

# Monitoring the Quality of Water, Sediments, and Biota of Lake Powell

*A partnership between the  
U.S. Geological Survey and the National Park Service*

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**U.S. Geological Survey**

# Today's Presentation

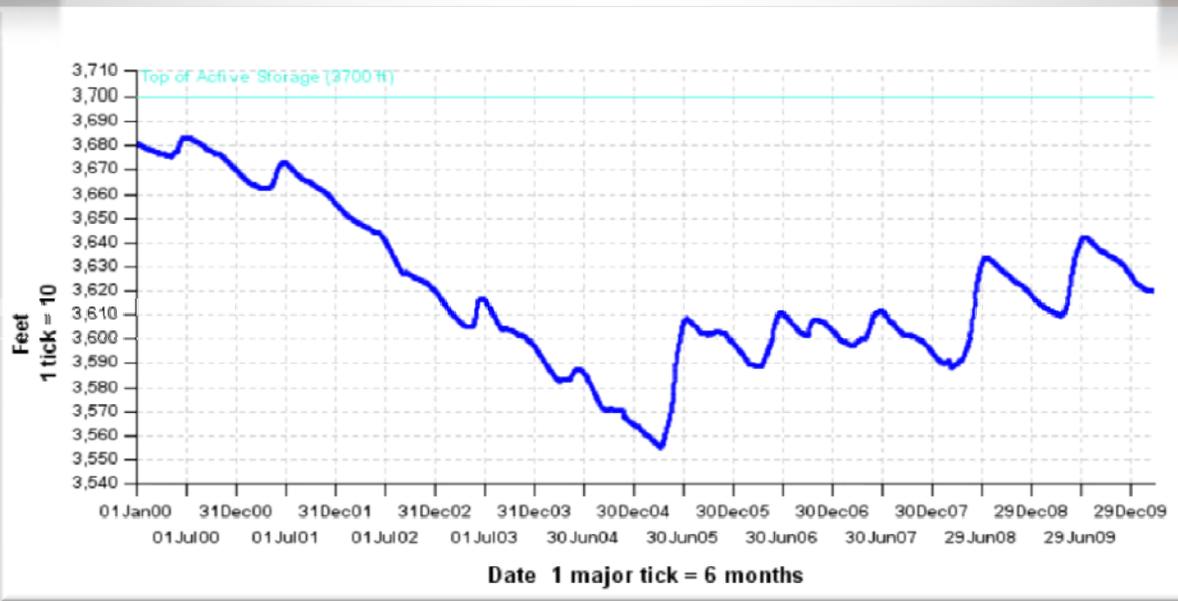
- Background and issues
- Design of the program
- Observations from past investigations
- Future plans and goals

## Lake Powell area



# Lake Powell Facts and Current Conditions

- Named after John Wesley Powell
- Glen Canyon Dam – completed in March 1963
- Reservoir filled to capacity in 1980
- 2<sup>nd</sup> Largest Reservoir (by volume) in the US
- About 2,000 miles of shoreline
- 2 – 3 million people visit the lake each year



# Management Issues

## ✓ Visitor and Recreational Use along with Contributions from the Watershed

- hydrocarbons (*volatile and semi-volatile*)
- oil and grease
- organochlorine pesticides
- pharmaceuticals and drugs
- household waste products
- trace elements
- nutrients
- bacteria
- quagga/zebra mussels



# The Design and Approach of the Program

- To determine the presence of contaminants in high-use areas, in water and sediments
- Establishment of a monitoring network for the entire reservoir
- To determine the potential for aquatic biota to bioaccumulate contaminants that are present
- To determine changes in water/sediment/biota quality over time

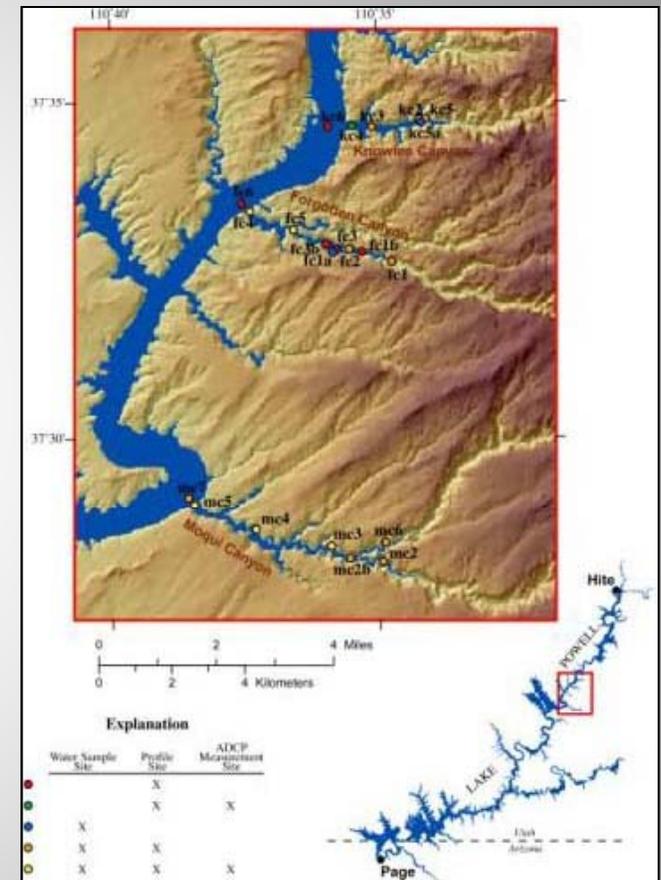
# Completed Design Components

- 1) The “Side Canyons” Study
- 2) The “Colorado River Delta” Study
- 3) Hydrocarbon Monitoring Plan
- 4) The “Sentinel Sites” Study



# The “Side Canyon” Study

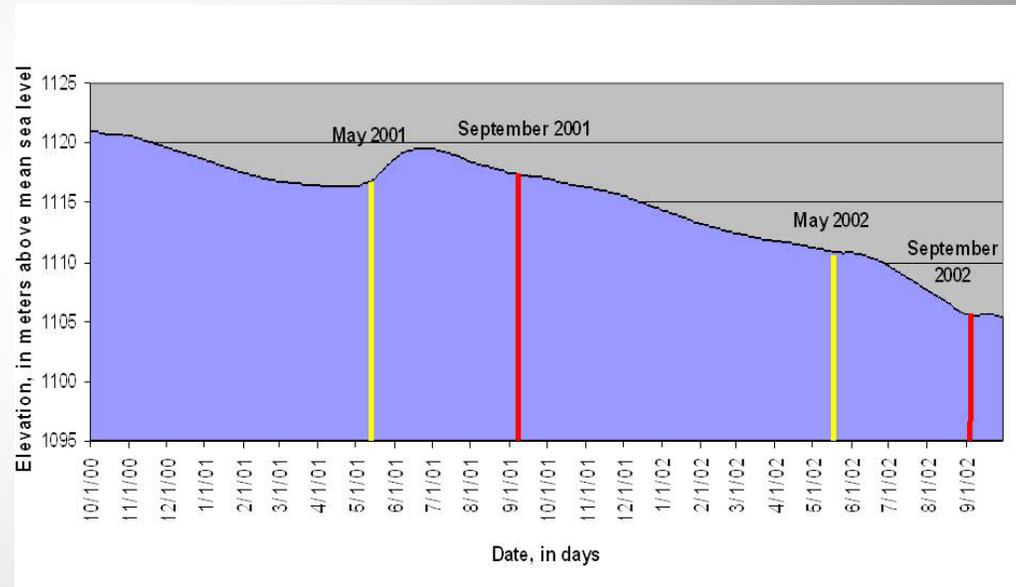
- 2 sampling periods, high-and low-visitor use
- 3 side canyons including 1 control canyon
- Water profiles of physiochemical properties
- Trace elements, majors, nutrients, organic carbon, pesticides, wastewater compounds
- Lakebed samples for PAHs and metals
- Velocity profiles



# Results

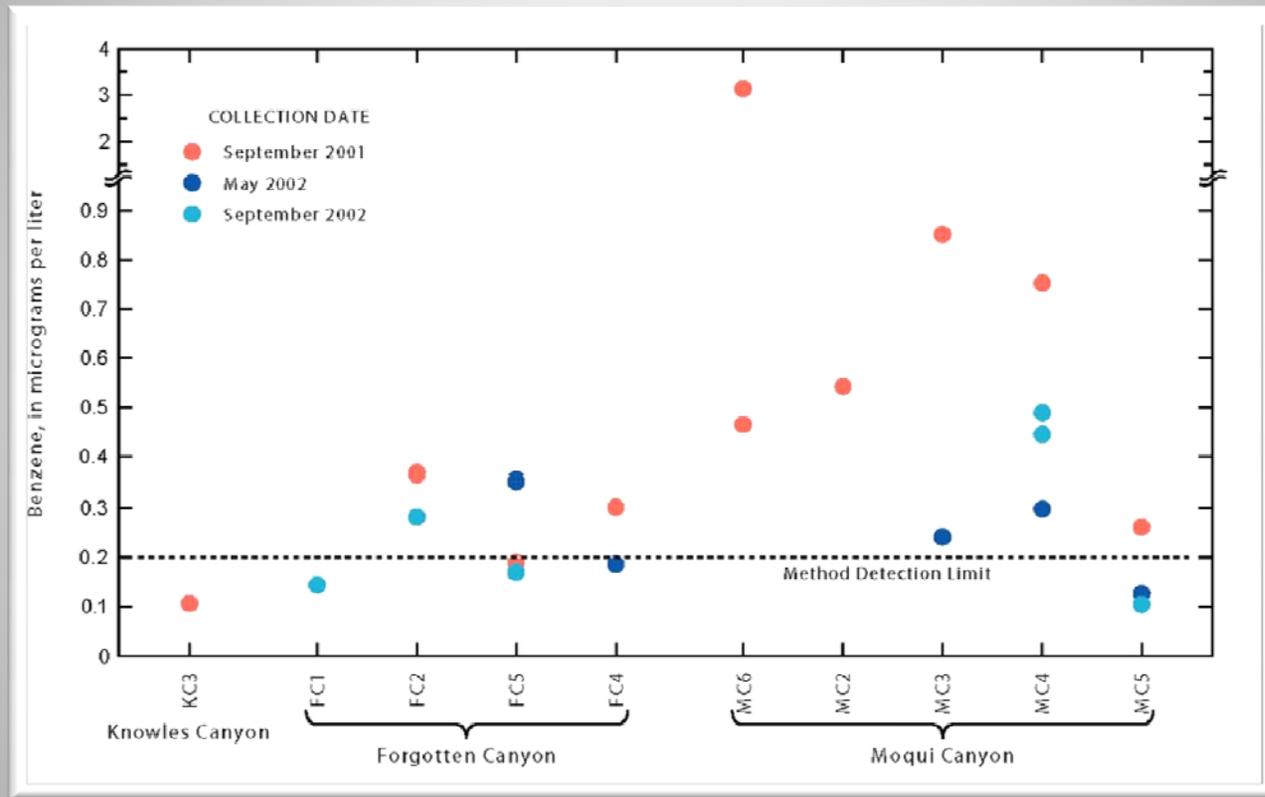
## “Side Canyons” Study

- Concentrations of selected metals were higher than those reported for most freshwater bodies
- Concentrations of organic compounds were not detected in the control canyon
- Concentrations of VOCs were higher during the high use period
- 33 organic wastewater compounds were detected out of 79 that were analyzed



# Results

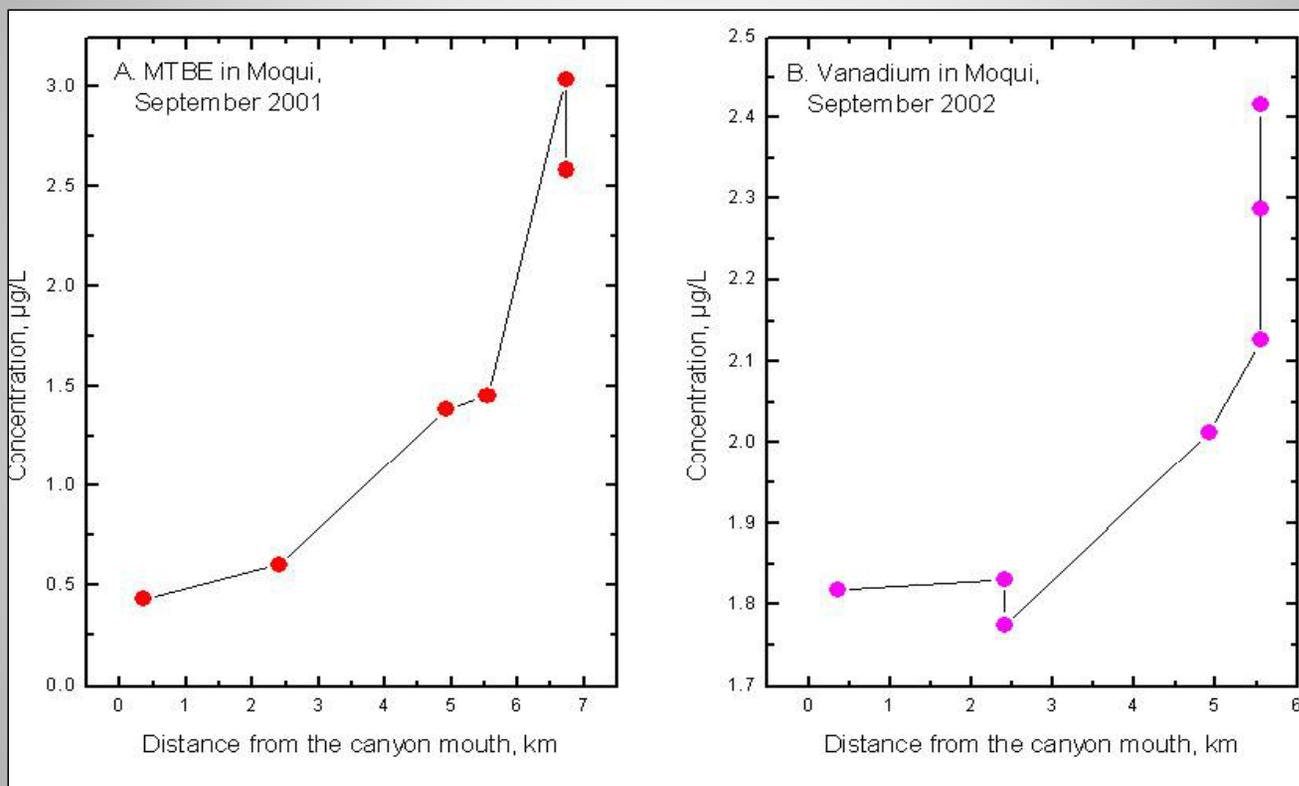
## “Side Canyons” Study



Higher concentrations of Benzene during higher visitor use period (orange and light blue dots)

# Results

## “Side Canyons” Study



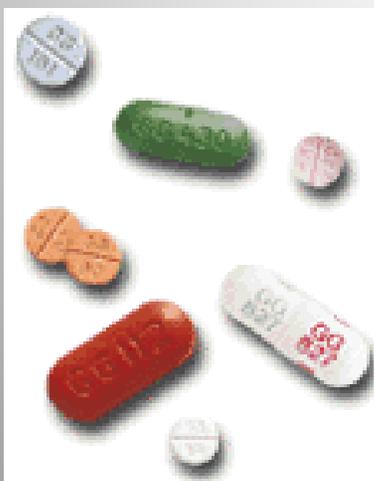
Increases in concentration from mouth to inflow area of Moqui Canyon

# Results

## “Side Canyons” Study

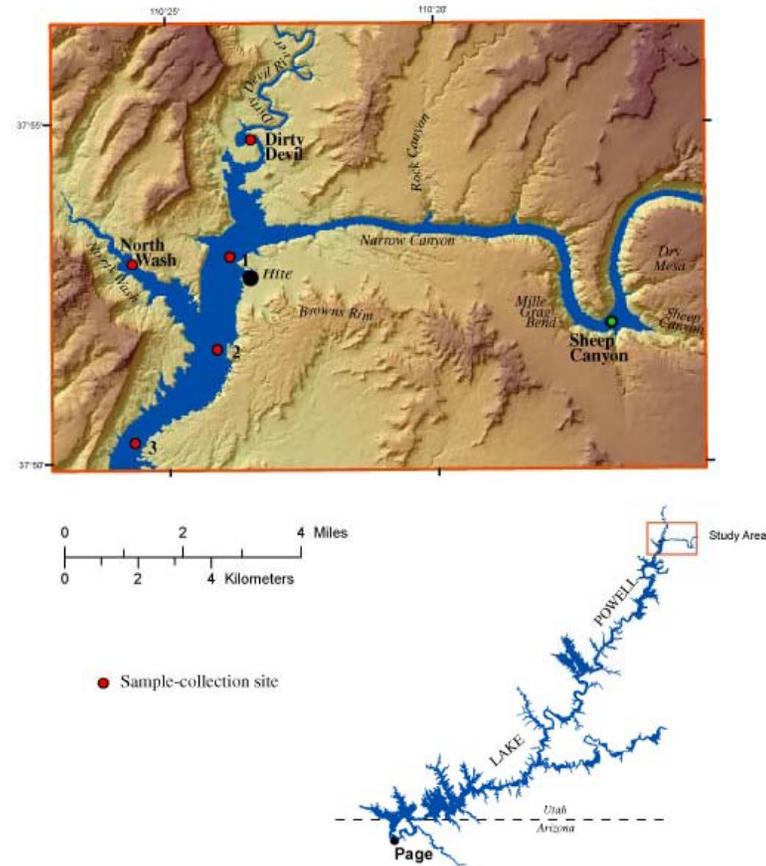
### Organic Wastewater Compounds

- Household products
- Insecticides/Pesticides
- Pharmaceuticals
- Waste water products
- Hormones and steroids



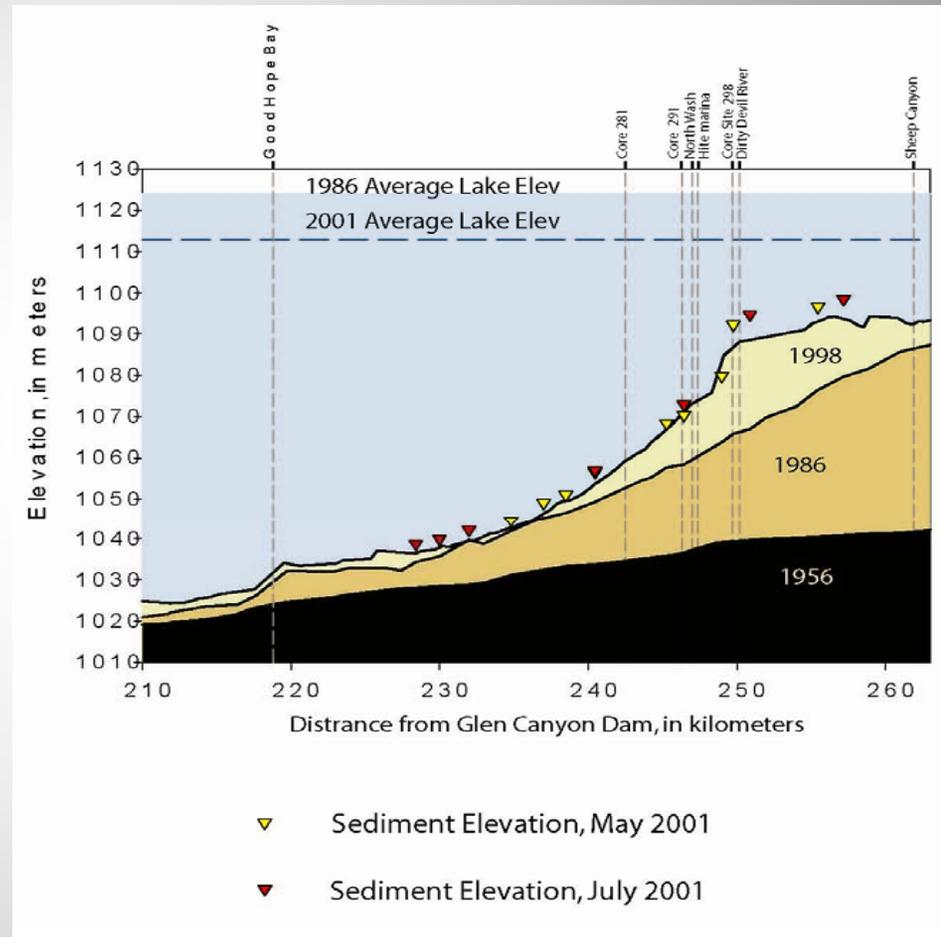
# “Colorado River Delta” Study

- Deep (3) and shallow (3) cores
- Overlying sediment-water interface and pore water
- Composited samples from deep cores
- Trace elements, majors, organic carbon, semi-volatile organics, pesticides
- Grain-size analysis



# “Colorado River Delta” Study

- Cores collected at 6 sites
- Approximate sediment accumulation rates (near Hite)
  - 1956 – 1986; 24 m
  - 1986 – 2001; 10 m
- Reservoir elevation difference from 1986 to 2001; 13 m
- Water depth (near Hite)
  - 1986; 41 m
  - 2001; 30 m



# Results

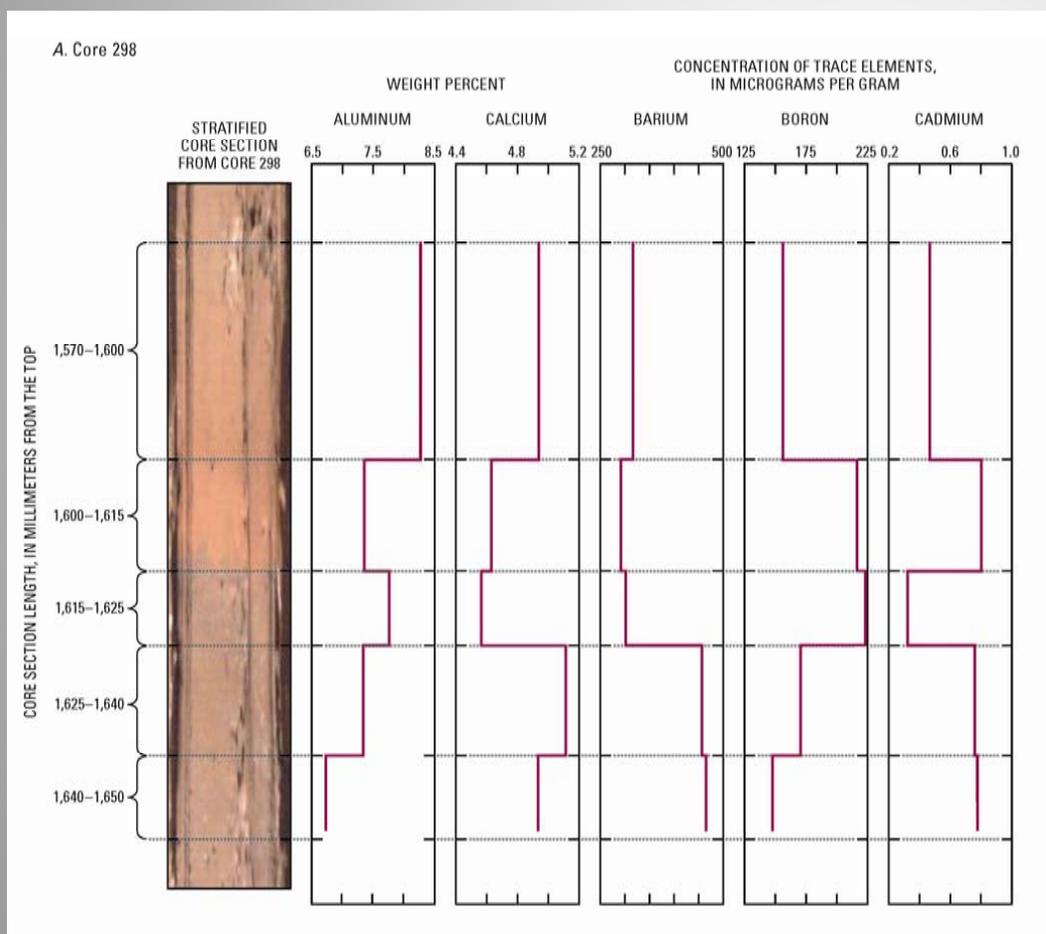
## “Colorado River Delta” Study



- Major elements concentrations were typical for delta sediments
- Trace elements concentrations were dependent on each element
- p,p'-DDE was the only halogenated organochlorine compound detected
- 19 parent PAHs were detected in concentrations above the LDL
- Gross alpha and gross beta radionuclide activities ranged between 11 and 18 pCi/g

# Results

## “Colorado River Delta” Study

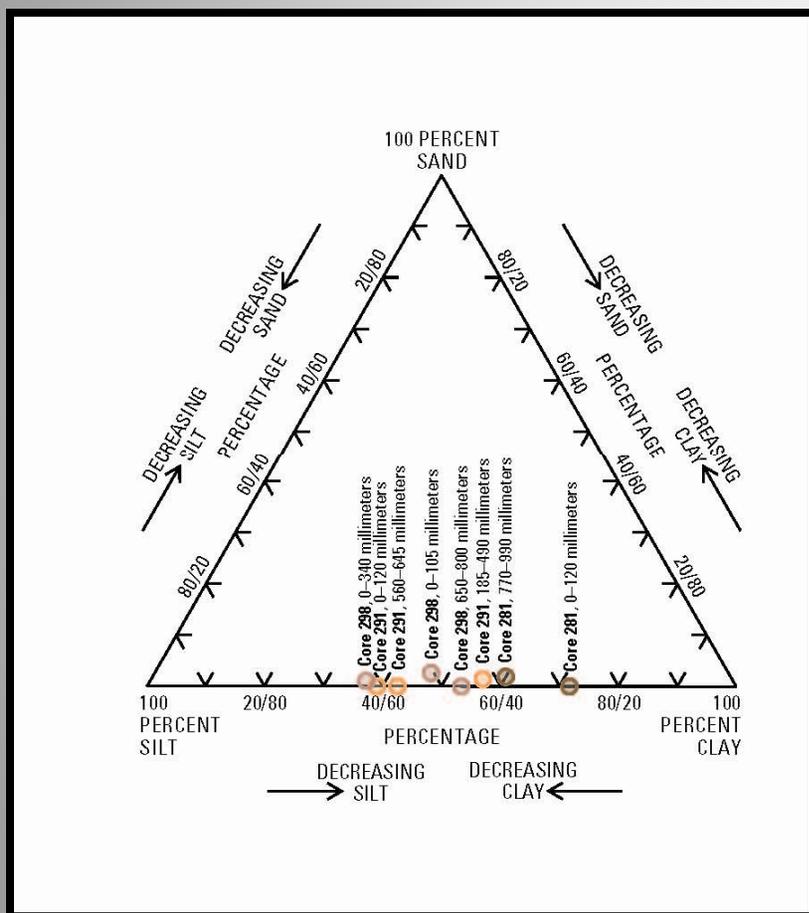


Chemistry varied in the cores dependent on sediment types



# Results

## “Colorado River Delta” Study



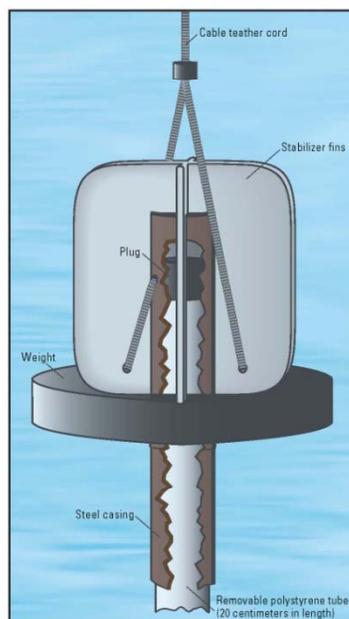
- Predominant particle sizes were silt and clay
- 99% of each sample had particle sizes  $\leq 0.0625$  mm
- 43% or more particles were  $<0.0004$  mm

# Results

## “Colorado River Delta” Study

### Pore water and Sediment-Water Interface

- Concentrations of metals in pore water - lower than sediment-water interface
- U and Se concentrations tended to be higher in pore waters



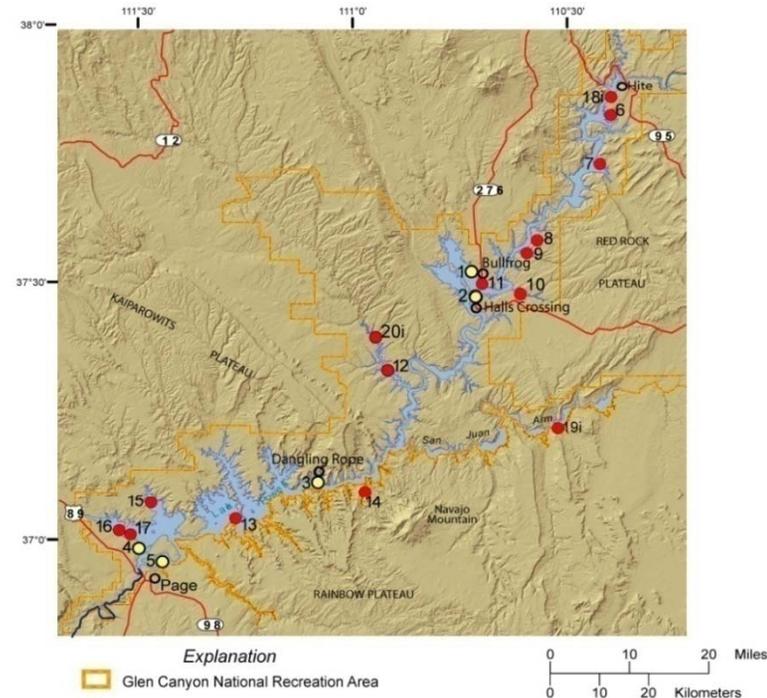
Modified core sampler for collection of Pore waters and sediment-water interface

# “Sentinel Sites” Study

- 20 Sites
- To establish base-line water-quality data
- To determine the changes in water quality
- To identify chemical and biological constituents that will serve as potential indicators of water quality



# “Sentinel Sites” Study



Site Number	Site Name	Site Number	Site Name
<b>Marinas</b>			
1	Bullfrog Marina	11	Stanton Creek
2	Halls Crossing Marina	12	Escalante River
3	Dangling Rope Marina	13	Padre Bay nr Dominquez Butte
4	Wahweap Marina	14	Rainbow Bridge
5	Antelope Marina (in operation 2005)	15	Warm Creek Bay
		16	Lone Rock
		17	State Line
<b>High-Use Sites</b>			
6	Farley Canyon	<b>Other Sites</b>	
7	Blue Notch	18i	Colorado River Inflow
8	Knowles Canyon	19i	San Juan River Inflow
9	Forgotten Canyon	20i	Escalante River Inflow
10	Moqui Canyon		

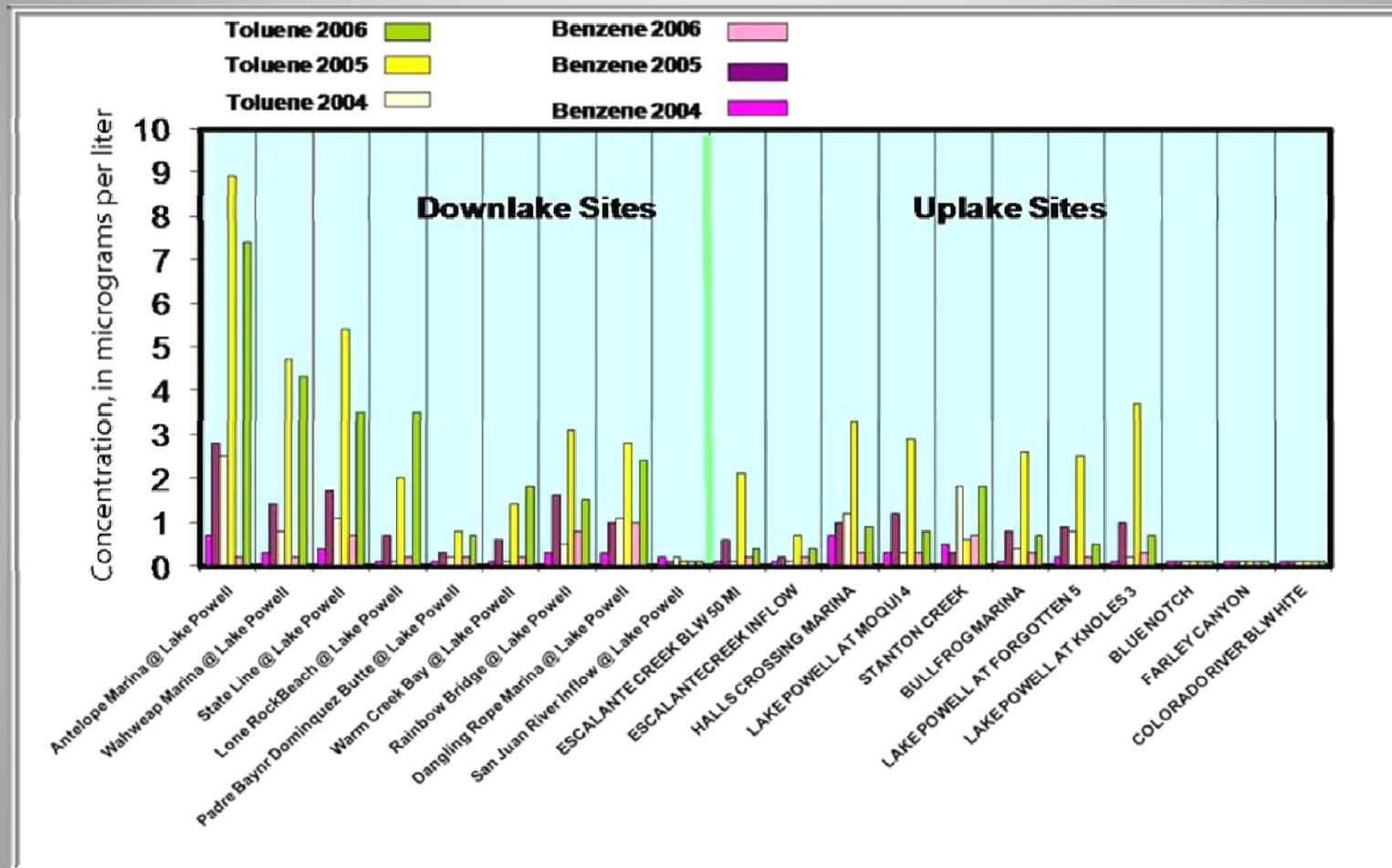


## Type of Sites

- 5 marinas
- 12 high-use sites
- 3 major inflow sites

# Results

## “Sentinel Sites”



# Results

## “Sentinel Sites”

### PAHS at Selected Sites

- **Lone Rock Beach**
  - 2,6-Dimethylnaphthalene
  - Isomers of naphthalene
- **San Juan Inflow**
  - Fluoranthene
  - Phenanthrene
  - Benzo [a] anthracene
  - Benzo [b] fluoranthene
  - Benzo [e] pyrene
  - Benzo [ghi] perylene
  - Benzo [k] fluoranthene
  - Isomers of naphthalene and anthracene
- **Wahweap Marina**
  - Isomers of naphthalene



# Future Plans

- Determine the potential for biota to bioaccumulate PAHs
- Determine the presence and distribution of contaminants in delta sediments of the Escalante and San Juan Rivers



# “Bioaccumulation” Study

- Sediment (lakebed) samples will be collected at 20 sites
  - Organic and inorganic analysis
- Water samples will be collected at 20 sites
  - PAHs, VOCs and inorganic constituents
- Semi-permeable membrane devices will be deployed at 20 sites
  - Three, 36 inch SPMDs will be deployed at each site



SPMD canister and lipid membranes

# “Sediment Quality” Study

## San Juan and Escalante River Deltas

- Deep and shallow cores
- Overlying sediment-water interface and pore water
- Trace elements, majors, organic carbon, and semi-volatile organics
- Grain-size analysis



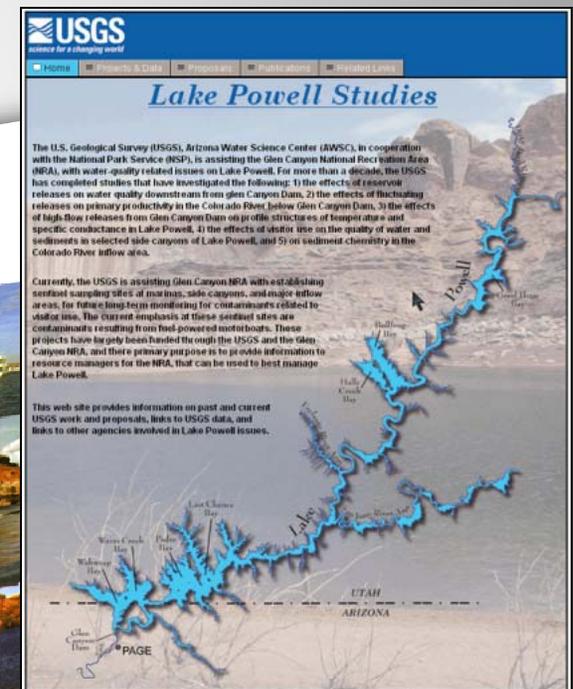
# Future Monitoring Goals

- Repeat visits and sampling at the 20 sampling
- Continue to characterize sediment chemistry at selected sites
- Establish permanent data-collection platforms to collect selected depth-profile water-quality data, velocity data, and meteorological data



# Products

- Sediment Chemistry of the Colorado River Delta of Lake Powell, Utah, 2001
- Physical and Chemical Characteristics of Knowles, Forgotten, and Moqui Canyons, and Effects of Recreational Use on Water Quality, Lake Powell, Arizona and Utah 2000-02
- A Monitoring Plan for the Occurrence of Hydrocarbon Constituents In Lakes Powell, Mead, and Mohave, Arizona, Nevada, and Utah 2004
- Interactive WEB Page



# Thank you

