Development of a Selenium Standard for the Open Waters of Great Salt Lake

Great Salt Lake Water Quality Studies

Science Panel Recommendations

May 2, 2008

CH2MHILL /CWECS

Science Panel Recommendations

1. The water quality standard should be a tissue-based standard, based upon the selenium concentration found in bird eggs.

(1) Concentration of Selenium in Water (1)

Geochemical and Microbiotic Environment

(2) Bioavailability of Selenium to Macrobiota (2)

Food Chain Behavioral Ecology

(3) Food Chain Exposure to Selenium (3)

Food Chain Physiology

(4) Food Chain Uptake of Selenium (4)

Avian Behavioral Ecology

(5) Avian Exposure to Selenium (5)

Avian Digestive Physiology

(6) Avian Uptake of Selenium (6)

Avian Reproductive Physiology

(7) Concentration of Selenium in Eggs (7)

Species Sensitivity to Selenium

Hatchability of Eggs

MSTF Model

Bioaccumulation Model Specific to GSL

Shorebird Regression Model, Gull Transfer Factor

Mallard Toxicity Curve

Science Panel Recommendations

2. A selenium water quality standard that prevents impairment for aquatic dependent wildlife of Great Salt Lake lies within the range of 6.4 to 16 mg Se/kg for bird eggs.

TABLE 1. Egg Selenium Concentration vs. Best Estimate of Reduction in Mallard Egg Hatchability

Egg Selenium Concentration (mg Se/kg dw)	Best Estimate of Reduction in Mallard Egg Hatchability		
	Most Likely	Best Case (2.5% chance of occurring)	Worst Case (2.5% chance of occurring)
6.4	2%	<1%	10%
8.2	3%	<1%	15%
12	10%	4%	26%
14	14%	5%	31%
16	21%	10%	38%

TABLE 2. Reduction in Mallard Egg Hatchability vs Best Estimate of Egg Selenium Concentration

Reduction in Mallard Egg Hatchability	Best Estimate of Egg Selenium Concentration (mg Se/kg dw)		
	Most Likely	95% Confident Value is Within This Range	
1%	5.7	1.6	9.4
3%	8.2	3.0	12
5%	9.8	4.1	14
10%	12	6.4	16
20%	16	10	20
50%	27	21	31

Science Panel Recommendations

3. For implementation, the water column concentration of selenium associated with the standard will be derived from the Bioaccumulation Model.

Possible model outcomes for shorebirds:

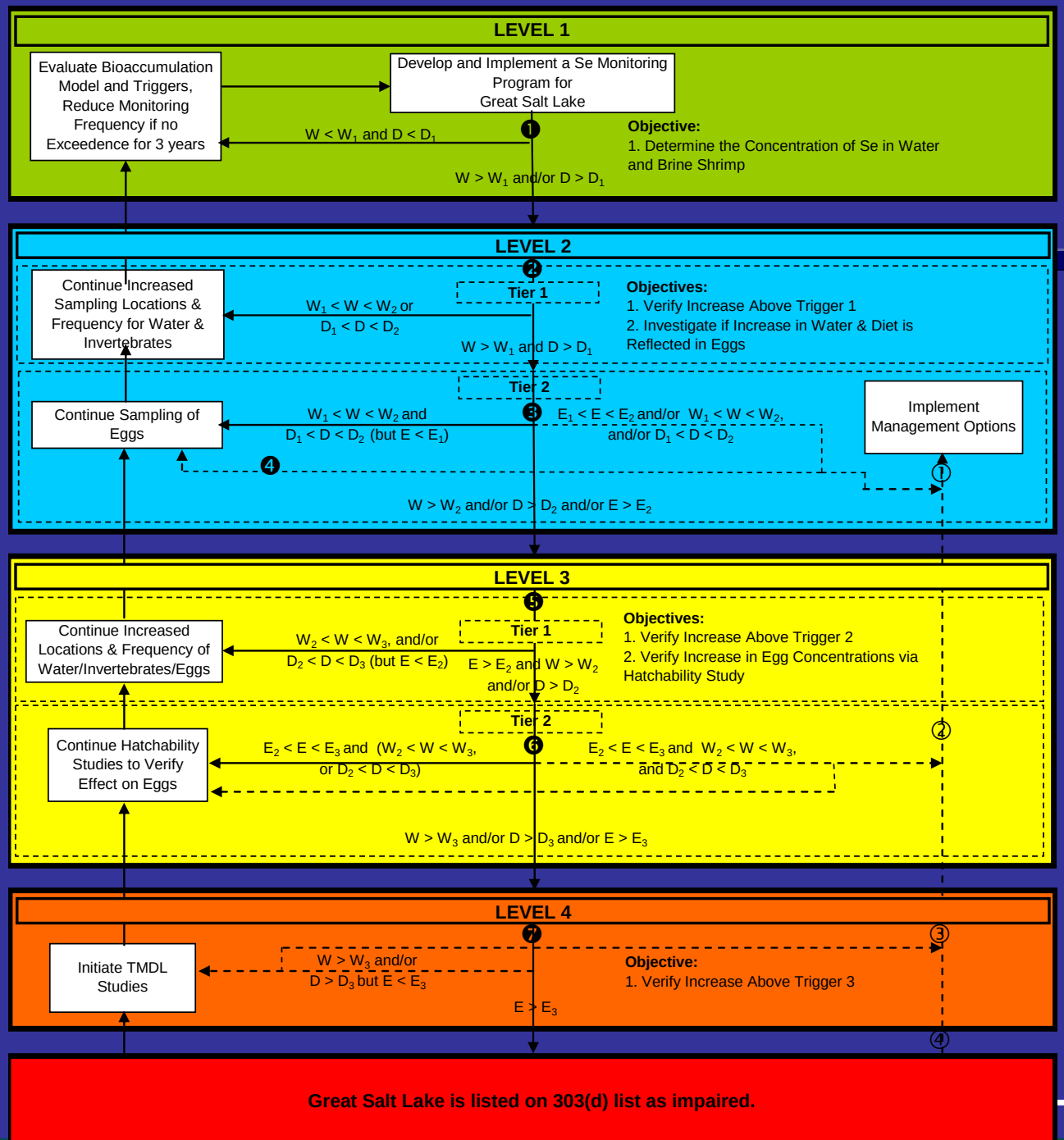
Egg Concentration (mg Se/kg dw)	Shorebird Diet Concentration (mg Se/kg dw)	Water Column Concentration (µg Se/L)
Measured Concentrations from Great Salt Lake (2006/2007)		
2.7	1.7	0.6
Predicted Values		
6.4	3.1	1.5
9.5	4.6	2.2
12	6.0	2.8
14	7.0	3.3
16	7.9	3.7

Possible model outcomes for gulls:

Egg Concentration (mg Se/kg dw)	Gull Diet Concentration (mg Se/kg dw)	Water Column Concentration (µg Se/L)
Measured Concentrations from Great Salt Lake (2006/2007)		
2.9	4.2	0.6
Predicted Values		
6.4	9.2	1.5
9.5	14	2.1
12	18	2.8
14	21	3.2
16	24	3.6

Science Panel Recommendations

4. The State should adopt a tiered approach for monitoring, assessment, and management options to ensure the selenium water quality standard is not exceeded.


LEVEL 1
Evaluate Bioaccumulation Model and Triggers, Reduce Monitoring Frequency if no Exceedence for 3 years
Develop and Implement a Se Monitoring Program for Great Salt Lake
W < W1 and D < D1
W > W1 and/or D > D1
Objective:
1. Determine the Concentration of Se in Water and Brine Shrimp
LEVEL 2
Continue Increased Sampling Locations & Frequency for Water & Invertebrates
Tier 1
W1 < W < W2 or D1 < D < D2
W > W1 and D > D1
Objectives:
1. Verify Increase Above Trigger 1
2. Investigate if Increase in Water & Diet is Reflected in Eggs
Tier 2
Continue Sampling of Eggs
W1 < W < W2 and D1 < D < D2 (but E < E1)
E1 < E < E2 and/or W1 < W < W2, and/or D1 < D < D2
Implement Management Options
W > W2 and/or D > D2 and/or E > E2
LEVEL 3
Continue Increased Locations & Frequency of Water/Invertebrates/Eggs
Tier 1
W2 < W < W3, and/or D2 < D < D3 (but E < E2)
E > E2 and W > W2 and/or D > D2
Objectives:
1. Verify Increase Above Trigger 2
2. Verify Increase in Egg Concentrations via Hatchability Study
Tier 2
Continue Hatchability Studies to Verify Effect on Eggs
E2 < E < E3 and (W2 < W < W3, or D2 < D < D3)
E2 < E < E3 and W2 < W < W3, and D2 < D < D3
W > W3 and/or D > D3 and/or E > E3
LEVEL 4
Initiate TMDL Studies
W > W3 and/or D > D3 but E < E3
E > E3
Objective:
1. Verify Increase Above Trigger 3
Great Salt Lake is listed on 303(d) list as impaired.

Science Panel Recommendations

5. **The State should conduct further research on a number of topics to validate and assess the current model and standard**
   - **Studies to better define relationship between water and brine shrimp at higher water selenium concentrations (0.5 – 5 ug/L).**

Research Recommendations

- Reassess Bioaccumulation Model and update
- Monitor Se in water and brine shrimp on regular basis
- Co-located diet/egg sampling
- Monitor tributary inflows and selenium loads (especially to North Arm)
- Sample atmospheric deposition of Se
- Phalarope study

Research Recommendations

- Further studies on non-reproductive effects
- Collect co-located water, brine fly and brine shrimp samples to verify TFs
- Studies to understand interaction of Se/Hg
- Verify current mixing zone assumptions

Science Panel Recommendations

6. Levels of protectiveness to be recommended by Steering Committee and determined by Water Quality Board
7. Individual position statements were prepared by each Science Panel member