Utah Division of Water Quality

Recommendations for Changes to the
Standards for Quality for Waters of the State

Triennial Review

Public Hearing: August 19, 2008

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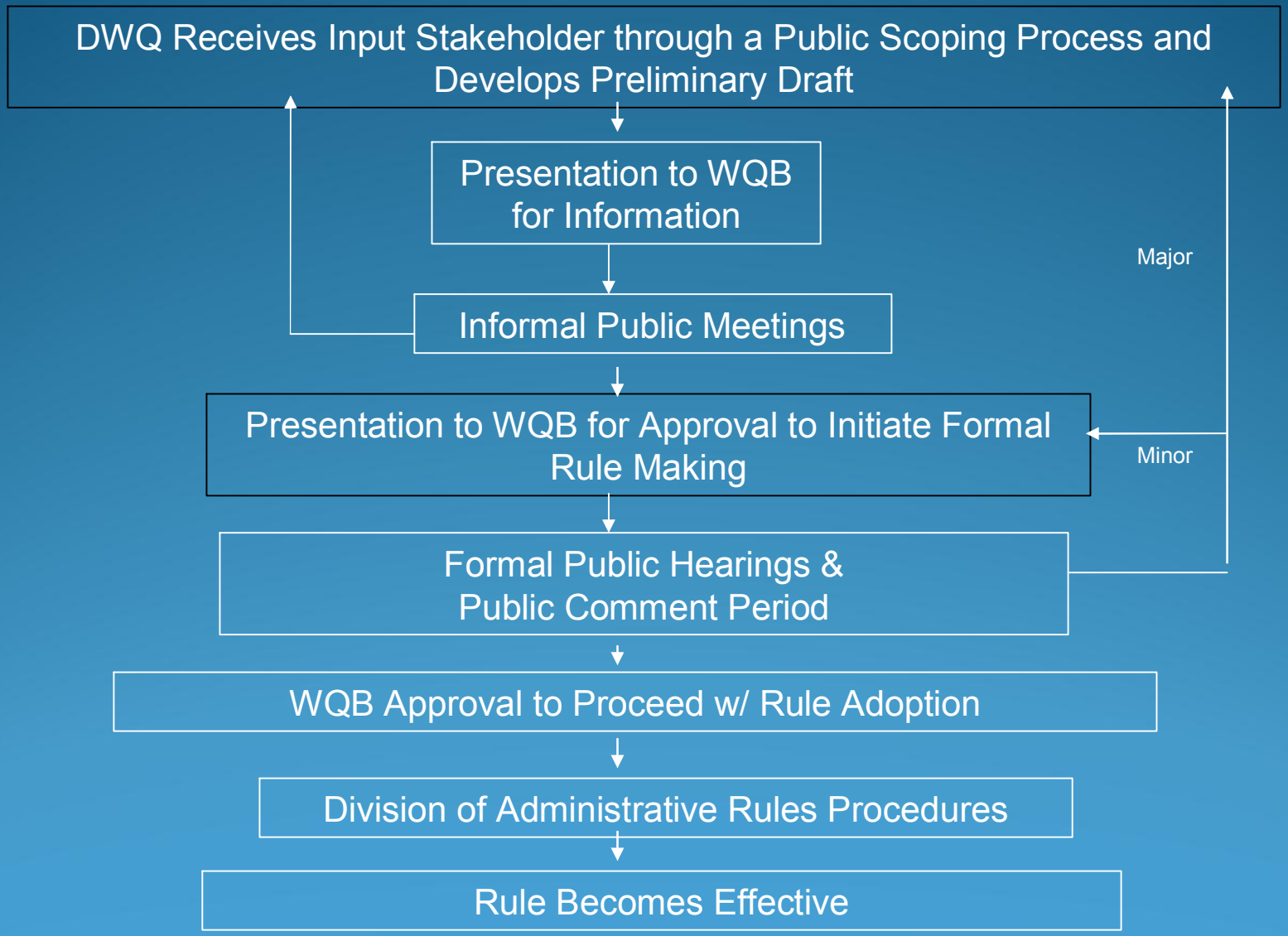
Utah Division of Water Quality
Salt Lake City, Utah

Water Quality Standards
The Foundation of Protection

- Beneficial Use
  - 3A Cold Water Fishery
- Numeric Criteria
  - 4.6 ug/l Selenium Chronic
- Narrative Criteria
  - "become offensive"
  - "undesirable physiological responses"
- Antidegradation Policy
  - Maintaining assimilative capacity

Putting the Triennial Review Process into Rule



Rule Making Language

- **Proposed changes shall be solicited from EPA, DWQ Staff, and the public.**
  - **Water Quality Standards Workgroup [Stakeholders]**
- **Informal public meetings may be held to present preliminary proposed changes to the public for comments and suggestions.**
- **Final proposed changes shall be presented to the Water Quality Board for their approval and authorization to initiate the formal rule-making.**

Rule Making Language, cont'd

- **Public hearings will be held to solicit formal comments from the public.**
- **The Executive Secretary shall incorporate appropriate changes and return to the Water Quality Board to petition for formal adoption of the proposed changes following the Division of Administrative Rules rule making procedures.**

Antidegradation (p. 2-3)

- **3.2 ~~High Quality~~ Waters – Category 1**
  - **No UPDES permits granted**
    - **Forests**
    - **Designated Segments**
- **3.3 ~~High Quality~~ Waters – Category 2**
  - **UPDES permitted but limits set at background**
    - **Electric Lake: Mine discharge**
- **3.4 Category 3**
  - **For all other waters of the state, UPDES permitted and degradation may occur pursuant to the conditions and review procedures outlined ~~below~~ in Section 3.5.**

[More]

Antidegradation, cont'd (p. 3)

- **Section 3.5**
  - **Combines antidegradation review into an introductory statement on Level I and Level II reviews. (p. 3)**
  - **Discusses where antidegradation Level I off-ramps not required. (p. 4)**
    - **Allows "end of pipe" concentrations for NPDES permits in "TMDL waters"**
  - **Changes the mathematical algorithm for a Level I off-ramp to define a *de minimus* effect. (p.5/6)**

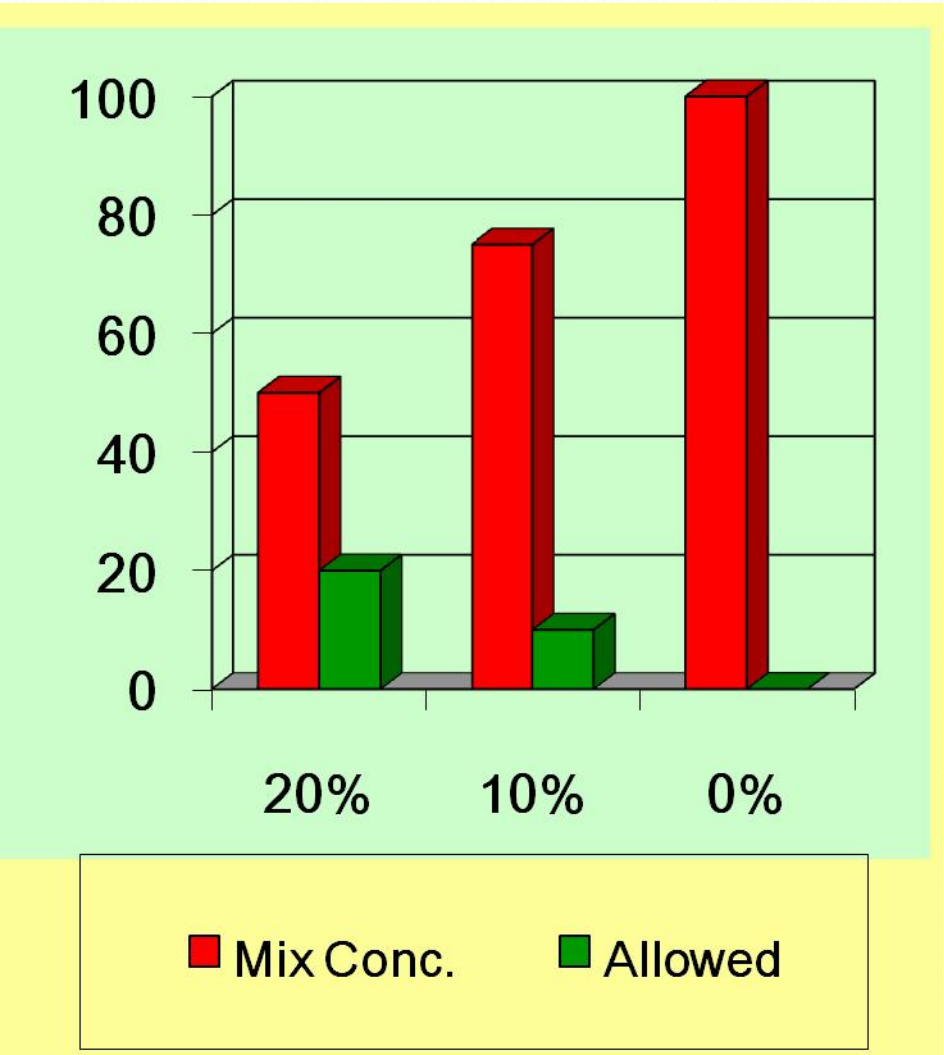
Antidegradation, cont'd

Level I Mathematical Off-ramps – Wasteload Analysis for Permits

- **6. The proposed concentration after mix:**
- **(a) Would be equal to or less than 50% of the criterion, and the project would consume less than 20% of remaining assimilative capacity; or,**
- **(b) Is greater than 50% and less than 75% of the criterion, and the project would consume less than 10% of the remaining assimilative capacity.**
- **(c) Exception: Level II reviews are required if the proposed concentration after mix is equal to or greater than 75% of the criterion.**

[More]

Level I Mathematical Off-Ramps (p. 5)



- **If No Changes in Permit: No Level II Required**
- **If Conc. After Mix is < 50% then 20% of assimilative capacity can be used.**
- **If between 50% and 75% then 10% can be used.**
- **0% if > 75% then none.**
  - [More]

Antidegradation Level II Review

(Information only)

- Less Degrading Alternatives (p. 7)
  - Innovative or alternative treatment options
  - More effective or higher treatment levels
  - Connections to existing facilities
  - Process changes or product material substitution
  - Seasonal discharges
  - Pollutant trading

[More]

Antidegradation Level II Review

(Information only)

- Less Degrading Alternatives (cont'd)
  - Other discharge locations
  - Land application
  - Total containment
  - Improved operation/maintenance
  - Other appropriate alternatives

Antidegradation, cont'd (p. 5)

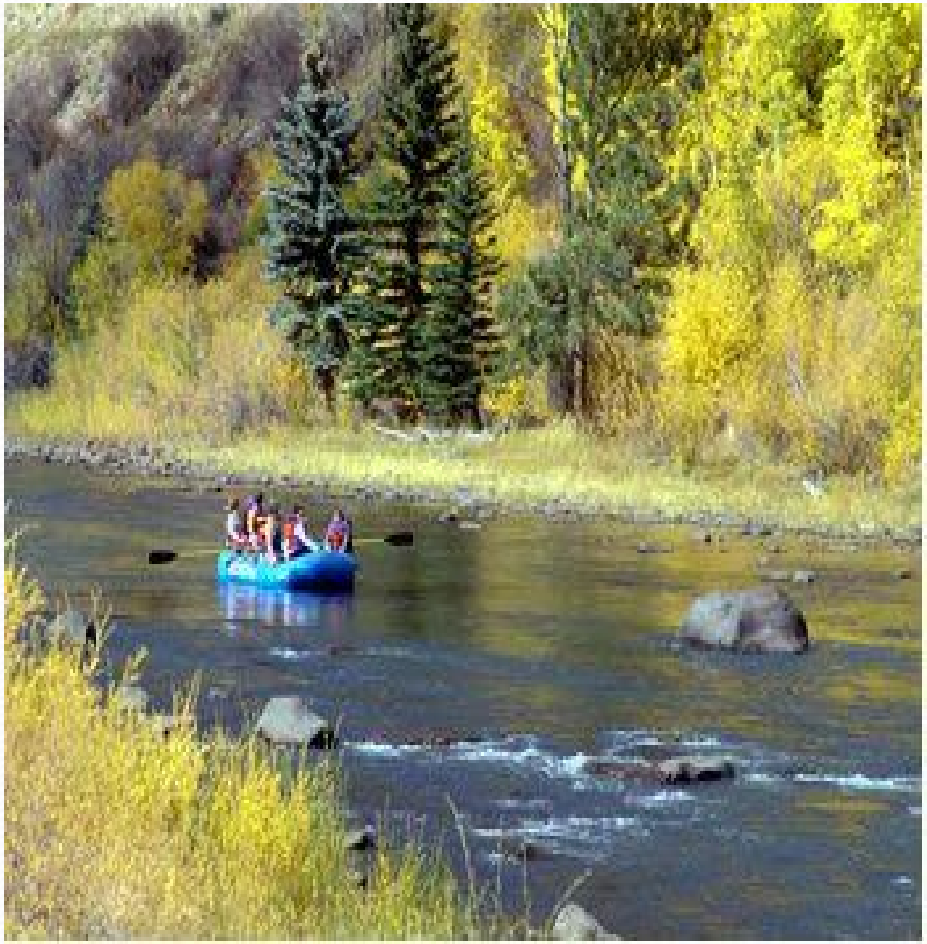
- ~~6. The affected waters are classified as 3C, 3D (and not 3A or 3B), or 3E waters, or are classified only as Class 4.~~
  - Antidegradation Level I Review off-ramp for use classification is eliminated.
  - DWR classifications are eliminated.

Changes to Use Classifications for various Waters of the State (p.11)

- Class 2A – Protected for frequent primary contact recreation ~~such as swimming~~ where there is a **high likelihood of ingestion of water or a high degree of bodily contact with the water**. Examples include, but are not limited to swimming, rafting, kayaking, driving, and water skiing.
- Class 2B – Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a **low likelihood of ingestion of water or low degree of bodily contact with the water**. Examples include, but are not limited to wading, hunting, and fishing

Primary Recreation Examples: Class 2A

Secondary Recreation Examples: Class 2B

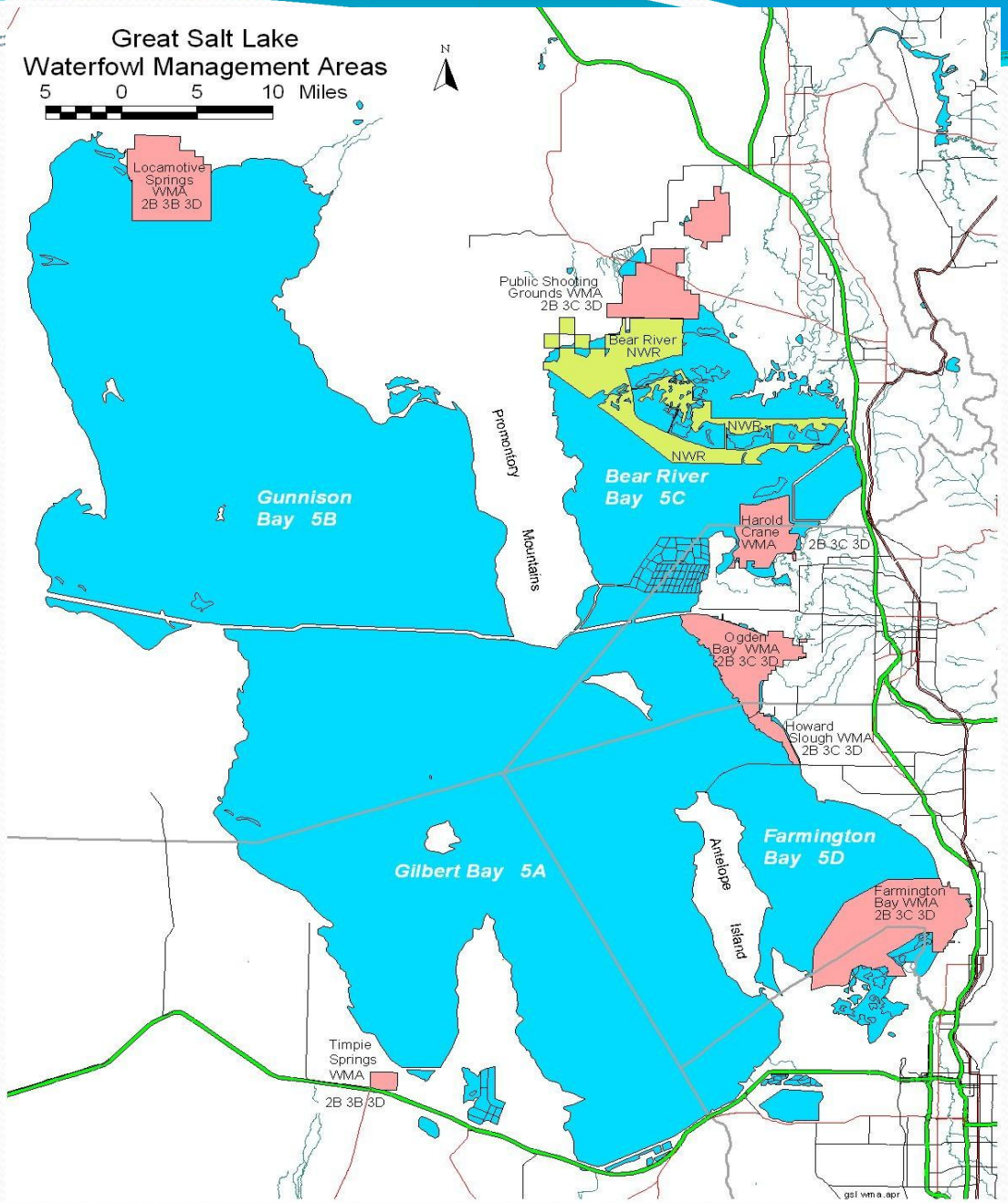


Segmentation of Great Salt Lake (p. 12-13; p. 44-46, 71)

- Dividing Great Salt Lake into 5 different areas as a function of ecosystem.
  - Sets high water mark at 4,208 ft.
  - Gilbert Bay (5A)
    - Primary Recreation
  - Gunnison Bay (5B), Bear River Bay (5C), Farmington Bay (5D)
    - Secondary Recreation
  - Transitional (mud-flat) wetlands (5E)
    - From 4,208 to open water of Great Salt Lake

Segmentation of Great Salt Lake (p. 12-13; p. 44-46, 71)

- Dividing Great Salt Lake into 5 different areas as a function of ecosystem.
  - Sets high water mark at 4,208 ft.
  - Gilbert Bay (5A)
    - Frequent Primary Contact Recreation
  - Gunnison Bay (5B), Bear River Bay (5C), Farmington Bay (5D)
    - Infrequent Primary Recreation and Secondary Recreation
  - Transitional (mud-flat) wetlands (5E)
    - From 4,208 to open water of Great Salt Lake
    - Infrequent Primary Recreation and Secondary Recreation


Great Salt Lake
Waterfowl Management Areas
5 0 5 10 Miles
N
Locamotive Springs WMA 2B 3B 3D
Public Shooting Grounds WMA 2B 3C 3D
Bear River NWR
NWR
NWR
Promontory Mountains
Gunnison Bay 5B
Bear River Bay 5C
Harold Crane WMA 2B 3C 3D
Ogden Bay WMA 2B 3C 3D
Howard Slough WMA 2B 3C 3D
Gilbert Bay 5A
Antelope Island
Farmington Bay 5D
Farmington Bay WMA 2B 3C 3D
Timpie Springs WMA 2B 3B 3D
gsl wma.apr

Great Salt Lake Mud Flats [Antelope Island]

Application of Standards (p. 13)

- Assessment of the beneficial uses will be conducted biannually.
- Assessment procedures will allow 10% of representative samples to exceed standards.
  - EPA approved so standards and assessment procedures are in conformity.

Changes to Use Classifications for various Waters of the State (p.19-30)

- Green River from confluence with Colorado River to state line changed from 2B to 2A (Secondary to Primary)
- Colorado River from Lake Powell to state line changed from 2B to 2A
  - This also picks up the San Juan River which discharges into "San Juan Arm" of Lake Powell

Changes to Use Classifications for various Waters of the State (p.19-30)

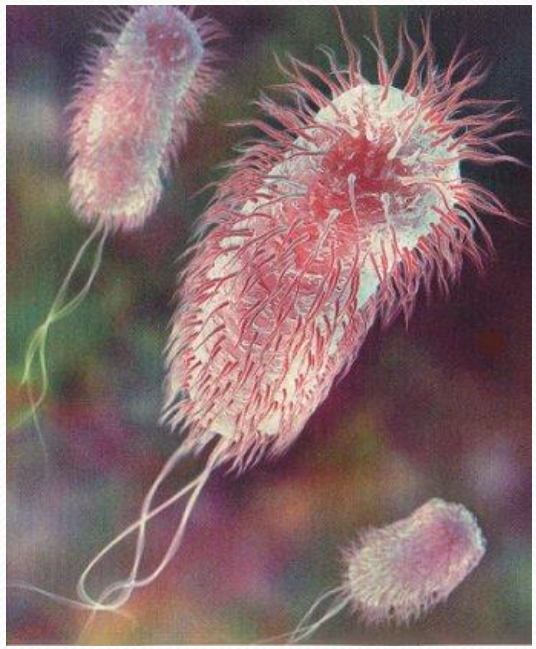
- **Escalante River:** Change from 3C (non-game fishery) to 3B (warm water fishery).
  - Seven (7) tributaries to the Escalante River: Change from 3B to 3A Classification (cold water fishery).
- **Saleratus Creek:** Add 3C to lower section and 3A to upper section [Bear River Drainage]
- **State Canal:** Given same criteria as Jordan River and the Surplus Canal (3B)
- **Salt Creek** (Crystal Hot Springs): Given same criteria as Malad River [Bear River Drainage]
  - TDS Concentration of ~20,450 mg/l

Changes to Classifications of the Waters of the State, cont'd (p.46)

- Clarify that lakes and reservoirs greater than 10 acres are assigned by default to the classification of the stream with which they are associated unless otherwise designated (instead of 20 acres).

Numeric Criteria: E. Coli (p.60, 64)

- **Change maximum criteria from 940 to 668 (1C, 2B) and from 576 to 409 (2A)**



- (7) For water quality assessment purposes, up to 10% of representative samples may exceed the 668 per 100 ml criterion (for 1C and 2B waters) and 409 per 100 ml (for 2A waters).

- (7) Measurement of E. coli using the Quanti-Tray/2000 procedure is approved as a field analysis. Other EPA approved methods may also be used.

Numeric Criteria – TDS (p.60)

- Total Dissolved Solids [TDS]
  - Remove Stockwatering @ 2000 mg/l
  - Set state-wide Agriculture [Class 4] @ 1200 mg/l
  - Restores criterion to pre-2003 value

Numeric Criteria TDS, (p. 61)

(Footnote)

(4) ~~Total dissolved solids (TDS) limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water. The total dissolved solids (TDS) standards shall be at background where it can be shown that natural or un-alterable conditions prevent its attainment. In such cases rule making will be undertaken to modify the standard accordingly.~~

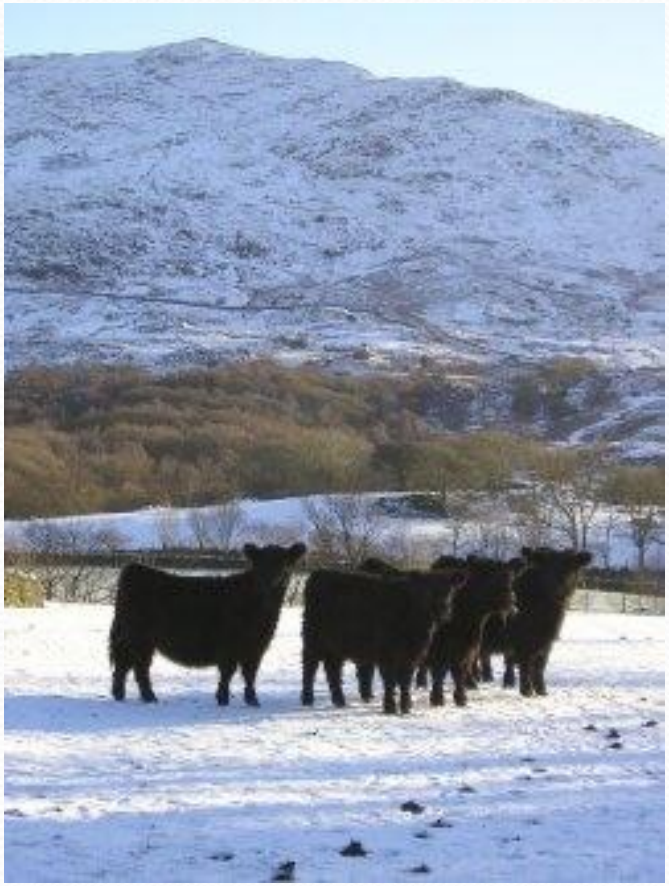
Numeric Criteria TDS (p. 61/62)(Footnote)

(4) Site-specific criteria for total dissolved solids may be adopted by rulemaking where it is demonstrated that:

(a) a less stringent criterion is appropriate because of natural or un-alterable conditions, or

Numeric Criteria (Footnote)

(4)(b) a less stringent, site-specific criterion and/or date specified criterion is protective of existing and attainable agricultural uses, or



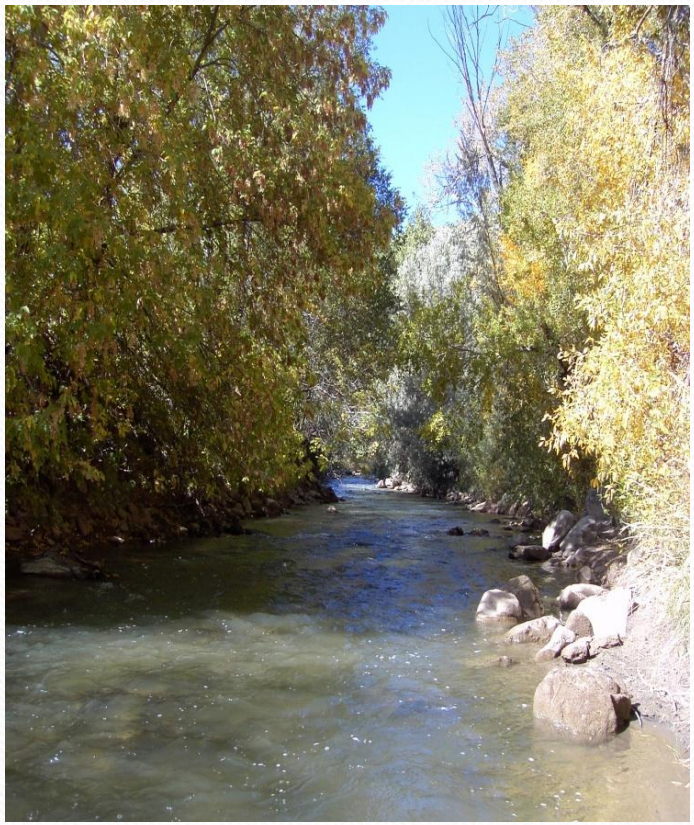
Numeric Criteria (Footnote)

(4) (c) a more stringent criterion is attainable and necessary for the protection of sensitive crops.

(4) For water quality assessment purposes, up to 10% of representative samples may exceed the standard.

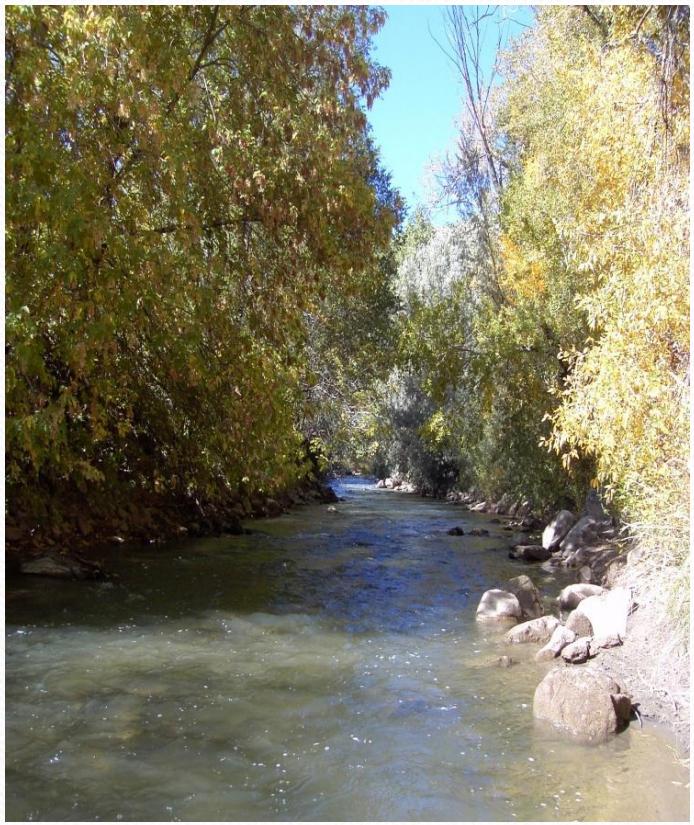
Numeric Criteria, TDS (p. 62-63)

- Add/Change Site Specific TDS Criteria for several areas where background is > 1,200 mg/l
  - Paria River,
  - Price River, tributaries.
    - Below 7,500 ft. elevation

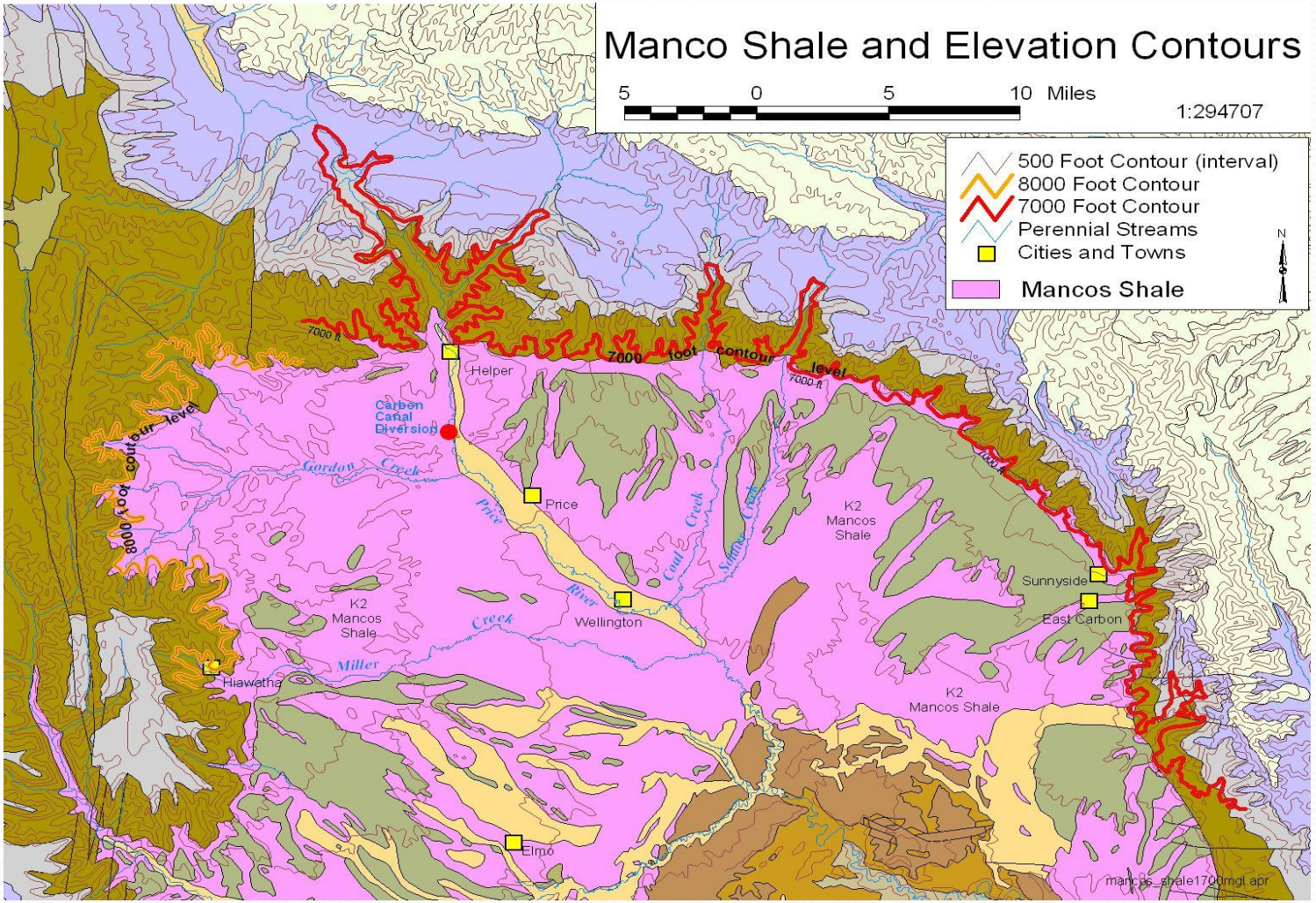


Numeric Criteria, TDS (p. 62-63)

- Reassessment
  - Quitchupah Creek
    - 2,600 mg/l to 1,700 mg/l
- Site Specific Criteria Request
  - South Fork of Spring Creek from confluence with Spring Creek to US 89
    - Irrigation Season
      - 1,200 mg/l to 1,600 mg/l
    - Non-Irrigation Season
      - 2,000 mg/l to 2,400 mg/l

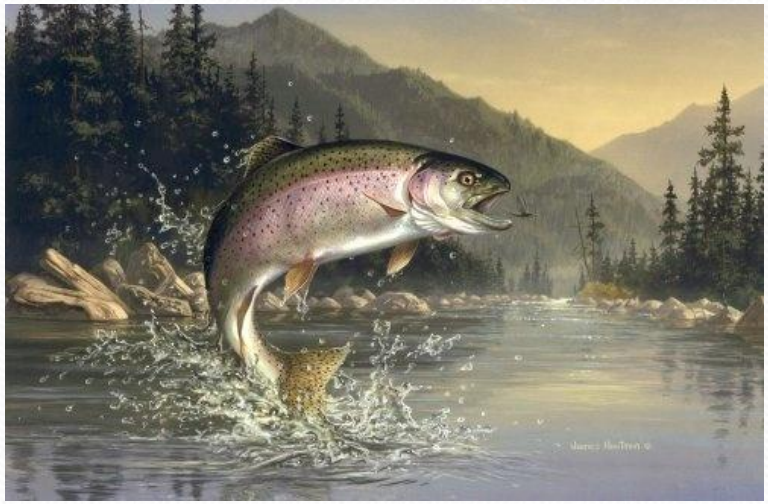


Remove site specific TDS criteria at elevations above 7,000-7500 feet. Returns value to 1,200 mg/l



Dissolved Oxygen (p. 65)

- Change Averaging Period
  - 1 Day Average changed to Minimum
    - Diurnal Swings
    - Low DO @ 4:00 am



  - Better conforms to EPA guidance and rules of other states

Other Numeric Criteria, etc.

- Ammonia
  - **Apply chronic criteria to all waters of the state** (p. 66)
- Toxics (p.67-68)
  - Add Diazionon and Nonylphenol to the water quality standards.
- Laboratory Methods (p. 69)
  - Laboratories to use **approved methods**, rather than specifically described methods or instruments.
- Total Phosphorus (p.70)
  - Clarify that total phosphorus in rivers, lakes and reservoirs is a pollution indicator.

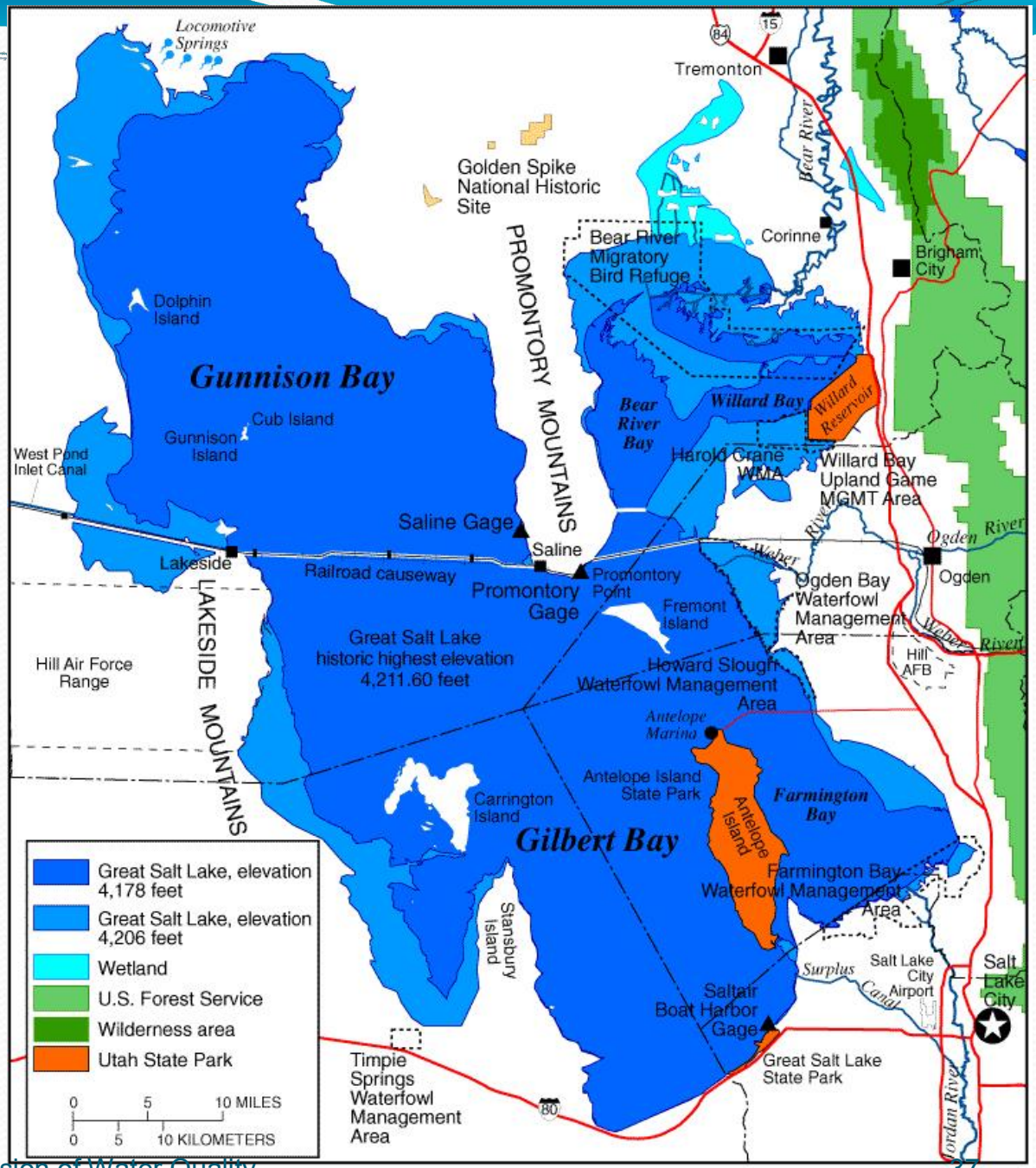
Questions on
this section of
Water Quality Standards?

Developing a Water Quality Standard for Great Salt Lake for Selenium and Other Issues

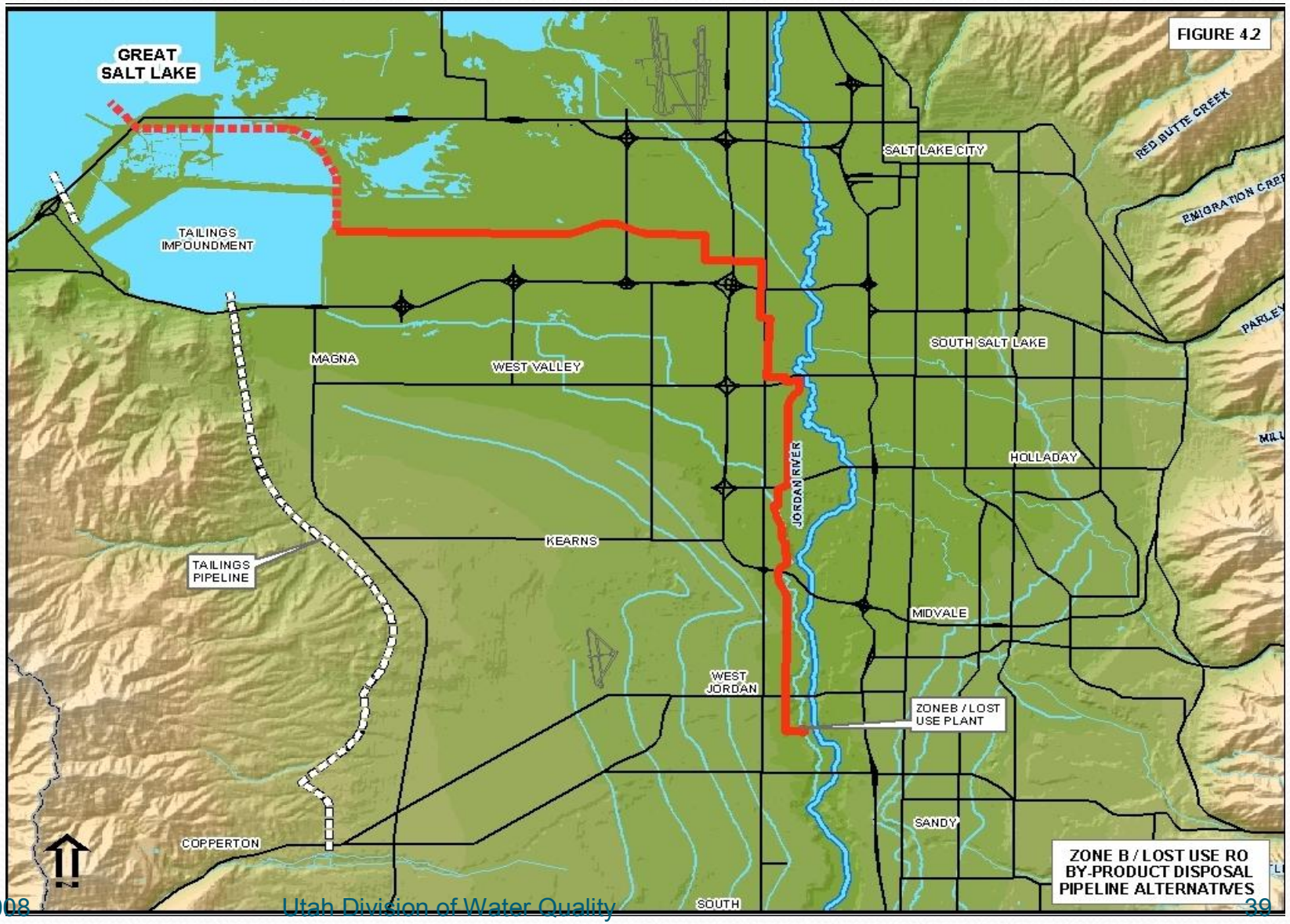
August 2008

William O. Moellmer, Ph.D.

The Great Salt Lake - Utah



Reverse Osmosis Brines Pipeline



Wildlife Selenium Problem

Kesterson Reservoir California – 1980's

- Subsurface agricultural drainage water was used for marsh management in Merced County, CA.
- Inflow Avg. ~300 µg/L selenium.
- All fish except mosquito fish disappeared.
- Selenium-induced effects, including dead or deformed embryos or chicks, were found in 39% of the nests.
- Many dead birds were found.

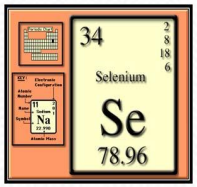
Biomagnification up the GSL Food Chain

[Might this be happening here?]

Brine Flies & Brine Shrimp

Birds

Deformities
[Teratogenesis]



Example of Teratogenic Effects

(from Seiler et al. 2003)

Gadwall (Kesterson Reservoir, California) with arrested development of lower bill, spoonbill narrowing of upper bill, and missing eyes

Example of Selenium Growth Effects

13 and 14 day-old avocet chicks from clean and splendiferous environments prior to hatching with same diet after hatching.

Bioaccumulation

- Selenium bioaccumulates in both aquatic and terrestrial food chains
  - Water to aquatic plants (algae) or invertebrates (brine shrimp) often 1000X waterborne concentration.
  - Function of chemical form (organic>selenite>selenate).
  - Ingestion is the main uptake pathway.

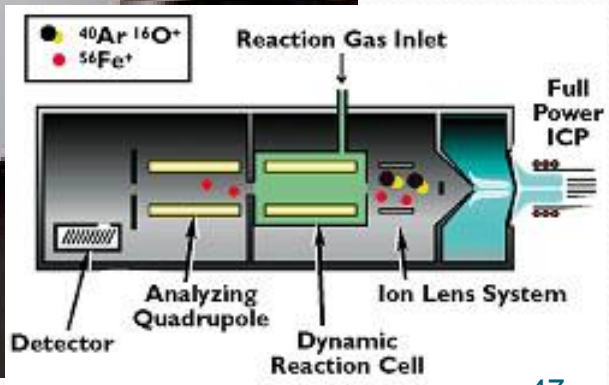
Concentration of Se in GSL

- It all starts with the water.
- **What is the concentration of Se in Great Salt Lake?**
- Data was very scattered and unreliable.
- Instrumentation was improving.
- Samples taken and sent to ERA Aurora, CO for:
  - Spiking
  - Round Robin (EPA $15,000 grant)
    - Concentration
    - Instrument

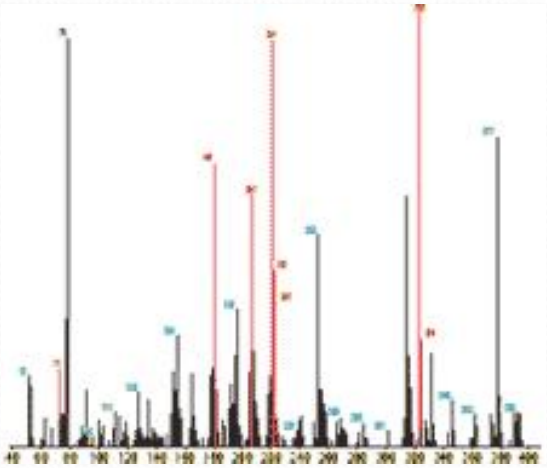
ICP-MS

Inductively Coupled Plasma Mass Spectrometer

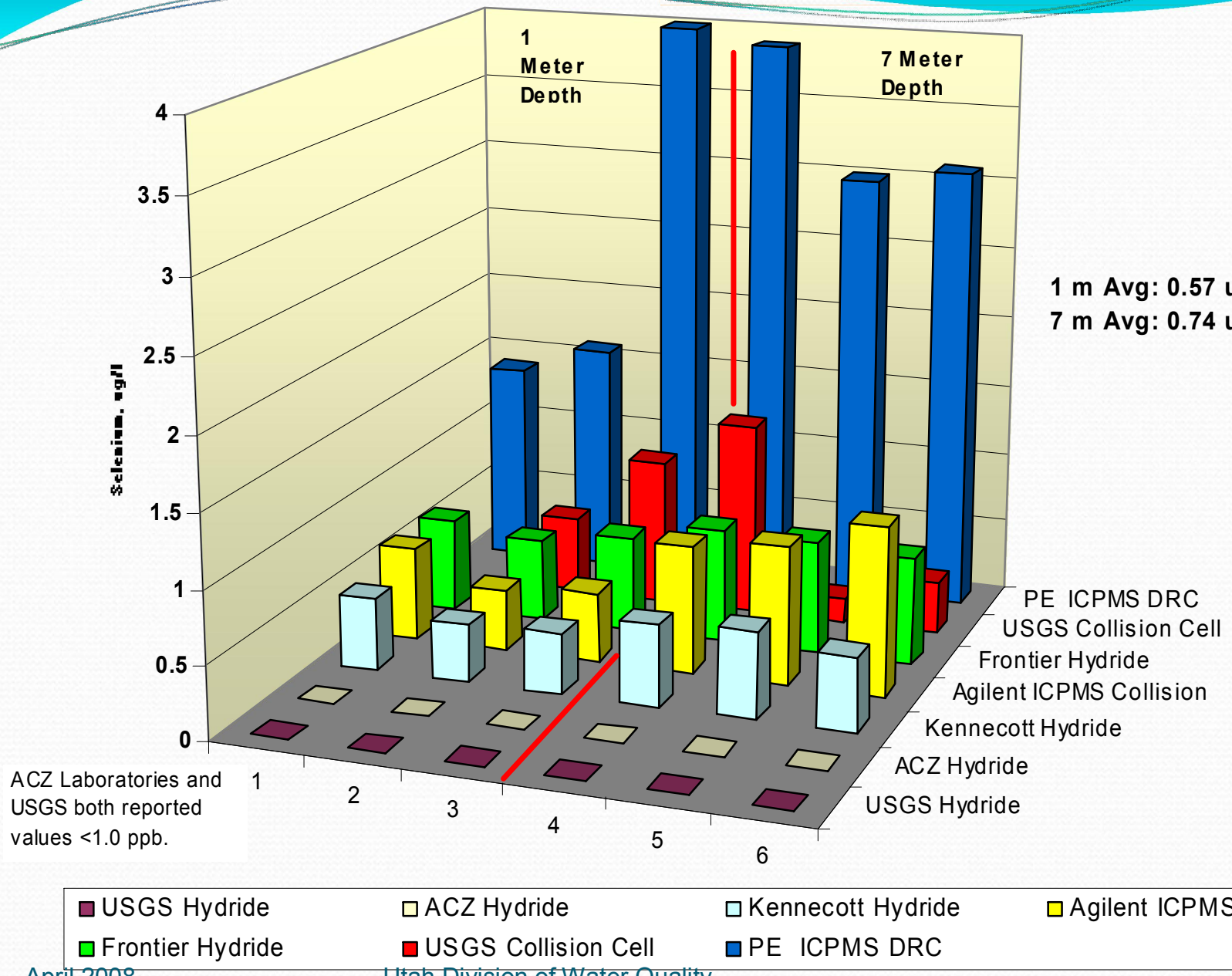
ICP-MS with Dynamic Reaction Cell (DRC) [P&E]



ICP-MS with Collision Cell [Agilent Technologies]



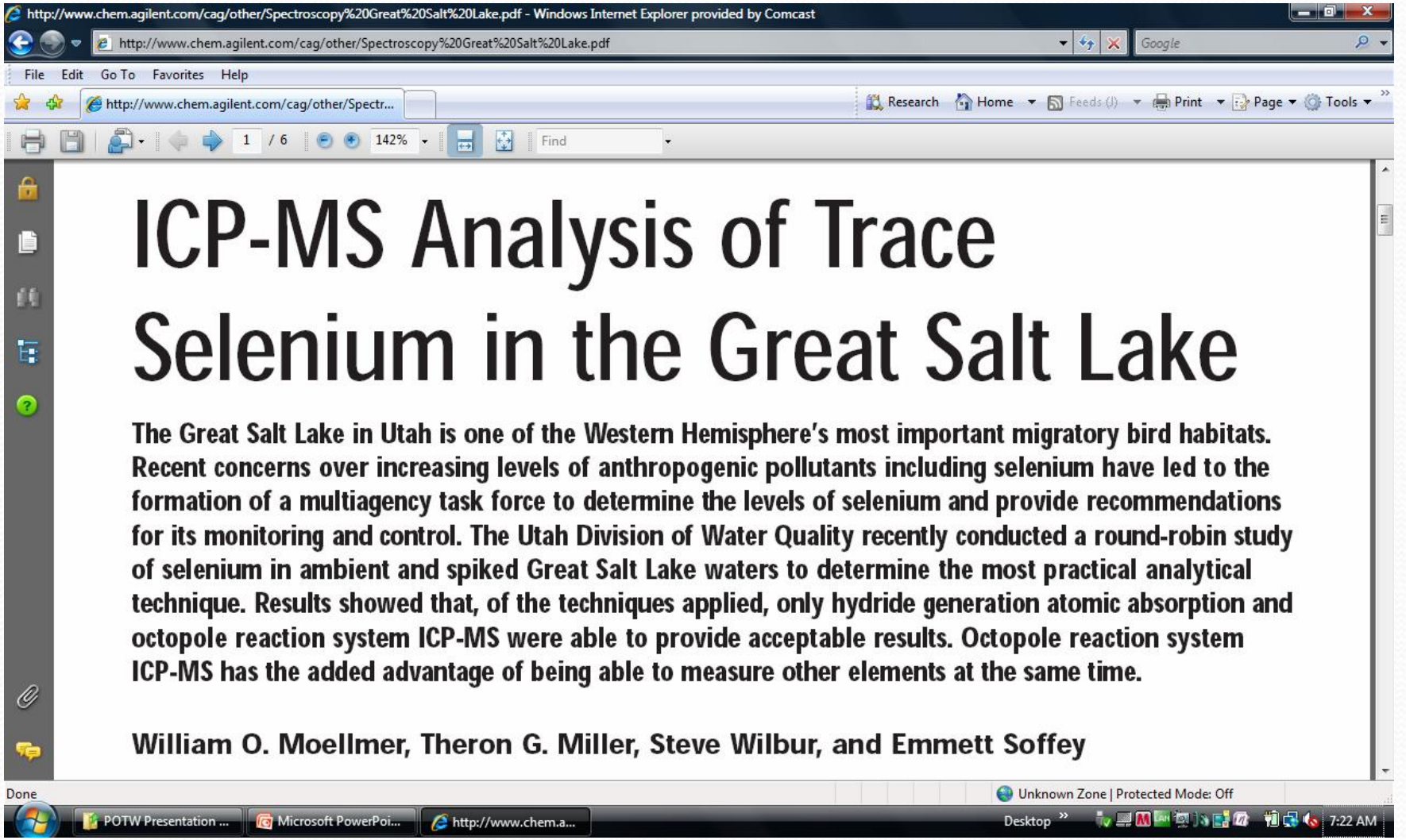
Concentration of Se in Gilbert Bay @ USGS Site



1 m Avg: 0.57 ug/l
7 m Avg: 0.74 ug/l

ACZ Laboratories and USGS both reported values <1.0 ppb.

Spectroscopy: January 2007



A local Steering Committee was established by the Utah Division of Water Quality to offer guidance and make a recommendation to the Water Quality Board.

The Committee established a Science Panel composed of the following members:

- **Anne Fairbrother, Ph.D. - EPA / Parametrix, Seattle, WA**
- **Joseph Skorupa, Ph.D. - US Fish & Wildlife Service, Washington, D.C.**
- **Theresa Presser, Ph.D. - US Geological Survey, Menlo Park, CA**
- William Wuerthele - EPA / Consultant, Denver, CO
- Theron Miller, Ph.D. - Utah Division of Water Quality, Park City, UT
- **William Adams, Ph.D. - Rio Tinto (Kennecott), Salt Lake City, UT**
- Brad Marden – Artemia Assoc. / Parliament, Ogden, UT
- Don Hayes, Ph.D. – Univ. of Louisiana (Lafayette), Lafayette, LA
- William Moellmer, Ph.D. – Utah Division of Water Quality, SLC, UT
- **Harry Ohlendorf, Ph.D. – CH2M-Hill, Sacramento, CA** [Consultant]

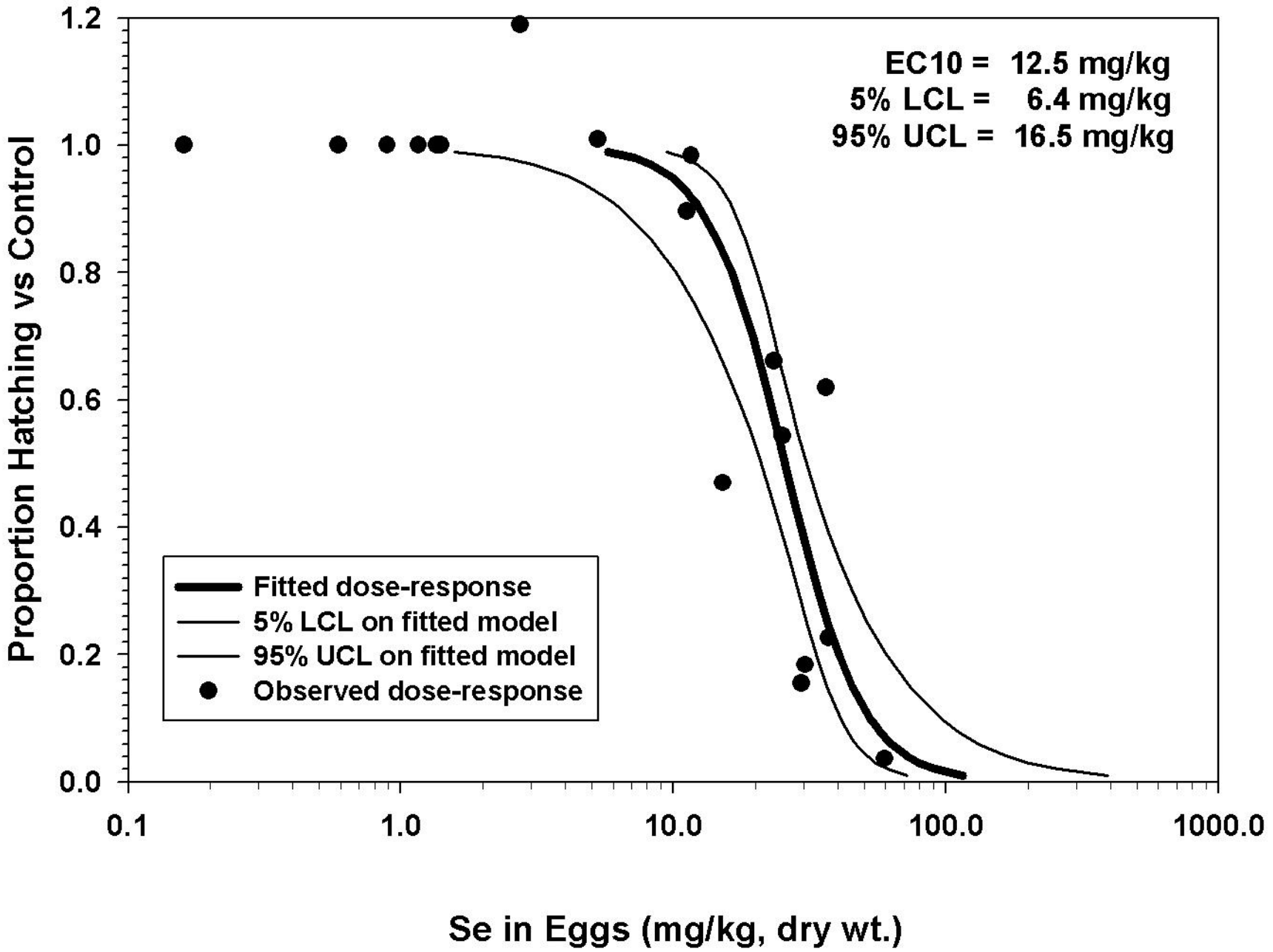


Figure 2. Mallard egg hatchability vs control as a function of selenium concentration in eggs.

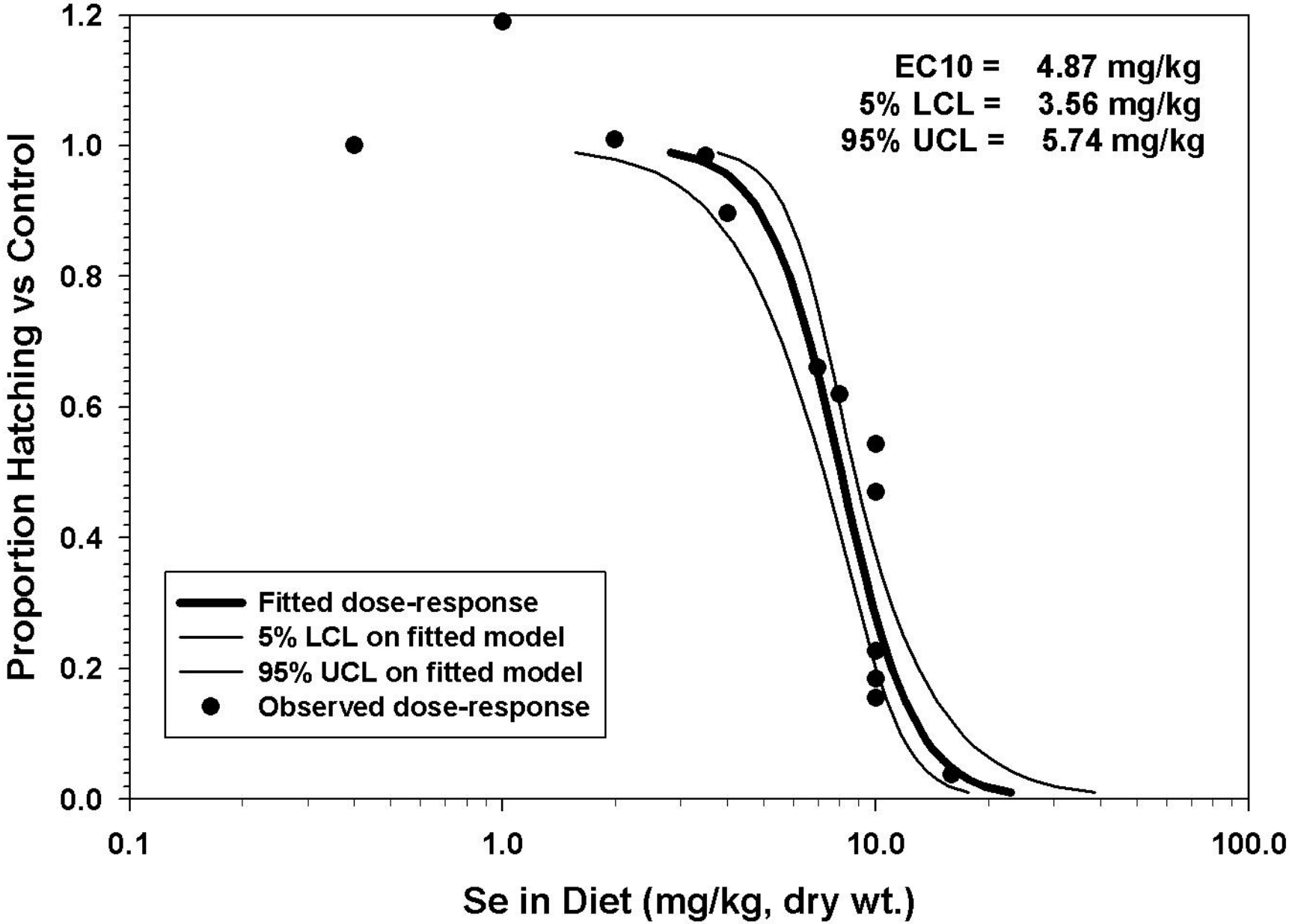
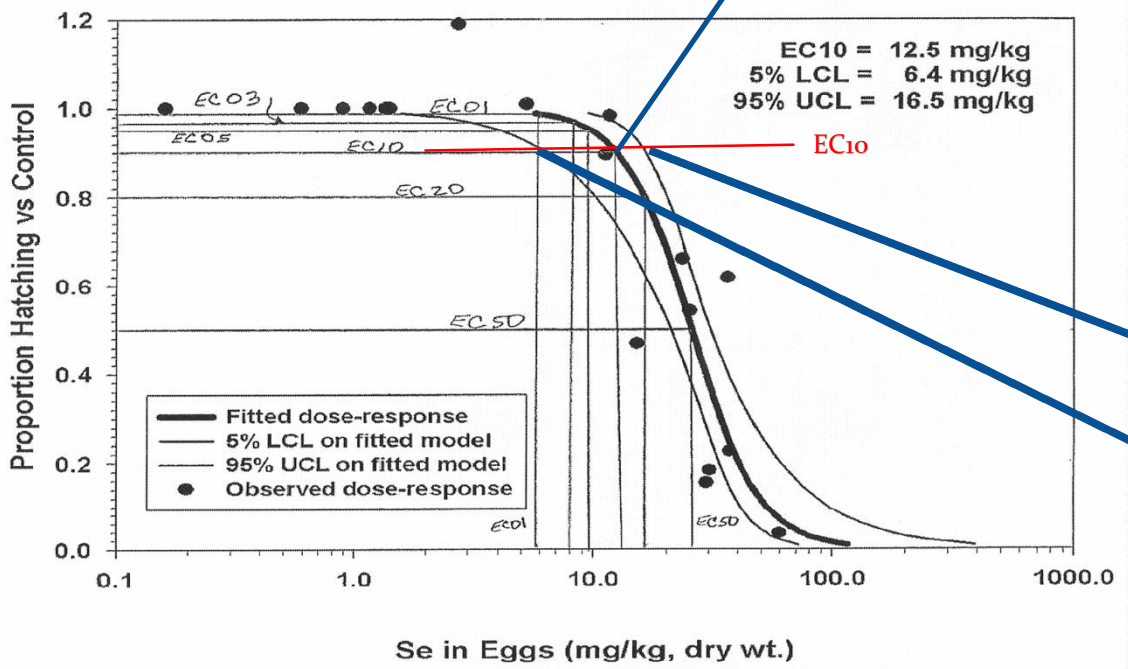


Figure 1. Mallard egg hatchability vs control as a function of selenium concentration in diet.

Evaluating the Toxicity Curve for the Mallard Duck [non-GSL feeder]



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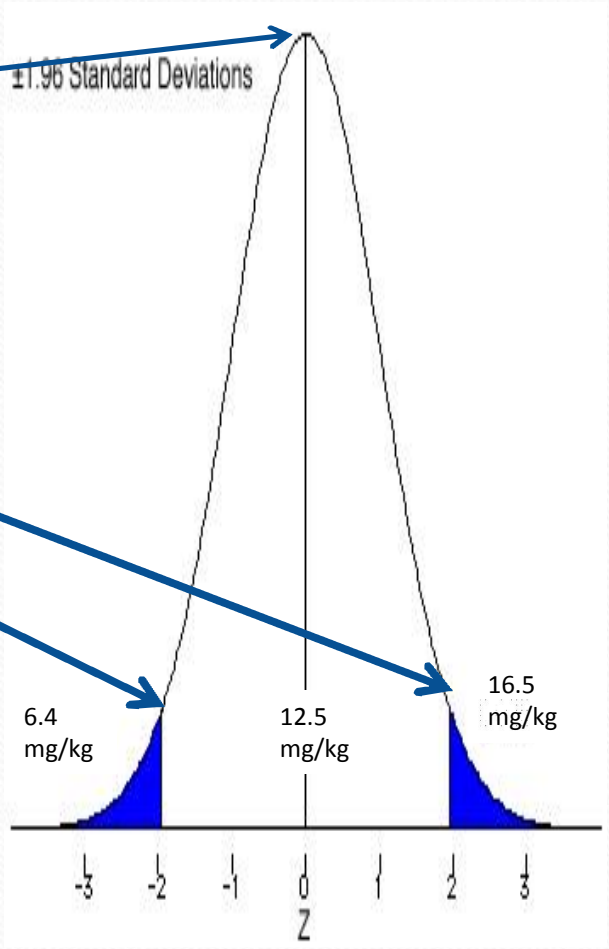
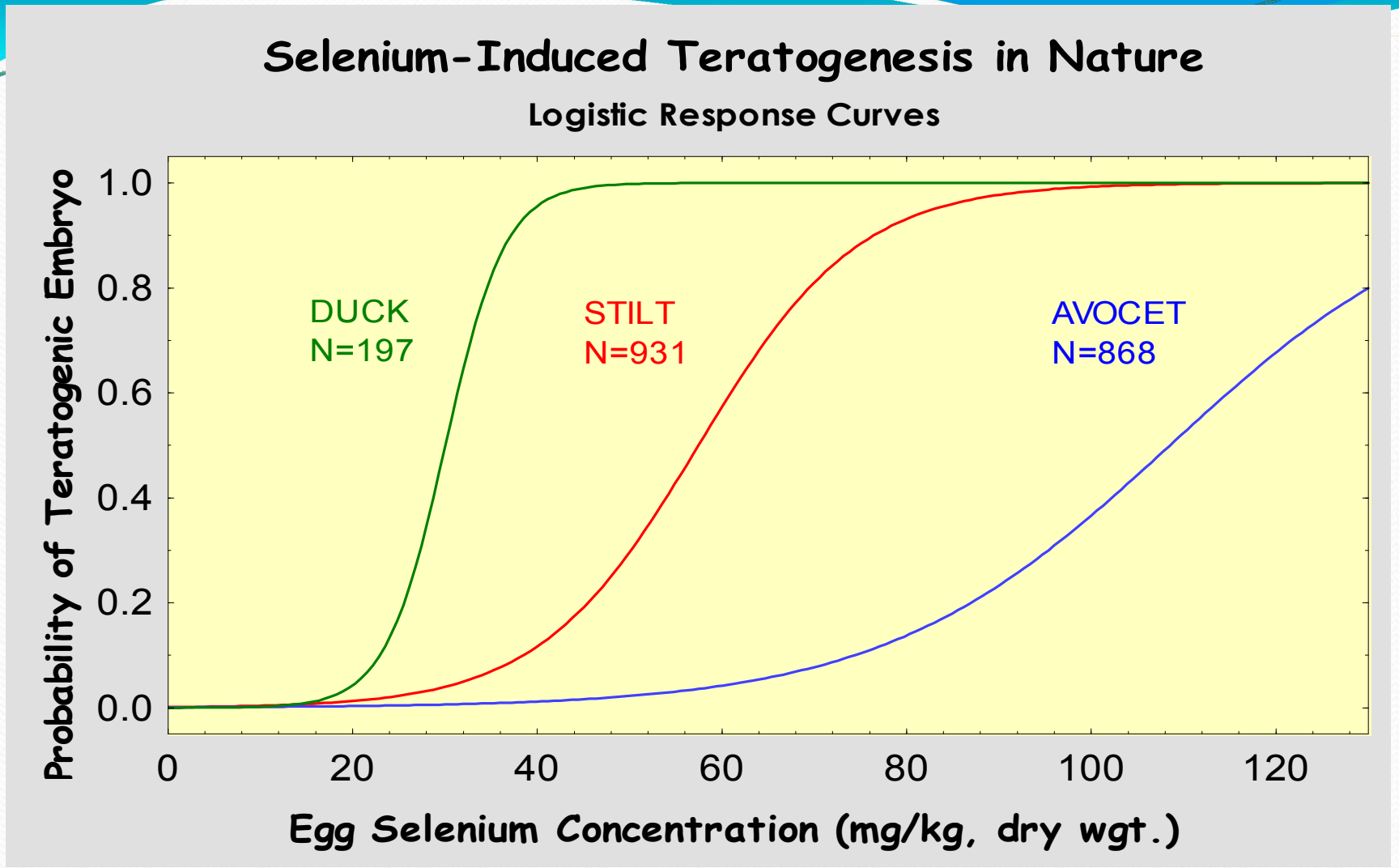
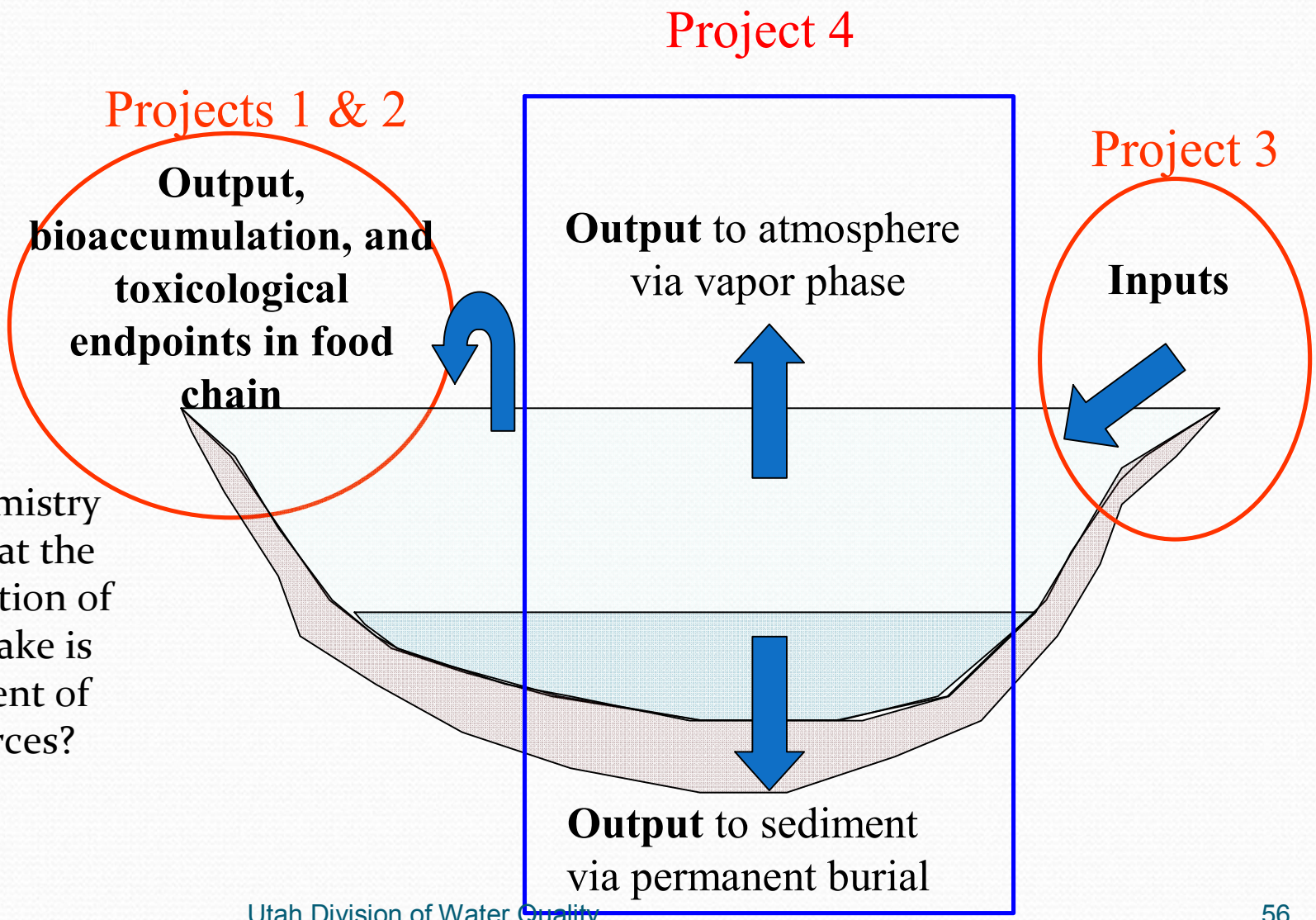


Poster 7



Logistic response curves for selenium-induced teratogenesis among black-necked stilt, American avocet, and duck eggs exposed to agricultural drainage water.

Science Panel Identified Four Projects to Meet Objective



Is the chemistry such as that the concentration of Se in the lake is independent of input sources?

Project 1 – Avian Ecology

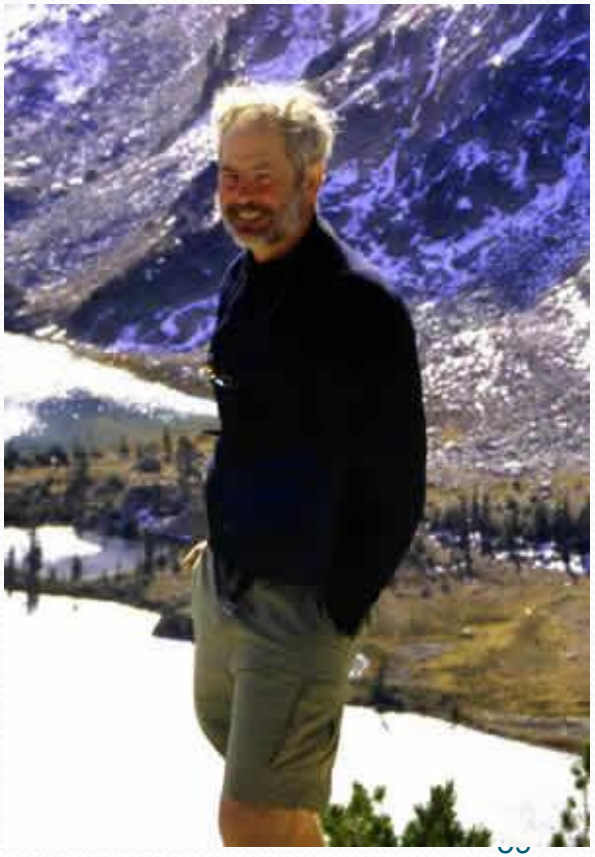
- Principal Investigators
  - Michael Conover, PhD [USU]
  - John Cavitt, PhD [Weber State]

Project 1 – Avian Ecology

Determine Se flux from bird diet to critical end points by determining ambient selenium concentrations in water, brine shrimp, brine flies, other food items, birds and bird eggs.

Project 2 – Aquatic Ecology

- Principal Investigators
  - Wayne Wurtsbaugh, PhD [USU]
  - Brad Marden [Parliament Fisheries and the Artemia Association]



Project 2: Design and Conduct Selenium Concentrations Synoptic Surveys in the Great Salt Lake

- Survey of Se in Periphyton and Brine Shrimp from the Benthic Zone
- Survey of Selenium in Water, Seston (plankton, organic detritus and inorganic particles such as silt) , and *Artemia*

ARTEMIA @

Utah State University

Project 3 – Selenium Loads

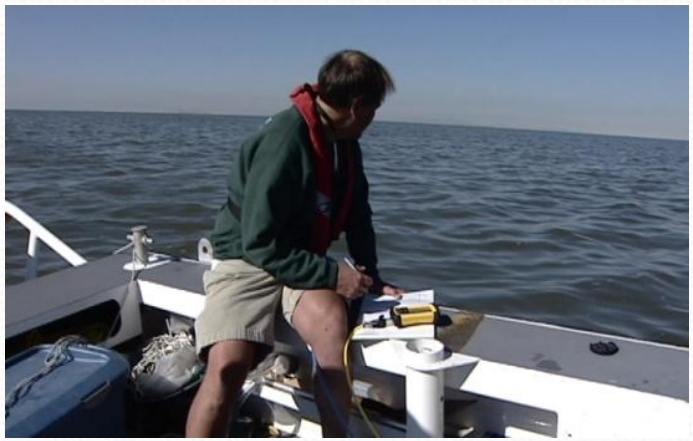
- Principal Investigators
  - Dave Naftz, PhD [USGS]
  - Bill Johnson, PhD [UofU]

Project 3: Measurement of Selenium Loads to the Great Salt Lakes

- Install Stream Gages on all Primary Point Sources Loading to the Main Body of the GSL
- Model Selenium Loadings to the GSL
- Estimate Selenium Loading to GSL from Groundwater Inputs

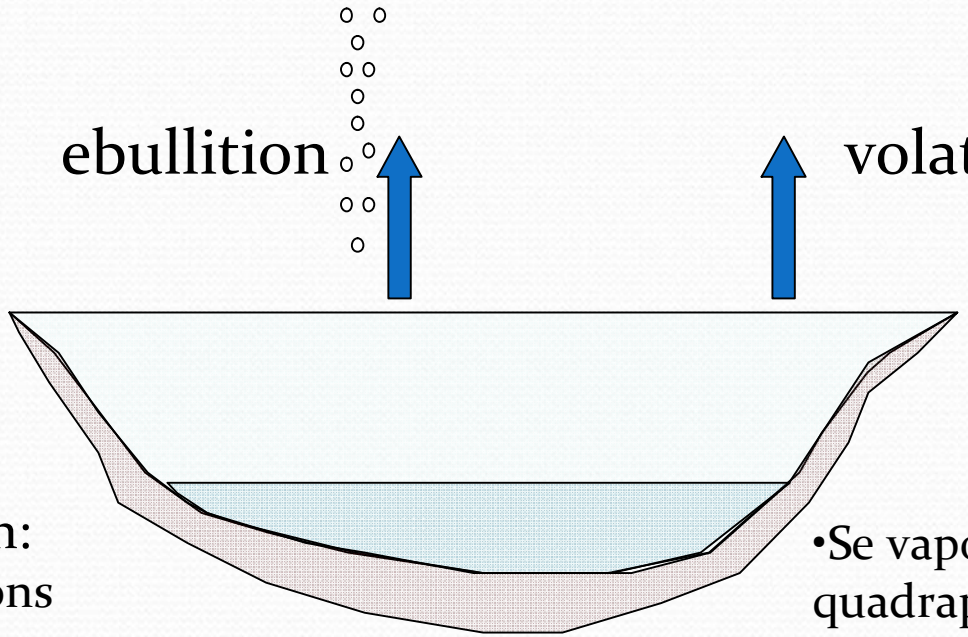
Project 4 – Se in Vapor/Sediment

- Principal Investigators
  - Bill Johnson, PhD [UofU]
  - Dave Naftz, PhD [USGS]



Project 4 – Se in Vapor/Sediment

Task 1. Vapor Selenium Flux



Ebullition:
- 20 locations
- 5 depths
- Semi-monthly
- Boat-mounted total dissolved gas probes
- Vapor collection via floating flux chamber

- Se vapor analyzed via quadrapole mass spectrometry
- Sediment grab samples for total organic carbon and total Se

Develop a Mathematical Model to Predict Bioaccumulation

- Mathematically define the pathway of selenium with "transfer factors" to the next level of the food web.
  - Water →
  - Algae →
  - Brine Shrimp & Brine Flies →
  - Bird Egg (Critical Endpoint)

- Predict the concentration of Se in the egg
- Compare the egg concentration to the tissue-based standard

Using a Mathematical Model to Predict Bioaccumulation

If the water in GSL were at "x" ug/L what does the model predict the concentration of selenium would be in the egg?

Water: ug/L (ppb)	Bird Egg: mg/kg (ppm)
0.60	2.53
1.0	4.32
2.0	8.80
3.0	13.3

ppb = parts per billion ppm = parts per million

Black-Necked Stilt

Project Costs

Project 1	**$312,900**
Project 2	**$163,300**
Project 3	**$213,600**
Project 4	**$347,000**
Program Support	**$198,700**
Undefined Support for '07/'08	**$106,200**
Subtotal	**$1,341,700**

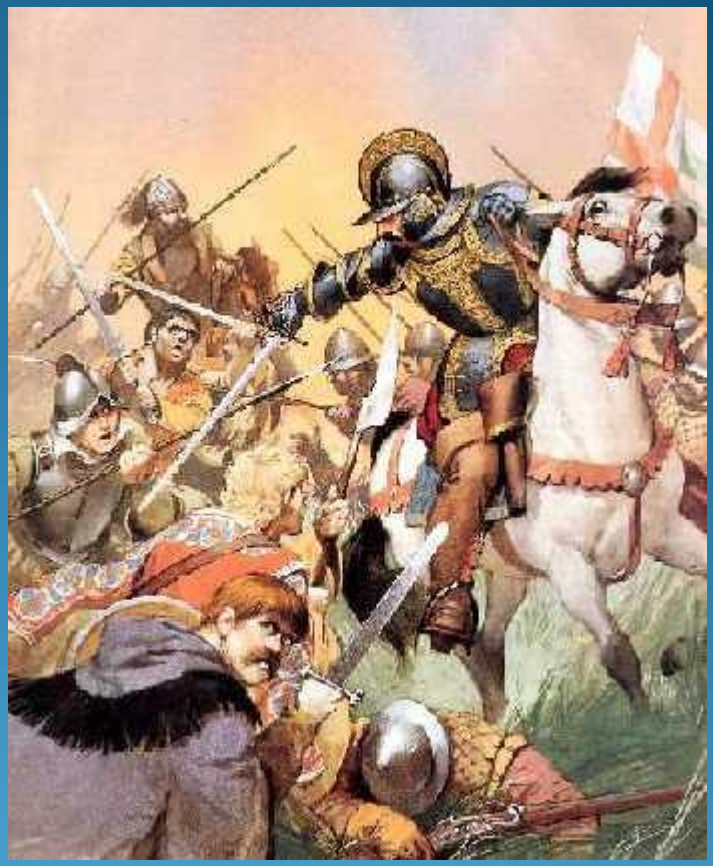
USGS Matching Funds
$124,000

Additional Cost [Science Panel]
$1,000,000

Total Costs ~
$2,650,000

With the Studies completed, the Science Panel was in a position to recommend a Standard.

Let the deliberations begin …..



Utah Division of Water Quality
May 2008

Protecting the Beneficial Use:

Should the standard be developed to protect the individual

- **No Effect Concentration: NEC**
- **Position of US Fish & Wildlife Service [USFWS]**
- **Migratory Bird Act & Endangered Species Act**

Should the standard be developed to protect the population?

- **Effective Concentration: EC**
- **Position of US Environmental Protection Agency**
- **Clean Water Act**
  - **Utah Water Quality Standards**
  - **Enforcement**

Protecting the Individual

- NEC: No Effect Concentration
  - Greatest concentration or amount of a substance, found by experiment, observation, or **statistical regression** that causes no alteration of morphology, functional capacity, growth, development or life span of target organism.
    - Position of the US Fish and Wildlife Service
      - **Protect the individual bird**
      - FWS to Consult with EPA in development of water quality standards

Protecting the Population

- Effect Concentration "EC"
  - Concentration or amount of a substance, found by experiment or observation, that causes an allowable alteration of morphology, functional capacity, growth, development or life span of target organisms distinguishable from those observed in normal (control) organisms of the same species and strain under the same defined conditions of exposure.
    - Position of the US Environmental Protection Agency [EPA]
      - **Protect the Population**
      - EC20 used on previous WQ Standards nationwide
      - EC10 used on Great Lakes Initiative
        Data Rich and Tissue Based Standard
      - Under Clean Water Act EPA is responsible to oversee the development of water quality standards

What is the Science Panel Recommendation for the Standard?

American Avocet

- Matrix: Bird Egg
- Frequency: Nesting season
- Measured as: Geometric Mean
- Range:
  - The Panel as a Whole: 6.4 – 16.5 mg/kg (ppm)
  - As Individual Panel Members:
    - 5 mg/kg — 1 Panel Member
    - 10.4 mg/kg — 1 Panel Member
    - 12 – 13 mg/kg — 6 Panel Members
- Include an Assessment Methodology
  - Monitor and Evaluate the Status of Bird Eggs and the Ecosystem
  - Act with more aggressive monitoring and initiate DWQ action when the concentration of Se in the eggs increase.

What is the Steering Committee Recommendation for the Standard?

- Matrix: Bird Egg
- Frequency: Nesting season
- Measured as: Geometric Mean
- Range:
  - As Individual Steering Committee Members:
    - 5 mg/kg — 5 Panel Members
    - 10.4 mg/kg — 1 Panel Member
    - 12 – 13 mg/kg — 10 Panel Members
- Include an Assessment Methodology
  - Monitor and Evaluate the Status of Bird Eggs and the Ecosystem
  - Act with more aggressive monitoring and initiate DWQ action when the concentration of Se in the eggs increase.


American Avocet

Presentation to the Water Quality Board

- The Steering Committee could not come to a 75% majority consensus for a recommended standard.
- Three positions were subsequently presented to the Board
  - 5 mg/kg [Representing the position of 5 Members]
  - 10.4 mg/kg [Representing the position of 1 Member]
  - 12.5 mg/kg [Representing the position of 10 Members]
- DWQ Staff did not make a position to the Board
- Board was invited to deliberate and develop the standard.
- Asked to include an Assessment/Monitoring Procedure

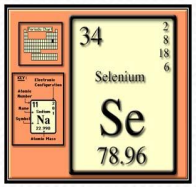
Water Quality Board Meeting
June 20, 2008 – Authorization to Proceed

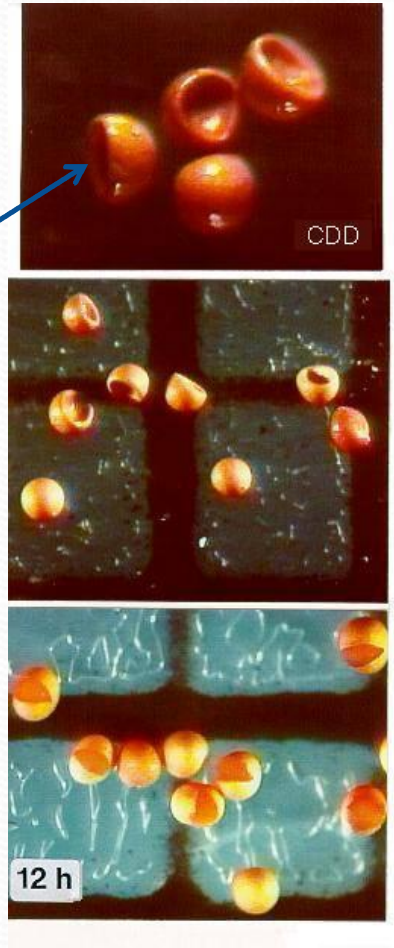
- 12.5 mg/kg (ppm) was chosen as the Standard
  - Tissue based whole egg
  - Shorebird egg
  - Dry weight
  - Over the nesting season
- Assessment / Monitoring Strategy
  - Included as a part of the standard
  - Developed by the Division of Water Quality

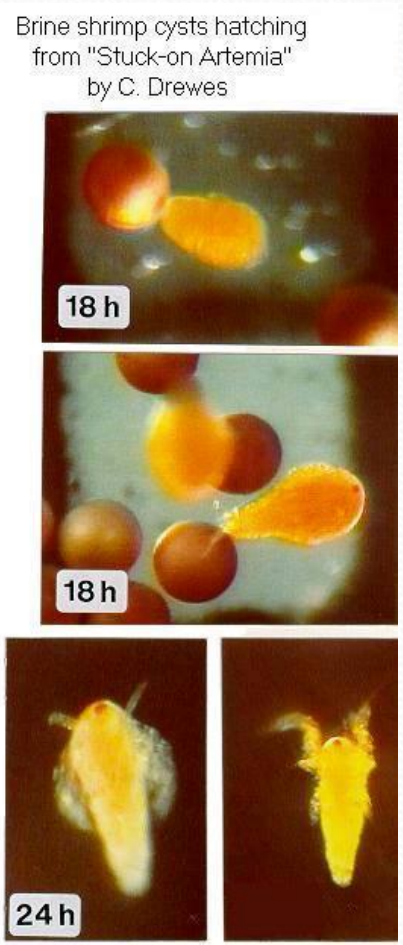
Assessment/Monitoring Procedure

SAMPLING		BIRD EGG CONC. PERCENT OF STANDARD	RESPONSE
Water Column and Brine Shrimp	Eggs (Geometric mean of 5 eggs)		
4 locations/annually	1 location / 1 species		.
4 locations/quarterly	2 locations / 1 species	40%	Antidegradation Level II Review is required for all new permits and renewals.
8 locations/quarterly	2 locations / 2 species	60%	Implement selenium caps on all permits.
8 locations/monthly	3 locations / 2 species Perform hatchability studies on 2 species	80%	Preliminary studies of load reductions
		100%	IMPAIRMENT: TMDL REQUIRED

Biomagnification up the GSL Food Chain: Brine Shrimp Industry







Prawn

Tilapia

Does the Se concentration in the first instar stage of the nauplii cause a potential problem for the brine shrimp industry?