# Water Quality Studies on the Great Salt Lake, Utah

## Developing a Selenium Standard

Utah Water Quality Board Meeting

August 18, 2006.

**William O. Moellmer, Ph.D.**
**Utah Division of Water Quality**

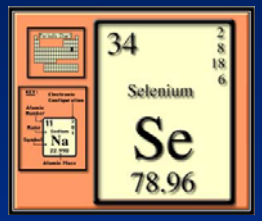
# Great Salt Lake Water Quality Studies

Program Objective:

Set a Site-Specific Numeric Water Quality Standard for Selenium for the Open Waters of the Great Salt Lake

What activities are necessary to achieve an interim Selenium standard by September 2007?

# Biomagnification up the Food Chain




Selenium in the Water

0.7 ug/l -> 4 mg/l

Brine Fly


Brine Shrimp

How much does the Se bio-magnify between the water and the bugs?

# Biomagnification up the Food Chain

Brine Flies & Brine Shrimp

Eared Grebe

California Gull

Black-Necked Stilt

How much does the Se bio-magnify between the bugs and the birds?

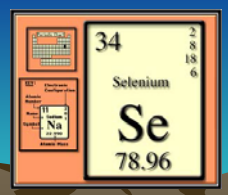
# Biomagnification up the Food Chain

Birds → Chicks

How much does the Se bio-magnify between birds and the chicks?


# Biomagnification up the Food Chain

BFA: BioAccumulation Factor




Water

BFA?

Brine Flies & Brine Shrimp

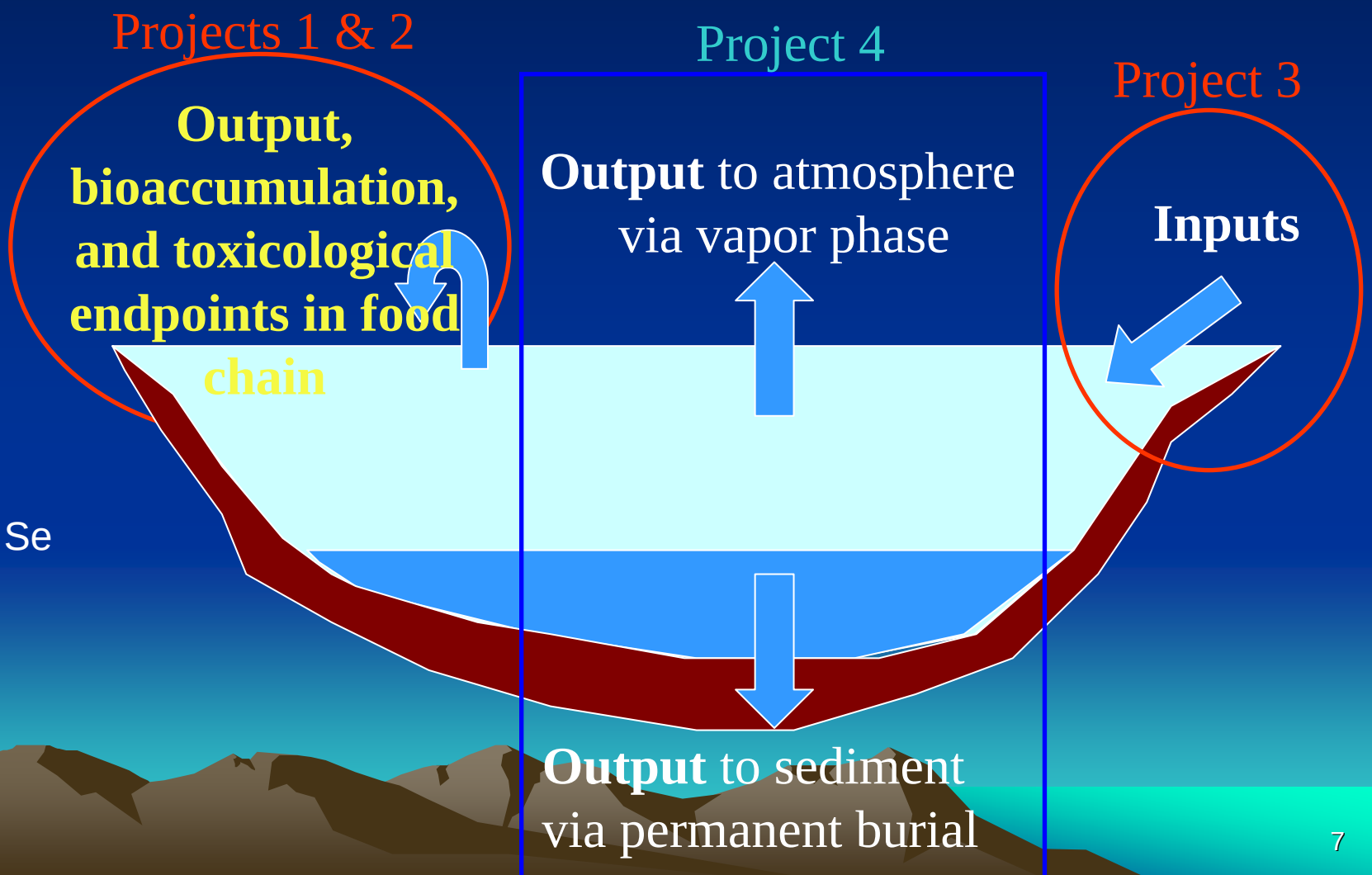
BFA?

Birds

BFA?

Chicks

# 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]
  - Clay Perschon
- Project Advisors
  - Gary Santolo, MS [CH2MHill]

# Project 1 – Avian Ecology

## Project Objective

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 1 – Avian Ecology

## Project Objective

Determine potential selenium effects on critical end points

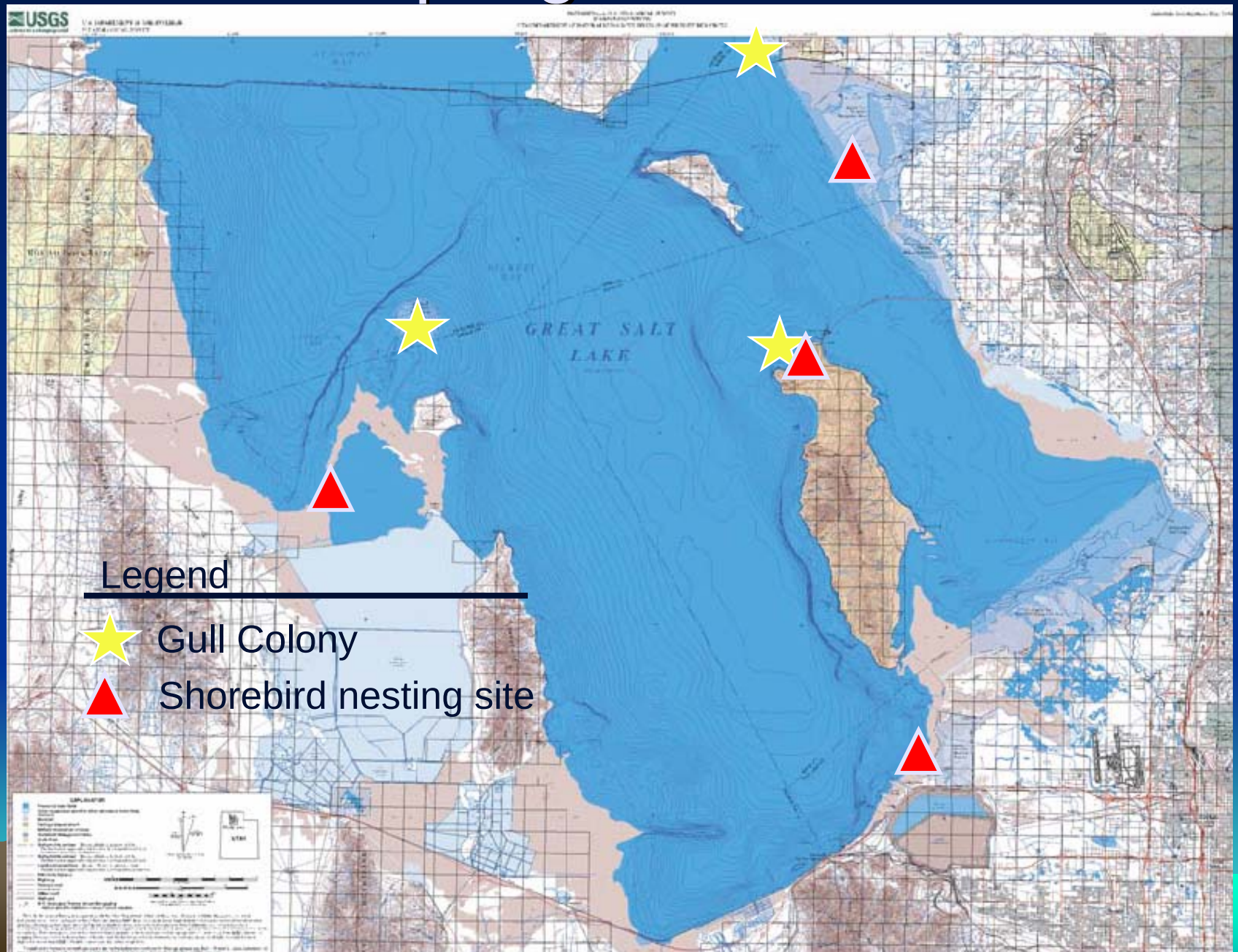
- biomagnification
- reproductive effects
- tissue burdens & survival

# Project 1 – Avian Ecology

## Project Tasks

1. Identify Nesting Sites [Completed]
   - Avocets/Stilts – 4 locations
   - California Gulls – 3 locations
2. Locate Foraging Areas [Completed]
3. Collect Adult Birds [Completed]
4. Sample Food Items, Sediment and Water [Completed]

# Sampling Locations



# Project 1 – Avian Ecology

## Project Tasks

5. Collect Eggs [Completed]
6. Revisit Nests to Check for Deformities [Completed]
7. Determine Se Concentrations [In Process]
8. Collect Over-wintering Birds
    1. Eared Grebes (October –January)
    2. Ducks (December – March)

# Project 2 – Aquatic Ecology

- Principal Investigators
  - Wayne Wurtsbaugh, PhD [USU]
  - Brad Marden [Parliament Fisheries]
- Project Advisor
  - Earl Byron, PhD [CH2MHill]

# Project 2 – Aquatic Ecology

## Project Objective

Determine spatial and temporal variation in Se concentrations in the water and in pelagic and benthic food web components leading to the birds of interest.

# Project 2 – Aquatic Ecology

Project Tasks

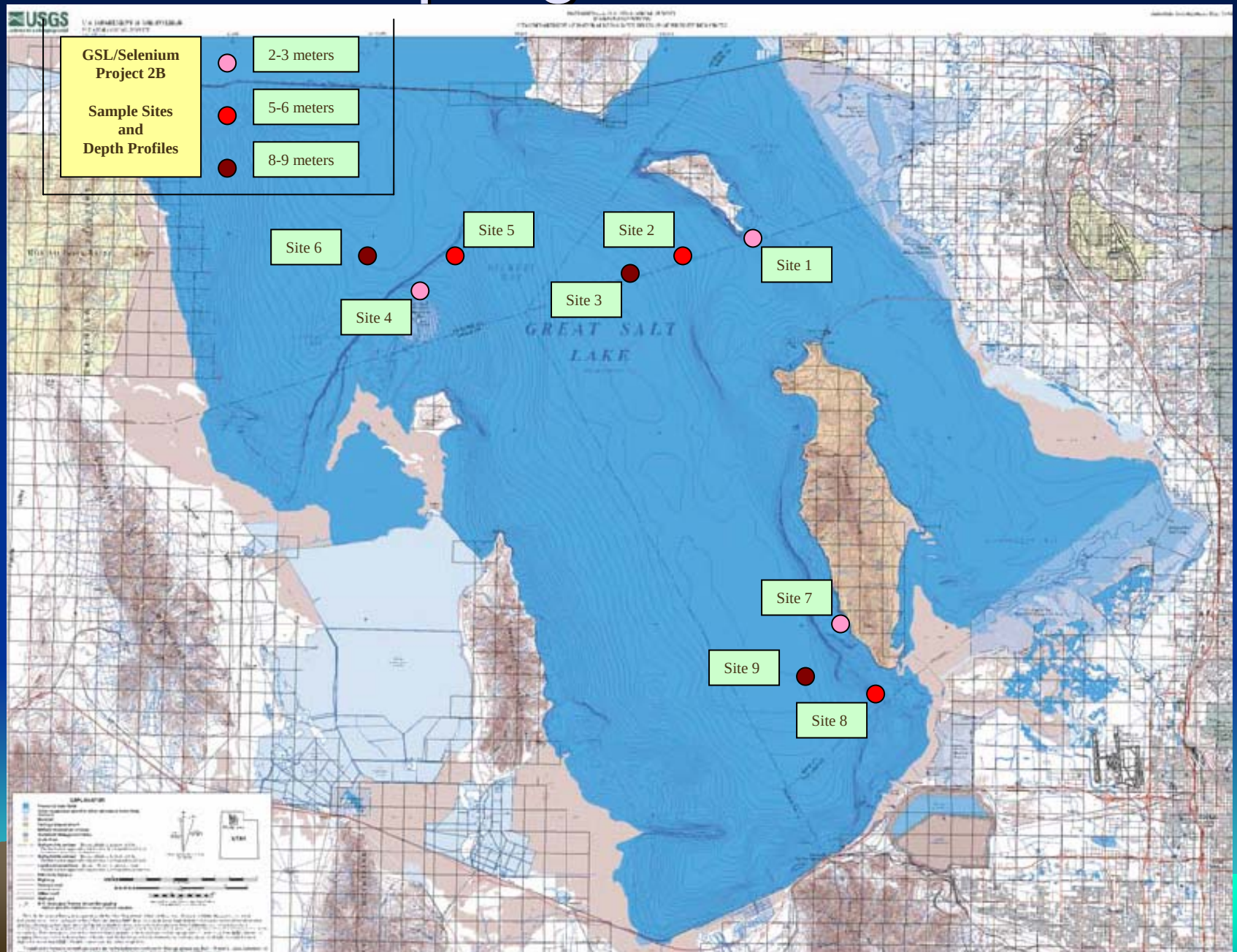
1. **Collect Periphyton, Brine Fly Larvae, Pupae and Adults in Benthic Habitats for Se Analyses** [Field Work Completed]
   - **Preliminary Study to Determine Link to Bird Diet (Two Locations)**
   - **Test Benthic Sampling Protocols That Have Never Been Used on GSL**
   - **Includes Sampling at Sandy, Muddy and Stromatolite Locations**

# Project 2 – Aquatic Ecology

## Project Tasks

2. **Synoptic Survey of Water, Seston & Artemia** [In Process]
   - **Document the Temporal and Spatial Characteristics of Total Se Concentration in Water and Correlate with Seston and Artemia Tissue Concentrations**
   - **Correlate Isotopic 15N & 13C Levels with Se Concentration in Artemia tissue**
   - **Monitor Primary Production Indicators and Record Artemia Population Dynamics**

# Sampling Locations



# Project 3 – Selenium Loads

- Principal Investigators
  - Dave Naftz, PhD [USGS]
  - Bill Johnson, PhD [UofU]
- Project Advisor
  - Earl Byron, PhD [CH2MHill]

# Project 3 – Selenium Loads

## Project Objective

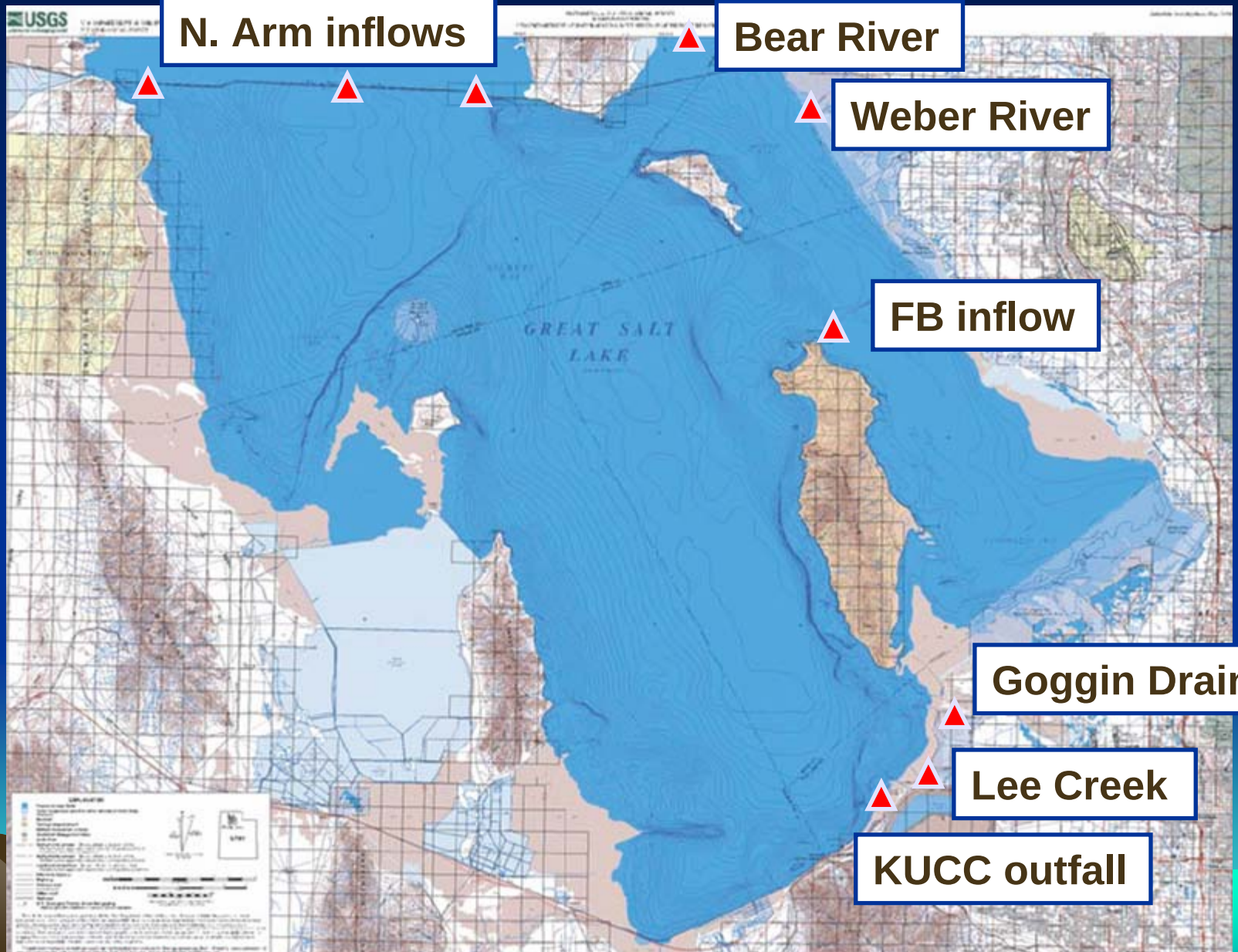
Measure discharge and Se loads from various sources to open waters of the Great Salt Lake to understand inputs to the ecosystem.

# Project 3 – Selenium Loads

## Project Tasks

1. Analyze USGS Archived Samples for Se Loads [Outside Contract Completed.]
2. Install Stream Gages on all Primary Point Sources of Se Loading to the Main Body of GSL [Completed. See USGS Website]
3. Monitoring/Modeling of Se Loadings to GSL (Natural & Point Sources) [In Process/2007]
4. Estimation of Se Load to GSL From Groundwater (Duke University) (Outside [Contract]

# Gage Locations



# Project 4 – Se in Vapor/Sediment

- Principal Investigators
  - Bill Johnson, PhD [UofU]
  - Dave Naftz, PhD [USGS]
- Project Advisor
  - Earl Byron, PhD [CH2MHill]

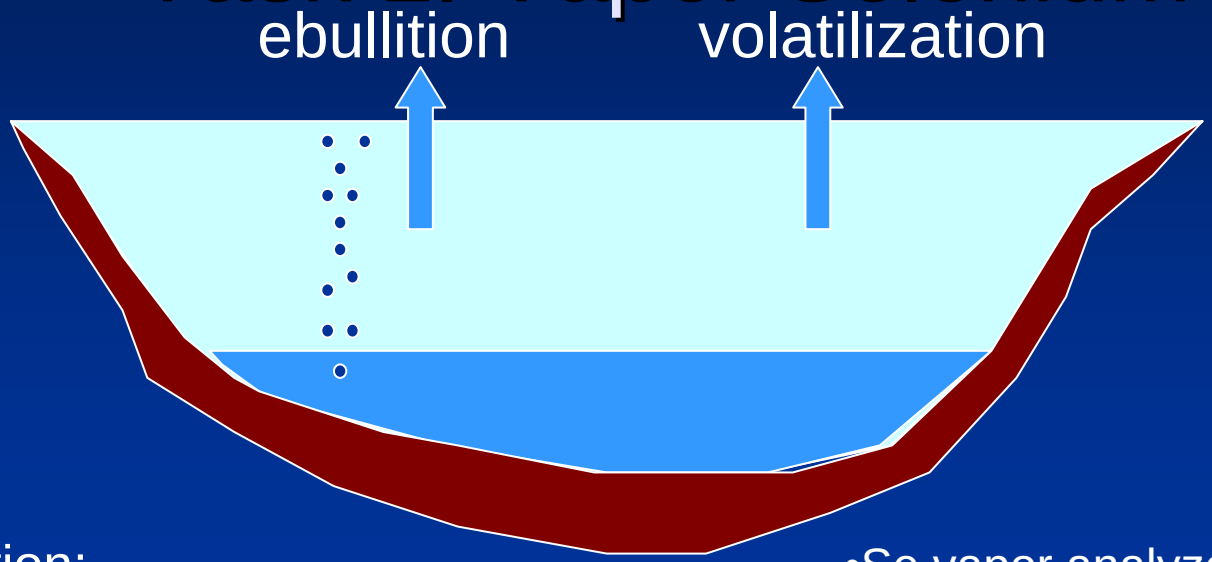
# Project 4 – Se in Vapor/Sediment

Project Objective

1. Are volatilization and ebullition (bubbling) significant release mechanisms for Se from the GSL?
2. Is Se stored in sediment and do mixing events re-mobilize the Se?
3. Does changing water elevation/lake area re-introduce Se into the water column?

# Project 4 – Se in Vapor/Sediment

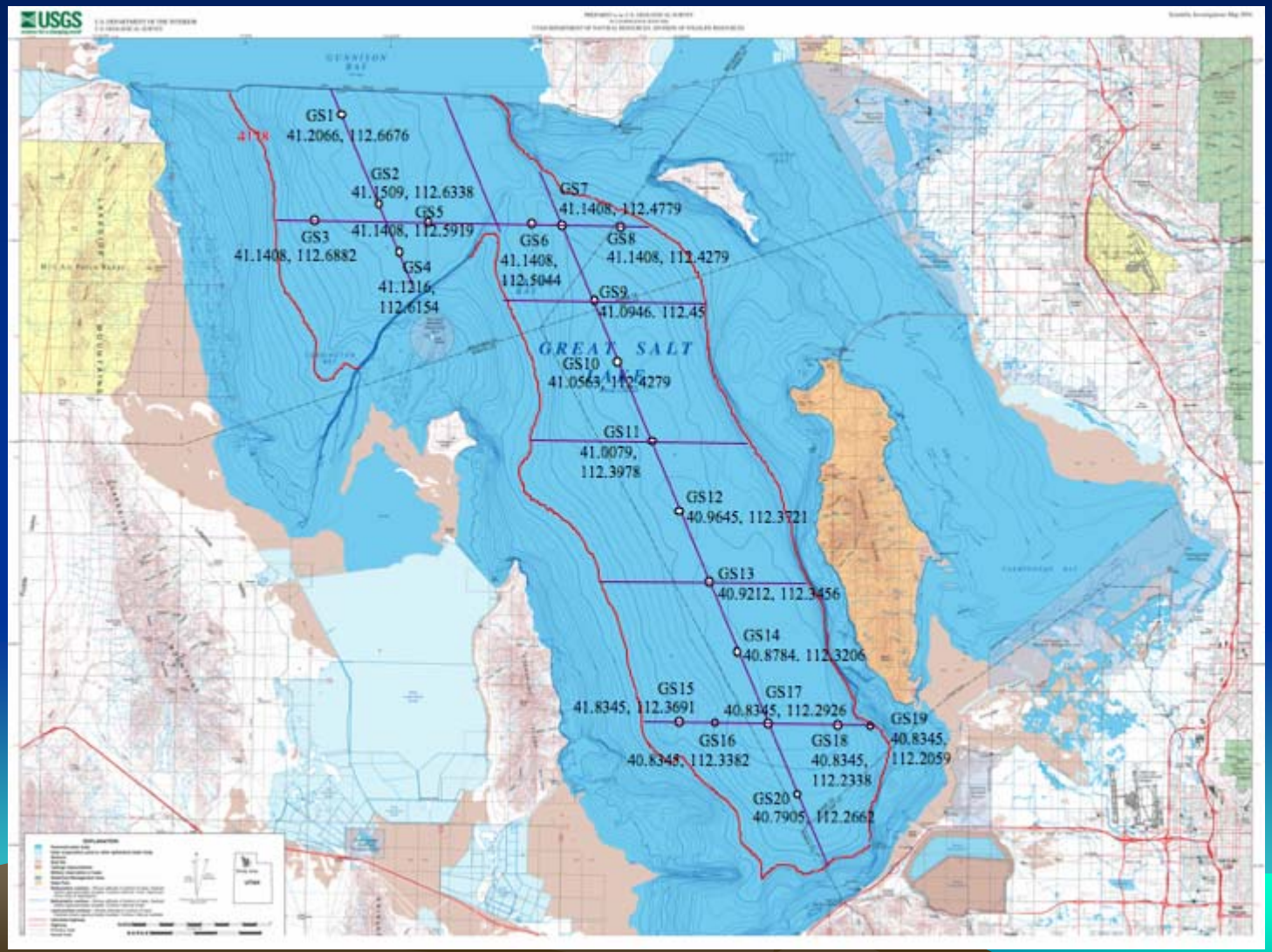
## Task 1. Vapor Selenium Flux




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

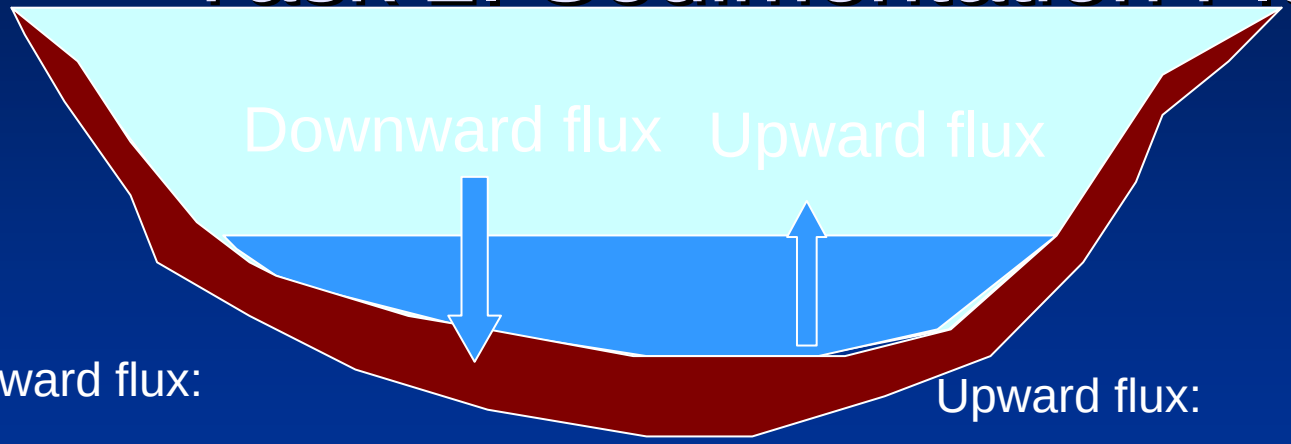
- Se vapor analyzed via quadrupole mass spectrometry
- Sediment grab samples for total organic carbon and total Se

# Project 4 – Se in Vapor/Sediment
## Total Dissolved Gas sampling locations



# Project 4 – Se in Vapor/Sediment

## Task 2. Sedimentation Flux




Downward flux:

- 2 sediment traps on lake bottom
- Sampled semi-monthly

- Water column samples at 2 depths at 2 locations
- Sampled semi-monthly

Upward flux:

- Thermistor string and turbidimeter deployed at five depths at two locations
- Retrieved semi-monthly

- Water column sampled following storm events

Total Se by extraction then HG-AA
Se phase identification by and FFF-ICP-MS

# Project 1 – Se in Vapor/Sediment

## Task 3. Lake Area Change/Permanency


**Lake area change:**

- 20 cores (submerged and exposed)
- Sequential extraction to determine Se release upon lake area change, e.g. submergence

Permanency:

- 3 cores
- Dating by 137Cs
- Selenium accumulation rates over past
- Comparison to present sedimentation rate
- Yields permanency of sedimentation

Total Se by extraction then HG-AA
Se phase identification by and FFF-ICP-MS
Overall Se budget will be developed in this task

# Program Support Task

Objective

**Provide technical direction, peer review/quality control, and coordination of all activities to achieve program objective while minimizing risk of challenge.**

# Program Support Task

Project Tasks

1. Planning and Design
2. Coordination/Management
3. Technical Oversight
4. Establish Data Quality Objectives
5. Quality Assurance/Data Management

# Project Schedule

- Project 1: 4/2006 - 5/2007
- Project 2: 4/2006 – 11/2006
- Project 3: 3/2006 – 5/2008
- Project 4: 6/2006 – 5/2007

# 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*** | |
| Total Cost | $1,465,700 |

# Great Salt Lake Water Quality Studies

Science Panel Meeting:

Planned for October 2007

Questions?