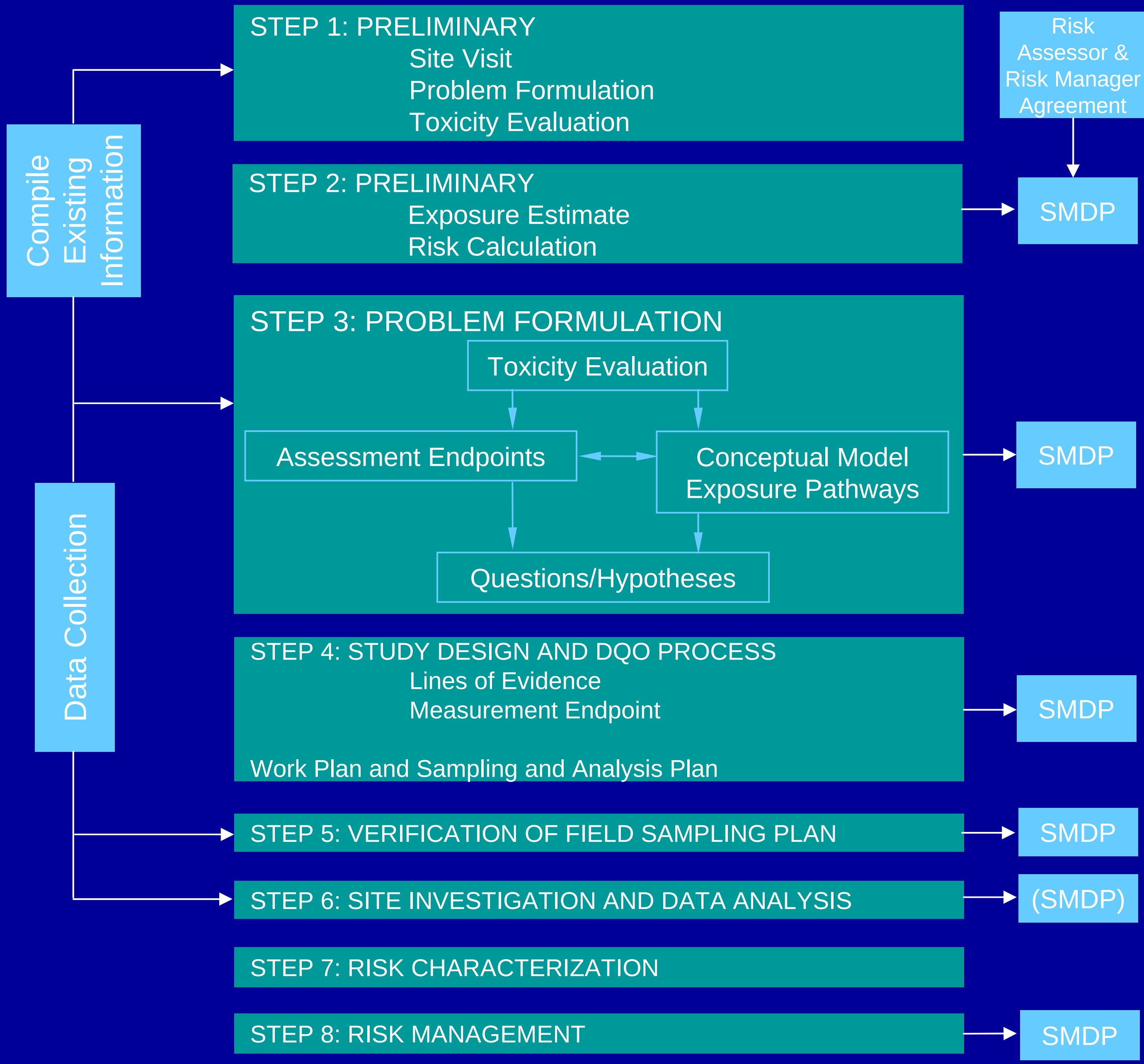
Ecological Risk Assessment Framework (U.S. EPA, 1992a)




STEP 1: PRELIMINARY
Site Visit
Problem Formulation
Toxicity Evaluation
Risk Assessor & Risk Manager Agreement
Compile Existing Information
STEP 2: PRELIMINARY
Exposure Estimate
Risk Calculation
SMDP
STEP 3: PROBLEM FORMULATION
Toxicity Evaluation
Assessment Endpoints
Conceptual Model Exposure Pathways
Questions/Hypotheses
SMDP
Data Collection
STEP 4: STUDY DESIGN AND DQO PROCESS
Lines of Evidence
Measurement Endpoint
Work Plan and Sampling and Analysis Plan
SMDP
STEP 5: VERIFICATION OF FIELD SAMPLING PLAN
SMDP
STEP 6: SITE INVESTIGATION AND DATA ANALYSIS
(SMDP)
STEP 7: RISK CHARACTERIZATION
STEP 8: RISK MANAGEMENT
SMDP

- Bioaccumulation and Field Tissue Residue Studies
  - Ability to accumulate the contaminant
  - Home range
  - Population size
  - Size/composites
- Population/Community Evaluations
- Toxicity Testing

- Need to separate physical impact from chemical risk
- Account for essentiality
- Incorporate availability and chemical form
- Determine if there are critical exposure pathways
- Link terrestrial and aquatic systems
- Acknowledge the natural risk level in the area
- Realize the solution may are not be concentration reduction

Because of the differences in chemical form we have varying risk at the same bulk element concentration within the Site.

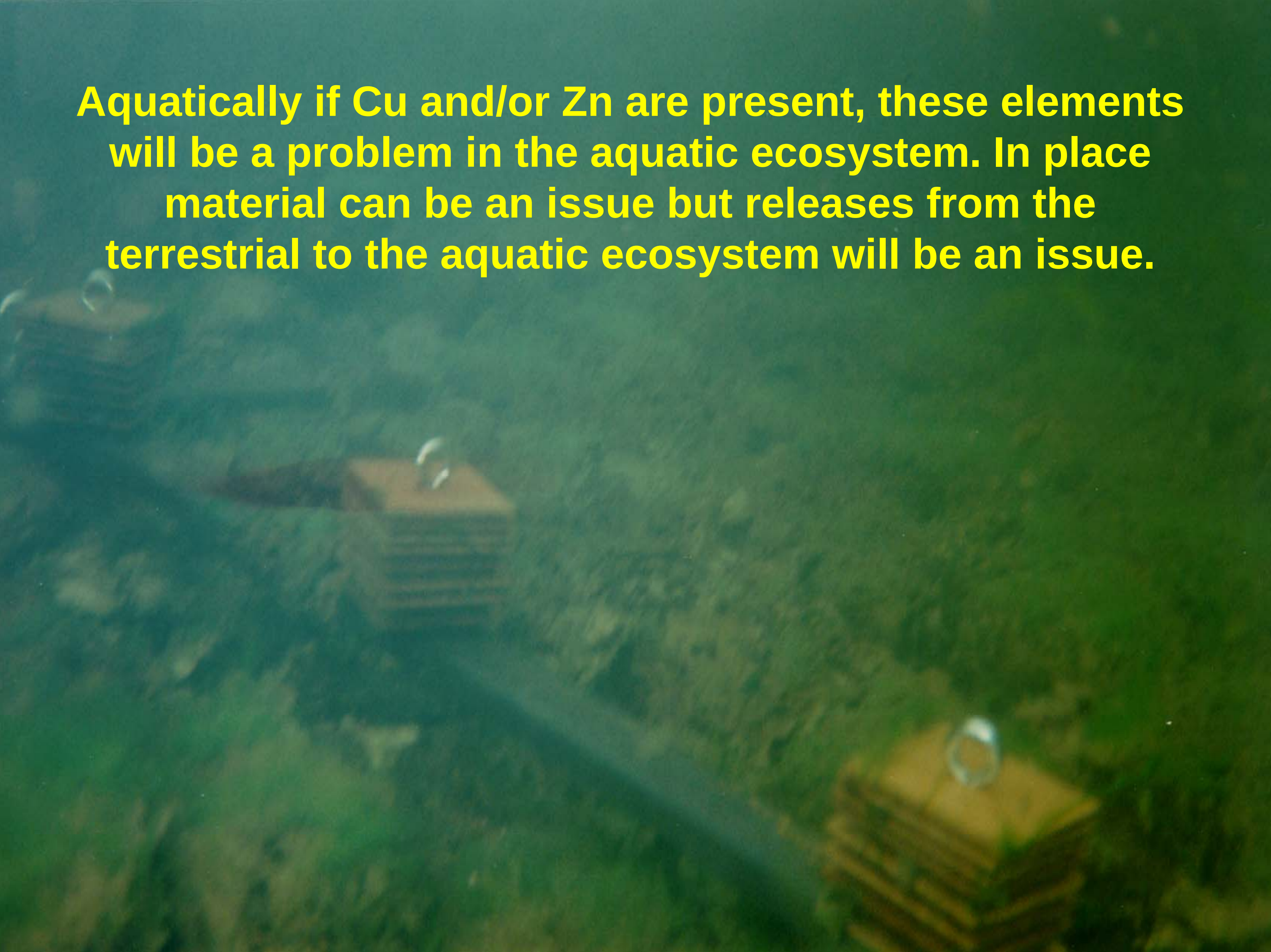
This can result in multiple PRGs

Element Availability and Chemical Form

Link terrestrial and aquatic systems

Terrestrially the problem elements include:

- Pb (direct exposure/ingestion of soil)
- Cd food chain dietary exposure



Aquatically if Cu and/or Zn are present, these elements will be a problem in the aquatic ecosystem. In place material can be an issue but releases from the terrestrial to the aquatic ecosystem will be an issue.

Mammal Trapping

- Overall Trapping Success
  18.9 %
- Total of 98 animals retained (five species)
- 94 kidney samples submitted for histopathology evaluation
- 37 subset of the 94 kidneys sent for Cd, Pb, and Zn analyses

Histopathology Results

- All Kidney Samples
- 9 could not be evaluated
- 61 no evidence of pathology
- 22 pathology consistent with metals exposure
- 2 pathology concludes metals exposure

- 37 kidney subset
- 1 could not be evaluated
- 27 no evidence of pathology
- 7 pathology consistent with metals exposure (included shrew)
- 2 pathology concludes metals exposure

Metals in Soil and Kidney
(mg/kg dw)

	Area			
	A	B	C	D
Cd				
Kidney – median	12	19	3.6	6.9
(range)	(1.4 – 28)	(3.4 – 32)	(1.7 – 11)	(2.2 – 36)
shrew n=1				60
Soil	15	15	3.2	4.9
Pb				
Kidney – median	3.8	15	1.8	0.6
shrew n=1				5.6
Soil	300	2100	160	110
Zn				
Kidney – median	71	73	74	70
shrew n=1				115
Soil	2100	2200	510	630

Kidney Summary Relative to Cd

27 kidneys with no apparent pathology

(Cd range 1.4 – 36 mg/kg dw)

7 kidneys with pathologoly consistent with metals exposure

(Cd range 2.1 – 60 mg/kg dw)

2 kidneys with evidence of metals exposure

(Cd 2.7 and 4 mg/kg dw)

Cadmium

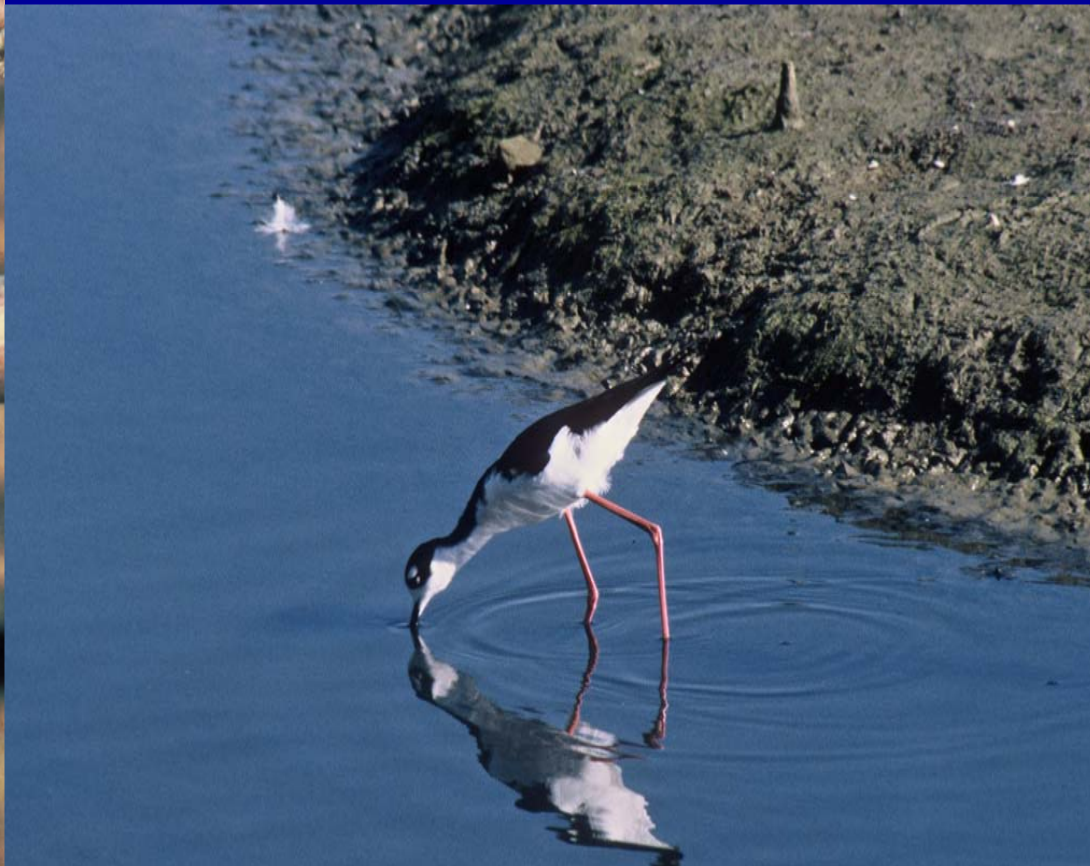
- Twenty four percent of the organisms evaluated showed some evidence of cellular level response to metals (Cd) exposure.
- There was no dose response relationship found.
- The conclusion of the pathology report was that there was some evidence of pathology in the kidneys of some of the animals but that the level of kidney effect was insufficient to “completely interfere with normal function”.

Cadmium

- Literature based Kidney Cd threshold effects concentrations range from 50 – 200 mg/kg dw.

- The kidney Cd concentrations found are at or below the threshold for effects estimates.

Critical Exposure Pathways



Risk is not a constant:

- Can have periods of little risk existing
- Critically exposed organisms are not around all year (e.g. birds)
- Critical exposure pathway may be temporal (e.g. insect emergence when birds are nesting; worms abundant in spring)
- There is a focused feeding
- Average exposure models and assessment will not capture this
- What and when you sample (collect data) can make a huge difference in you conclusion
- Our conservative deterministic exposures may not be so crazy

The success of an ERA is determined by:

- the ERA being technically sound relative to the questions and issues;
- the ability of the ERA to effectively communicate the technical issues, information and the technical/reasoned justification for the conclusions.