Selenium Toxicological Assessment

Technical Memorandum 3

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Presentation to
Advisory Committee
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OBJECTIVES

- Compile and review existing toxicity data
- Identify data most relevant to setting a numeric target for NSFB fish and wildlife:
  - Chronic exposure to single chemical (Se)
  - Controlled experimental conditions
  - Dietary exposure
  - Tissue concentrations reported

Methods

- Performed scientific literature searches
- Reviewed published scientific papers
- Reviewed USEPA documents
- Obtained gray-literature cited in
  - Scientific papers
  - USEPA documents

What are the Uncertainties?

- Wide variety of “effect” levels (criteria) reported (e.g., LOAEL, NOAEL, Effect Thresholds, Species Mean Chronic Values, EC10, ...)

- Wide variety of toxicity endpoints measured (e.g., survival, reproduction, swimming activity, deformities, cellular changes,.....)

Key Findings - Fish

- Reviewed 78 studies
- Toxicity data available for the following species that occur in the Bay-Delta
  - White Sturgeon
  - Sacramento Splittail
- Other well studied species include
  - Salmon
  - Rainbow trout
  - Bluegill
  - Fathead minnows

Table 3-3. Summary of Fish Toxicity Studies (excerpt)

Fish	Effect Threshold (mg/kg-dw)				Endpoint
	Liver	Muscle	Whole Body		
Bluegill	11.2	2.9	3.2		S, BW, L
Bluegill	20.3	6.5	6.0		BW, L
Bluegill	38.4	15.4	13.8		R
Bluegill	14.9	2.9	3.0		BW, R, S
channel catfish	-	3.3	3.3		BW
chinook salmon	24.5	8.4	7.6		BW, L
chinook salmon	45.3	19.3	17.1		BW, L, S
fathead minnow	-	-	-		BW
fathead minnow	20.3	6.1	6.0		BW
fathead minnow	-	-	5.5		D
rainbow trout	7.8	1.8	1.7		BW, L
rainbow trout	173.8	-	53.1		BW, FG, S
rainbow trout	63.2	-	19.1		BW, S, FG
rainbow trout	38.8	2.1	2.0		BW, FG
splittail	24.8	12.3	10.8		D
white sturgeon	28.7	29.0	18.2		BW, SA

Table 3-4 Species mean chronic values calculated from the identified fish toxicity studies

Even with the calculation of mean values, the range of toxicity values remains large

Fish	Species	Water Type	SMCV (mg/kg-dw)		
			Liver	Muscle	Whole body
Bluegill	*Lepomis macrochirus*	fresh	19.0	5.4	5.3
Channel catfish	*Ictalurus punctatus*	fresh	-	3.3	3.3
Chinook salmon	*Oncorhynchus tshawytscha*	fresh	24.5	8.4	7.6
Chinook salmon	*Oncorhynchus tshawytscha*	brackish	45.3	19.3	17.1
Fathead minnow	*Pimephales promelas*	fresh	20.3	6.1	6.0
Rainbow trout	*Oncorhynchus mykiss*	fresh	42.7	1.9	7.6
splittail	*Pogonichthys macrolepidotus*	fresh	24.8	12.3	10.8
White sturgeon	*Acipenser transmontanus*	fresh	28.7	29.0	18.2

Effects of Data Analysis on Reported Toxicity Values – Chinook Salmon Example

- Hamilton et al, 1990, Effects Threshold Values 7.6 mg/kg-dw (freshwater), 17.1 mg/kg-dw (brackish water)

- Beckon (2007), Hamilton et al (1990) + additional data, regression analysis, EC10 = 1.84 mg/kg-dw & EC20 = 2.5 mg/kg-dw

- TM 3: variability associated with calculated EC10 and EC20 could affect selection of toxicity value

Fish Toxicity Values - Summary

- Toxic effect to fish demonstrated
- Comprehensive review conducted, wide range of toxicity values presented, affected by:
  - Test endpoints
  - Effect level
  - Analytical approach
  - Water quality conditions
  - Life stage tested
- Limited data for Bay-Delta Species

Key Findings - Birds

- Reviewed 46 studies
- Toxicity data available for the following species that occur in the Bay
  - Mallards
  - Eiders
- Other well studied species include
  - Chickens

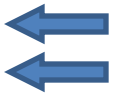
Table 4-2. Summary of Bird Dietary Toxicity Studies (excerpt) – *a wide range of toxicity values reported*

Bird	(mg/kg-dw)			Effect		Endpoint
	NOAEL	LOAEL	Effect threshold	Major	Minor	
Chicken	0.15	10	1.2	X		BW
Chicken	0.9	4.3	2.0	X		BW
Chicken	4.3	13.5	7.6	X		BW, S
Chicken	0.2	15	1.7	X		BW
Chicken	3	5	3.9	X		R
Common eider	20.6	57.7	34.5	X		BW
Mallard	22.3	44.7	31.6	X		C
Mallard	11.2	22.3	15.8	X		S
Mallard	0.6	10.6	2.6	X		R
Mallard	0.4	9.8	2.1	X		R
Mallard	10.9	27.3	17.3	X		BW, R
Mallard	0.2	10.9	1.5	X		R
Mallard	10.9	21.6	15.3	X		BW
Mallard	10.9	21.6	15.3	X		BW
Mallard	4.6	9.0	6.4	X		R
Mallard	17.0	33.7	24.0	X		BW
Mallard	0.4	11.6	2.3		X	E
Mallard	0.2	16.9	1.9	X		BW
Mallard	16.9	66.9	33.6	X		BW, S
Mallard	0.2	16.9	1.9	X		BW
Mallard	0.2	16.5	1.9		X	E
Mallard	16.5	65.4	32.9	X		BW
Mallard	16.5	65.4	32.9	X		S
Mallard	0.2	16.5	1.9		X	E
Mallard	0.2	16.5	1.9	X		BW
Mallard	0.2	16.9	1.9		X	E
Mallard	13.8	33.8	21.6	X		BW, S
Mallard	0.37	6.5	1.6	X		R
Mallard	3.9	7.8	5.5	X		BW, R
Pheasant[1]	0.4	9.3	1.9	X		R, S
Screech owl	8.8	30	16.2	X		BW, R
Screech owl	0.3	8.8	1.6		X	E

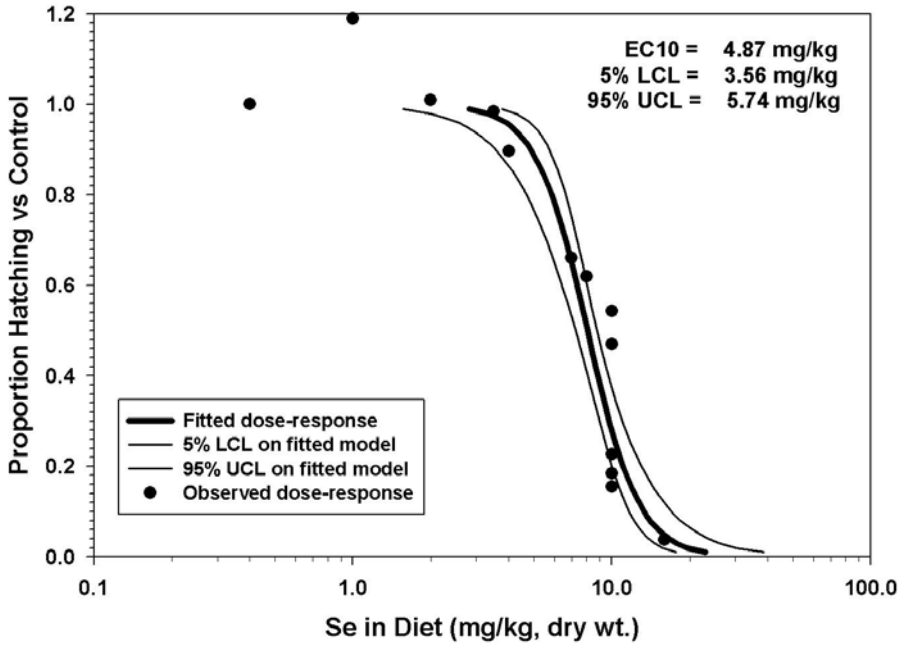
Summary of Information from Table 4-7, Calculation of Species Mean Chronic Values from NOAELs and LOAELs

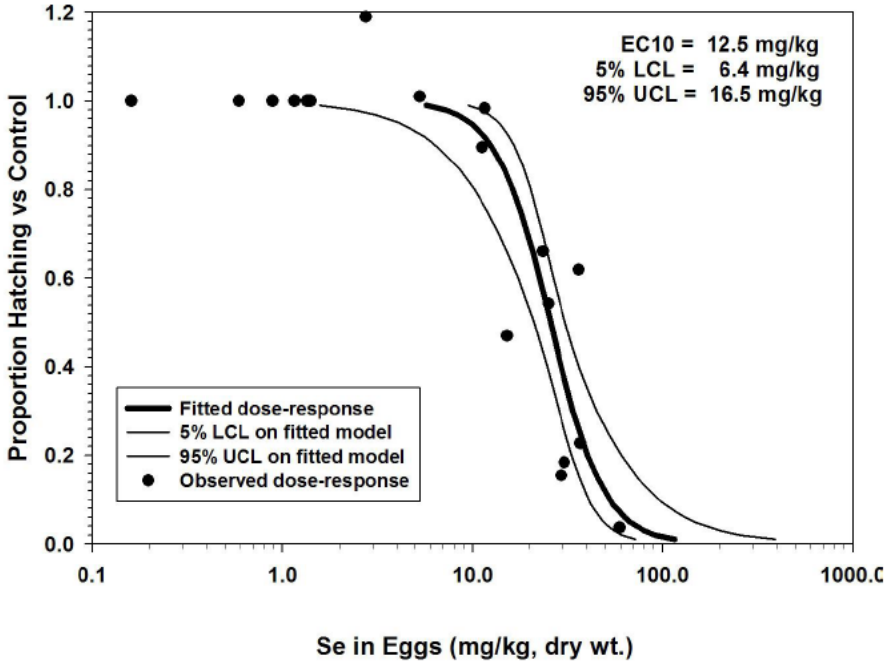
Even with the calculation of mean values, the range of toxicity values remains large

Bird	Chick		Adult		Reproductive success
Chicken	2.9		7.1		4.6
Eider			34.5		
Mallard	10.4		22.1		3.6
Pheasant					1.9
Screech owl					16.2



State of Utah is deriving dietary selenium screen values protective of birds, based on reanalysis (regression) analysis of the same date reviewed in TM 3





Proposed screening values for dietary selenium in the range of 4.4 – 5.4 mg-kg-dw, but uncertainties persist

Summary

- Multiple choices for screening values from the literature, values affected not only the species-life stage-endpoint-toxicity level, but also the methods used in the analysis of the data
- Some new toxicity research ongoing, need for site-species-data use specific information
- Multiple issues can affect the implementation of screening values/numeric targets