



Protection Levels for Selenium in the Great Salt Lake

**A Discussion with the
Great Salt Lake Steering Committee**

**What are the Panel's recommended
guidelines for a water quality standard
for selenium?**

February 22, 2008



Program Objective

Define a site-specific, numeric water quality standard for selenium (Se) that prevents impairment of the beneficial uses of the open waters of the Great Salt Lake

Recommended Guidelines

It is the opinion of the Science Panel that a Se water quality standard that prevents impairment for aquatic wildlife of the GSL lies within the ranges of:

- 3.6 – 5.7 mg Se/kg for bird diet items, and**
- 6.4 – 16 mg Se/kg for bird eggs.**



Qualifications, Application, and Precaution

- There is uncertainty in the guidelines, as reflected by the range of Se concentrations.
- The guidelines would be applied by back-calculating from tissue to water.
- The Panel recognizes the need for conservatism in application of the guideline that will be recommended.



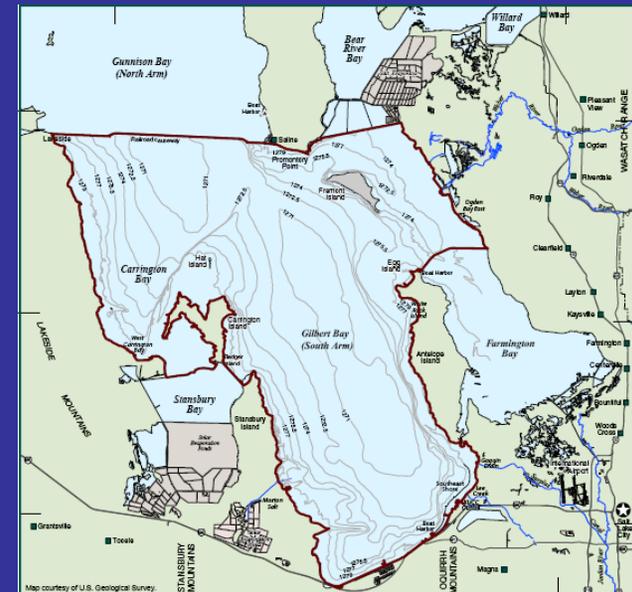
Questions You Might Ask

- **What is the basis for this recommendation?**
- **How does the range represent levels of protection?**
- **What will the Science Panel provide to the Steering Committee?**

What is the basis for this recommendation?

1. Birds are likely the beneficial users that are the most sensitive to Se on the GSL:

- Water quality standard will be developed to be protective of birds that feed primarily on open waters of the GSL
- Exposure of birds to Se is mainly through their diet



What is the basis for this recommendation?

- 2. Best-documented, most sensitive, and most readily monitored effect of Se on birds is reproductive success:**
- Other endpoints such as body condition for migratory birds or adult mortality are important, but related Se concentrations are undetermined at this time
 - Reproductive success is considered more sensitive than those other endpoints
 - Success is measured by egg hatchability, i.e., the number of eggs that are incubated full term and hatch vs. those that don't hatch

What is the basis for this recommendation?

- 3. Se concentration in eggs can be directly related to expected reproductive success, i.e., egg hatchability:**
- Direct determination of egg hatchability requires extensive monitoring
 - Eggs are sacrificed when sampled
 - Sampling is possible only during nesting season (~2 month period)

What is the basis for this recommendation?

- 4. Field-collected food items can be used to represent the bird diet to estimate bird exposure to Se and predict reproductive success:**
- Samples can be obtained throughout the year (though spring nesting season is most important)
 - Easier to obtain routine samples than to sample eggs
 - EPA is considering a tissue-based criteria for aquatic life

What is the basis for this recommendation?

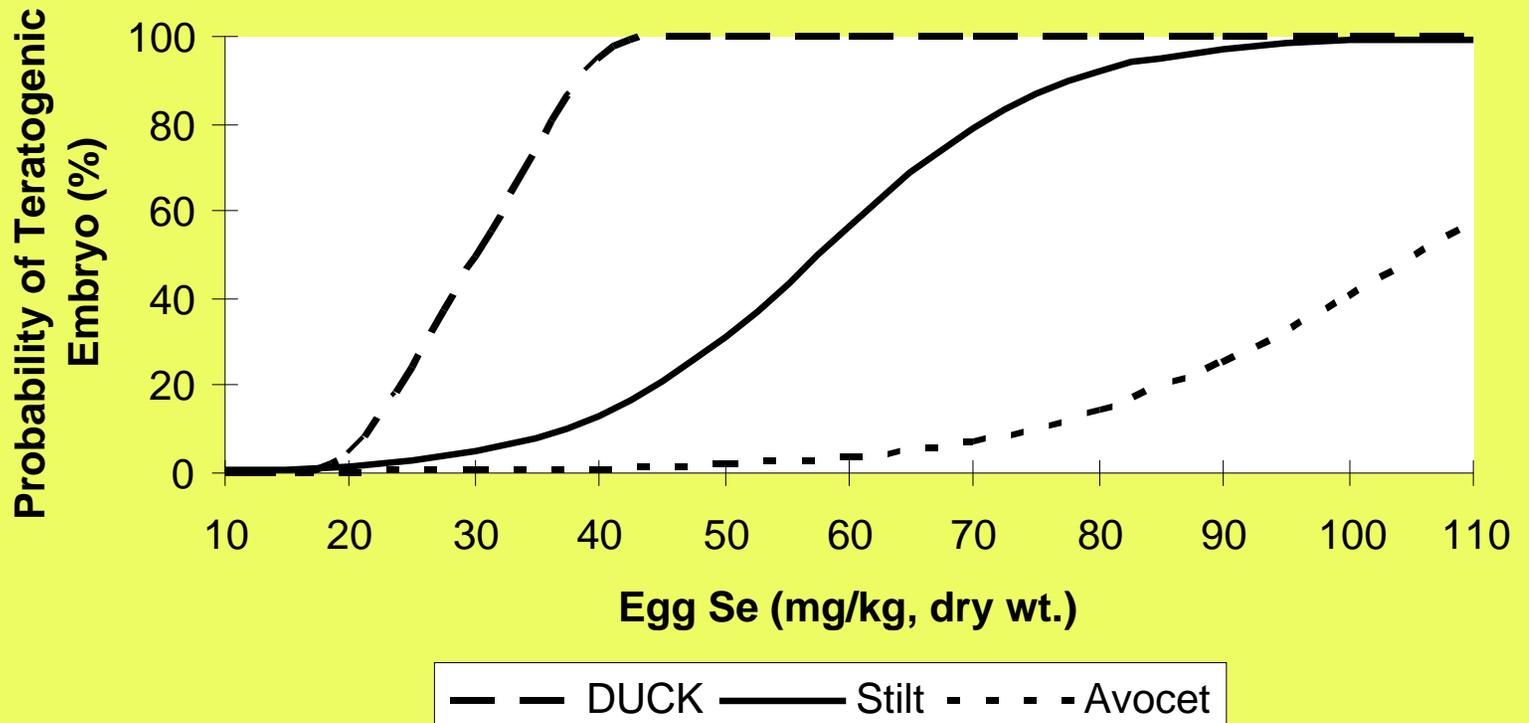
5. Laboratory studies with mallards provide the best available data for relating bird exposure and effects of Se:

- Best data set for Se effects on egg hatchability is for mallards
- Panel reviewed the literature for best data describing Se effects on egg hatchability
- Data set identified is from 6 laboratory studies relating Se concentration in diet and eggs to egg hatchability
- Panel agreed to use Ohlendorf (2003) to establish the range

What is the basis for this recommendation?

- 6. Mallards as a species are more sensitive to Se than other species that commonly nest at the GSL:**
- Birds that typically use saline habitats (e.g., avocets) seem to be less sensitive than closely related species typical of freshwater habitats (e.g., stilts); see USDI NIWQP report
 - Using mallard data builds conservatism, or a safety factor, into any water quality standard

Relative sensitivity of duck, stilt, and avocet to teratogenic effects (deformities)



What is the basis for this recommendation?

- 7. Research for the GSL Se Program included development of a model that characterizes the transfer of Se from water to the birds' diet and then to the birds' eggs:**
 - Allows the development of a water concentration from specific diet and egg Se concentrations (by back-calculation)

How does the range represent levels of protection?

- Each range of values (diet or egg) is determined from a toxicity curve established in the laboratory (Ohlendorf 2003)

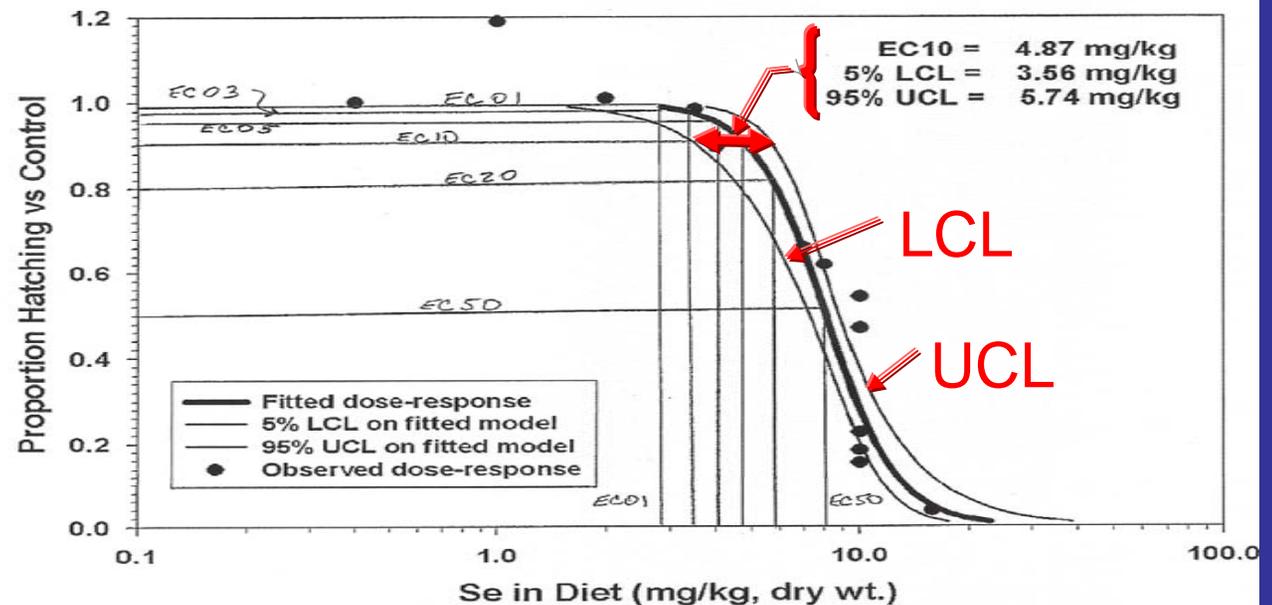


Figure 1. Mallard egg hatchability vs control as a function of selenium concentration in diet.

How does the range represent levels of protection?

- The curve helps define the effect, in this case % not hatching, for a given Se concentration.
- EC_x - The EC_x is the concentration (in the diet or egg) at which X% of the eggs that are incubated to full term do not hatch because of Se exposure (i.e., 100 - X% of the eggs hatch successfully despite Se exposure of the hen).

What does the EC_x mean?

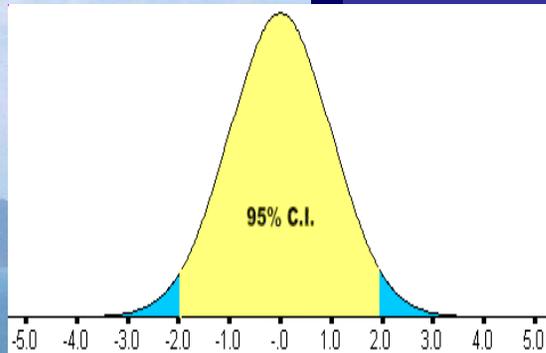
- When birds are exposed to the EC_x in the diet, or concentrations reach the EC_x in the eggs, up to an additional X% hatching failure may occur
- The population significance of this failure depends on other losses (e.g., predation, flooding, etc.)

What does the EC_x NOT mean?

- It does NOT mean that X% of the bird population using the GSL will die.
- The EC_x we are using considers hatching success and does not apply to other endpoints, such as effects on the adult population:
 - Hatching success is a more sensitive endpoint than adult survival

How does the range represent levels of protection?

- Effect = reduction in hatching success



Concentration (mg Se/kg)	Best Estimate for Effect Level		
	Best Case	Maximum Likelihood	Worst Case
Diet			
3.6	< 1%	3%	10%
4.9	4%	10%	24%
5.7	10%	18%	32%
Egg			
6.4	< 1%	1.5%	10%
12	3.5%	10%	26%
16	10%	21%	38%

Mallard Toxicity Curve - Egg

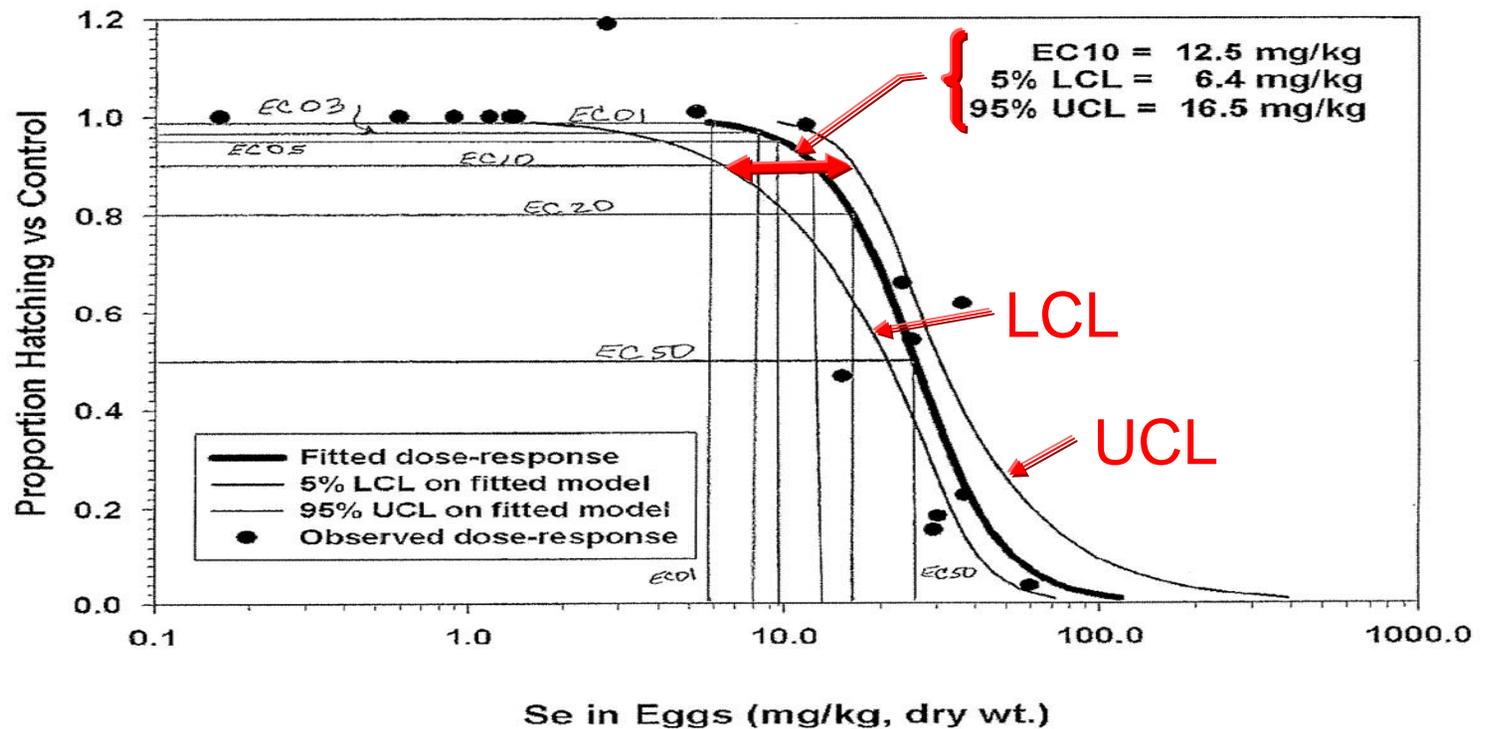


Figure 2. Mallard egg hatchability vs control as a function of selenium concentration in eggs.



What will the Science Panel provide to the Steering Committee?

- **Recommended guidelines**
- **Technical documentation of supporting studies**
- **A palette of values relating tissue Se concentrations to water Se concentrations**
- **Individual recommendations for water quality standard**