Deep Creek Lake Introduction

Sediment Calculations and Reduction Strategies

Garrett County, MD
April 7, 2014

Richard Ortt -- Resource Assessment Service

410-554-5541 / rortt@dnr.state.md.us

Meeting Goals

- Discussion of what has happened with the Analysis of Sediment in Deep Creek Lake

- Discuss alternatives analysis and sediment reduction strategies.

Completed Work

- 2008 – USGS Study
  - Radionucliede study of 5 cores in DCL documented sediment amounts varying between 4 and 12 inches.
- September 2011
  - Analyzed 10 Coves for sedimentation using current bathymetric depths and depths documented on a 1970 bathymetric chart.
  - Four of the Ten sites demonstrated some degree of sedimentation
  - Report Published
- October 2011
  - Collected 50 surficial sediment samples.
  - Analyzed for physical properties, elemental properties, and nutrients.
  - Report Published
- April 2012 – March 2013
  - Sub-Bottom Seismics collected at 50 meter transects throughout the lake; with the exception of 100 m transects collected in the large open areas.
  - Current Bathymetry collected along the same sub-bottom seismic lines
  - Complete sidescan sonar imagery collected of the Lake
  - Complete gps referenced shoreline video inventory
  - Collected 42 Sediment cores
  - Sediment is mapped spatially throughout the Lake

Completed Work (continued)

- March 2013 – November 2013
  - Radionucliede study of 4 cores by University of Maryland confirming MGS observations and measurements.
- July 2013 – December 2013
  - Alternatives Analysis
    - Economic Analysis
    - Environmental Analysis
    - Recreational Analysis
    - Cultural Analysis
  - Best Management Practices Development
    - HOA/Retrofit design plans to be integrated within the watershed
    - Property owner pamphlet for sediment/nutrient reduction
- December 2013-January 2014
  - State and Local Government review of findings

Deep Creek Lake Sediment

Preliminary Assessment

Historical Data (Very Little)
Reconnaissance Survey (Sep 2011)

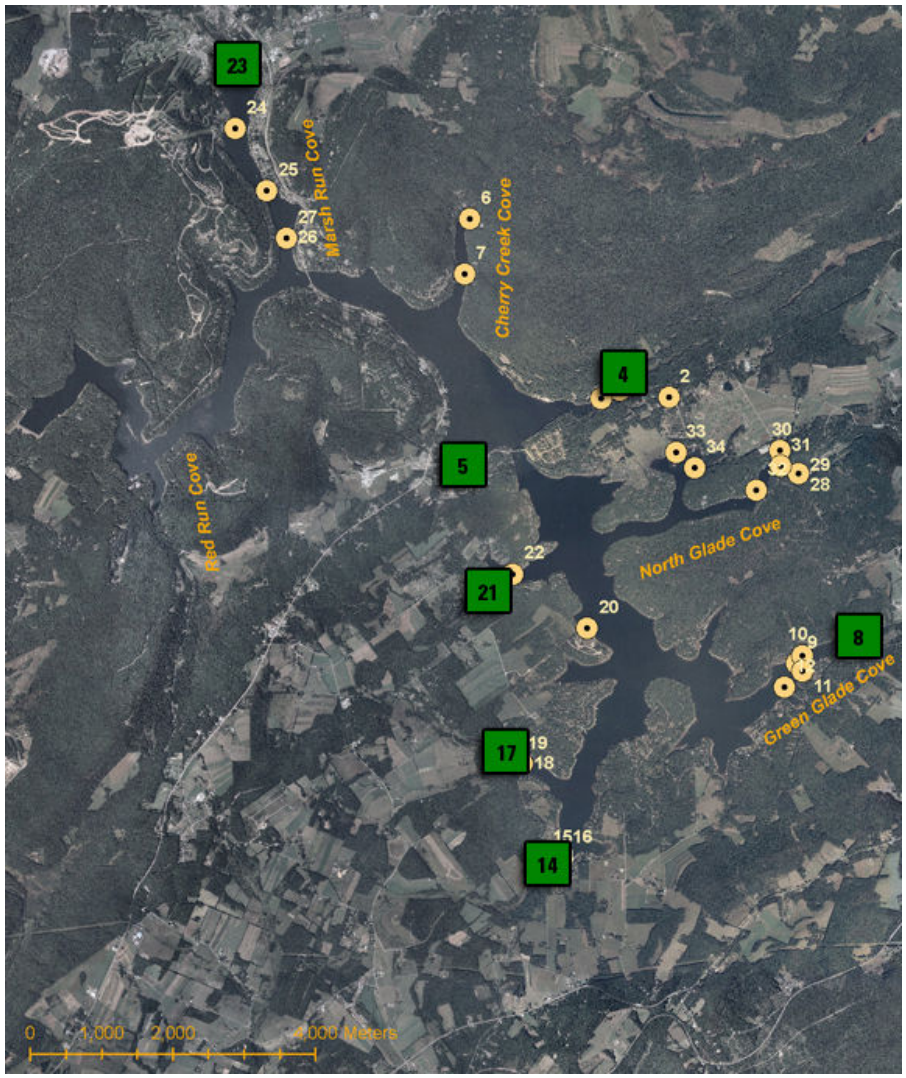
Deep Creek Lake Sediment

2008 USGS Sedimentation Study

Determination of Sedimentation Rates and selected dates using collected field cores and Cesium Dating

USGS Calculated Sediment Thickness between 1963 and 2008

Core	Sediment Thickness (Inches)
4	11.9
8	11.6
17	4.5
21	4.03
23	6.1



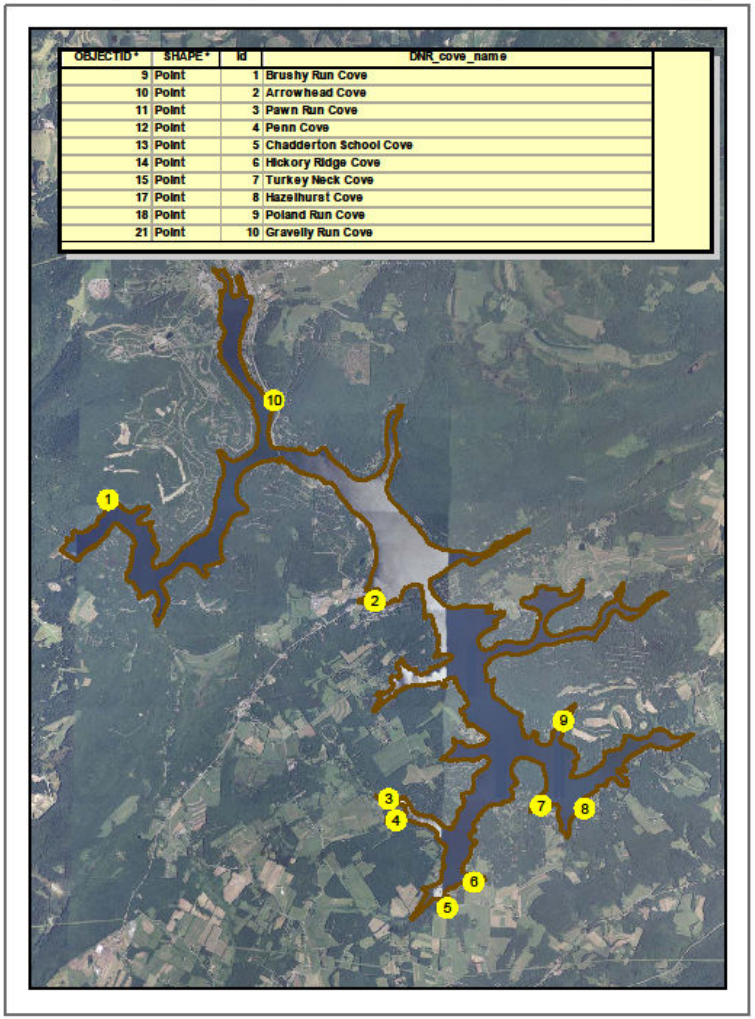
Deep Creek Lake Sediment

September 2011 DNR Selected Study Sites

- **Ten Study Sites were collected based on land use, slope, soil types, sub-watershed size, and State Park Manager concerns**

- **These sites were studied to assist in focussing additional efforts. They should not be viewed as the only coves where there were sediment concerns.**

Deep Creek Lake -- Selected Coves for Sediment Study

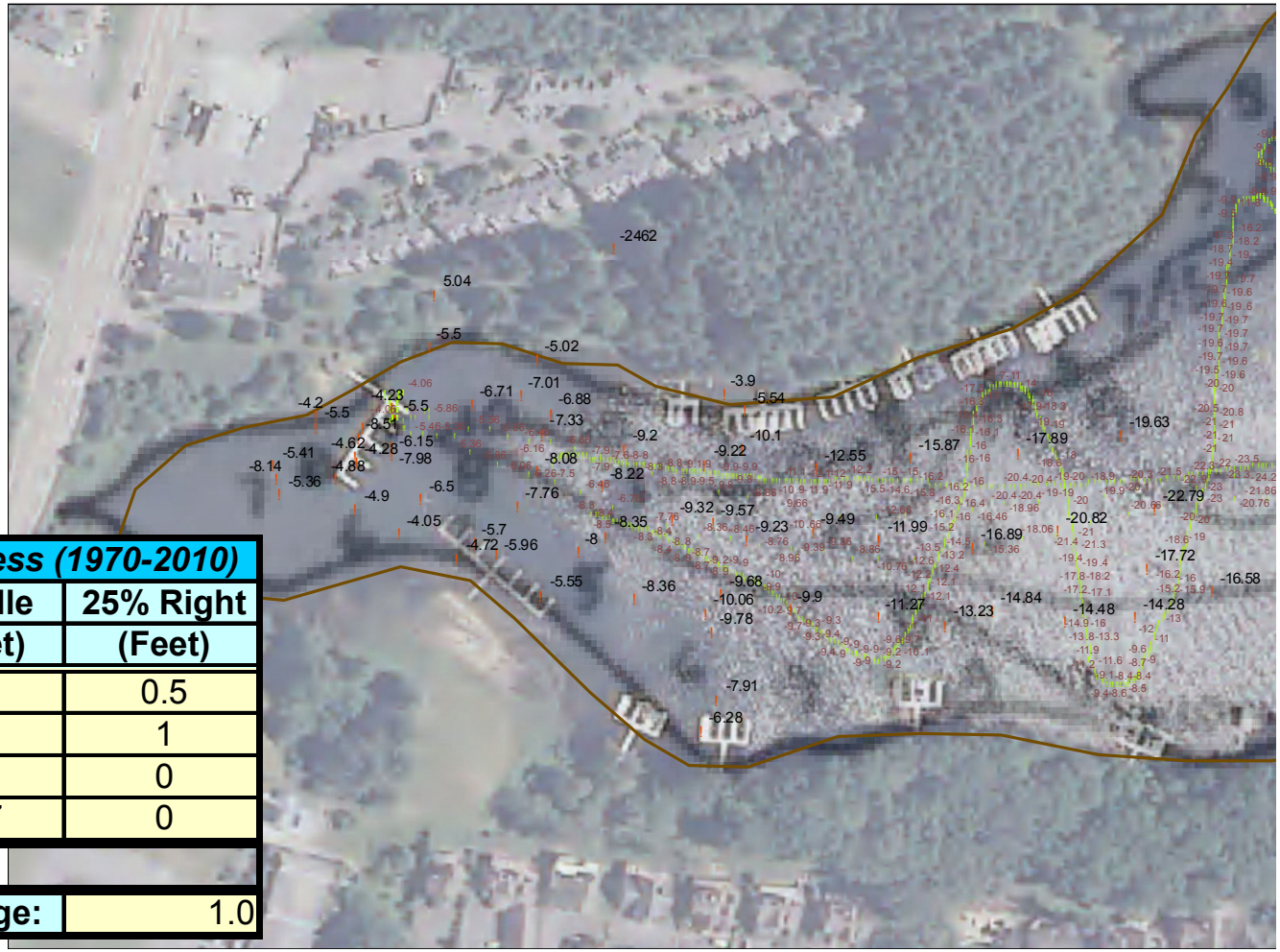


Deep Creek Lake Sediment

Site 2

Arrowhead Cove

Deep Creek Lake
Detail of Site 2
Arrowhead Cove



Estimated Sediment Thickness (1970-2010)			
Transect (Feet)	**25% Left (Feet)**	**Middle (Feet)**	**25% Right (Feet)**
150	0.5	0	0.5
300	3	3	1
600	1	2	0
900	0	0.7	0
Maximum:	3.0	**Average:**	1.0

Summary of Results

- Erosional Sites—Mean observed changes < -0.5 feet accumulation:
  - Site 1 (Brushy Run)
  - Site 10 (Gravelly Run Cove)
- No Change—Mean observed changes between -0.5 and 0.5 feet:
  - Site 6 (Hickory Ridge Cove)
  - Site 7 (Turkey Neck Cove)
  - Site 8 (Hazelhurst Cove)
  - Site 4 (Penn Cove)
- Depositional Sites – Mean observed changes > 0.5 feet accumulation
  - Site 5 (Chadderton School Cove)
  - Site 2 (Arrowhead Cove)
  - Site 3 (Pawn Run Cove)
  - Site 9 (Poland Run Cove)

Generalized Results

- Where sedimentation is occurring, it is occurring between 0 and 900 feet from the cove headwaters. Analysis beyond 900 feet shows very little accumulation, and where present, it is confined to significant depths (>20 feet depth).

- In relation to water depth, the *highest* percentage of water depth lost at observed locations is:

  - 38% (3 feet in 8 feet) in Chadderton Schoolhouse
  - 33% (3 feet in 9 feet depth) in Arrowhead Cove
  - 28% (2.5 feet in 9 feet) in Poland Run
  - 15% (1.5 feet in 10 feet) in Penn Cove
  - All other sites demonstrate less than a 5% loss of water depth.

DNR Issued Sediment Management Plan (Secretary Signed –2011)

- Goals of Plan
  - **Identify the accumulated sediment**
  - **Understand the environmental relationships**
  - **Analyze the alternatives (Alternatives Analysis)**
  - **Reduce sediment input**

- Vetted Plan throughout Leadership Team
- Distributed to POB, Garrett County, etc.

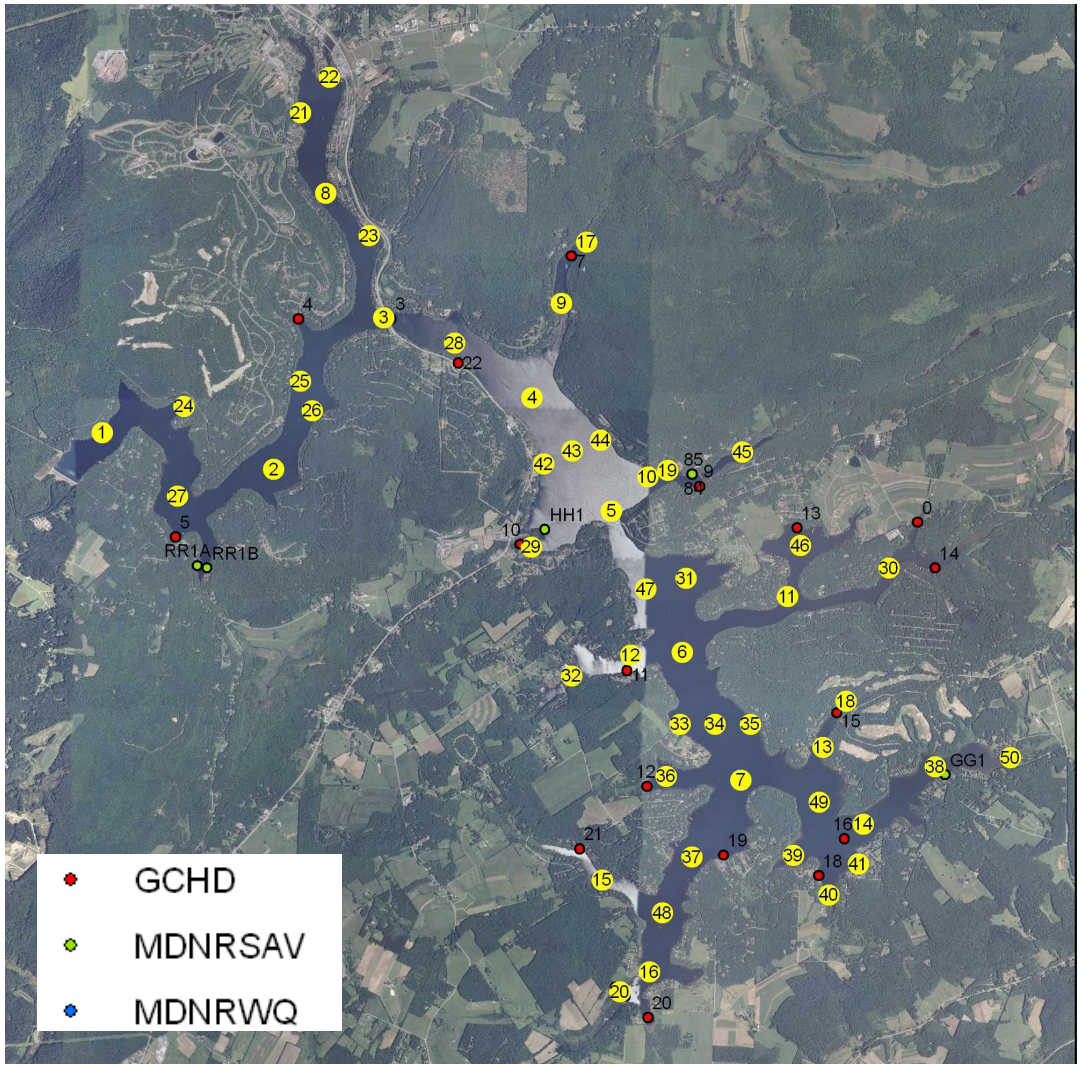
Deep Creek Lake Sediment

Sediment Character

50 Surficial Samples collected in 2011

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Deep Creek Lake Sediment



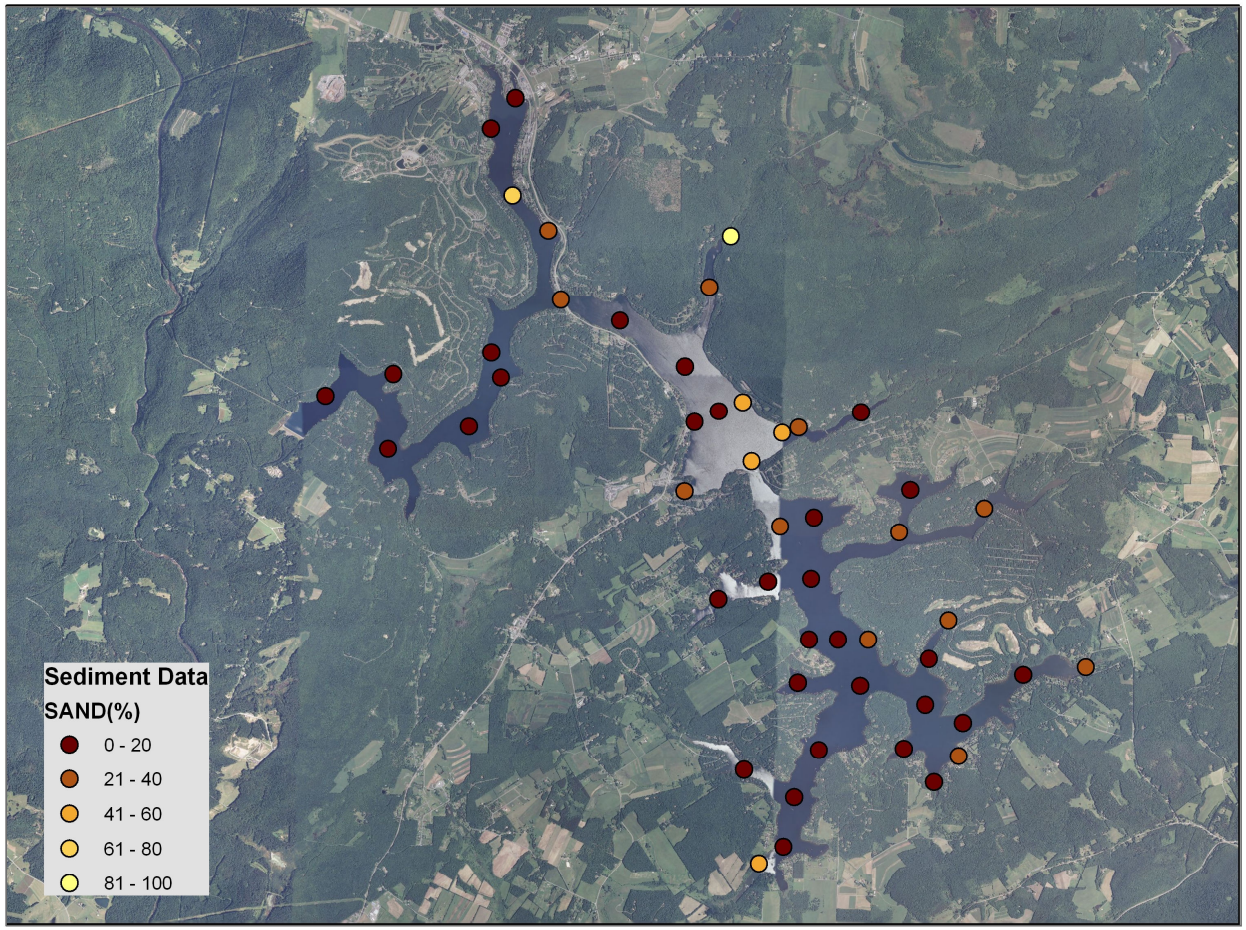
Sediment Sample Locations

- Fifty (50) sediment grab samples were collected Oct. 2011 (Yellow Dots).
- Sites selected to achieve spatial coverage; some sites located at Md DNR WQ and SAV monitoring stations and Garret County Health Dept. Stations.
- Sediment Analyzed for physical properties, elemental properties, and nutrients.

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Deep Creek Lake Sediment

Deep Creek Lake -- Sediment Samples



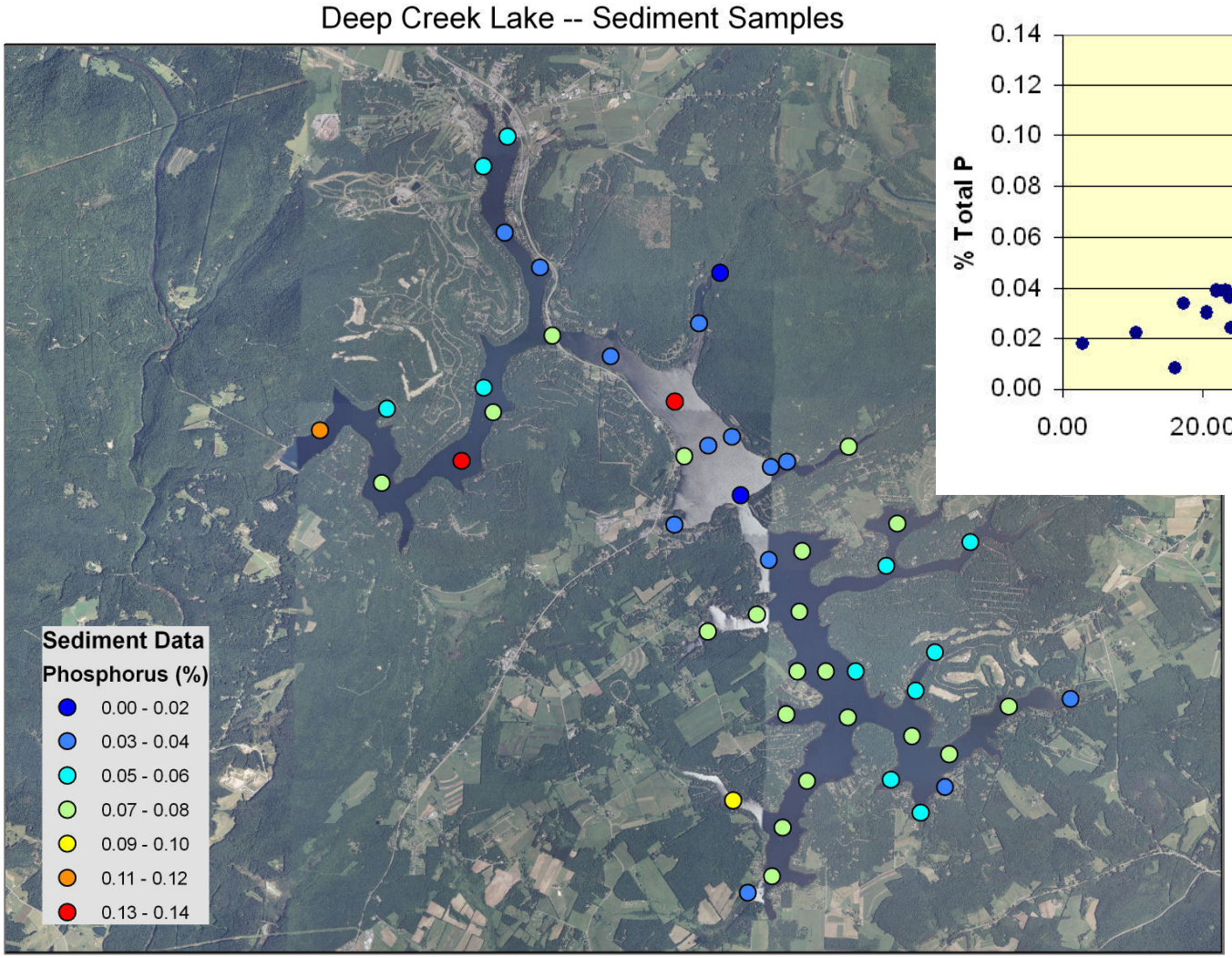
Sediment Types

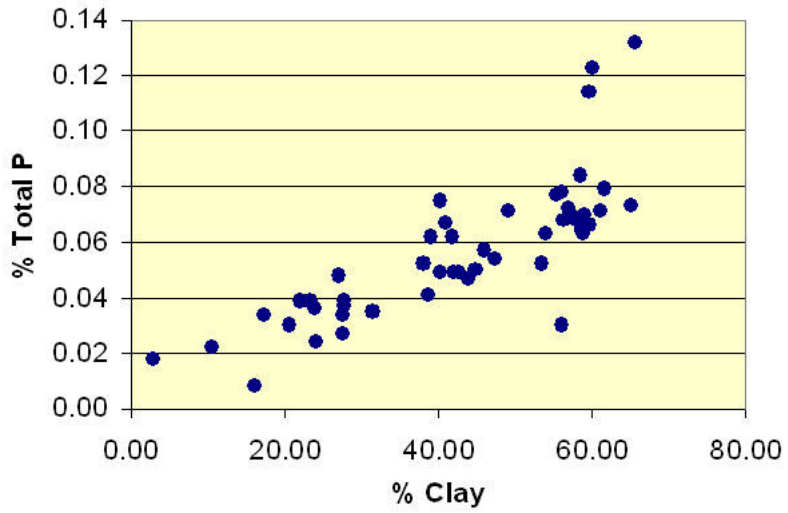
- Sediments descriptions ranged from black, smooth mud to reddish brown gritty mud.
- Average textural content: 18%Sand; 39%Silt; 43% Clay

Classification	#
Sand	1
Silty-Sand	3
Sand-Silt-Clay	14
Clayey-Silt	8
Silty-Clay	24

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Deep Creek Lake Sediment





Total Phosphorus

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Deep Creek Lake Sediment

Element	New Germany	Deep Creek	Triadelphia	Rocky Gorge	Loch Raven
P	0.62	**0.75**	1.06	0.88	
Cd	0.9	**8.90**	4.93	1.89	0.28
Cr	1.05	**1.19**		0.93	1.62
Cu	0.52	**0.62**	0.83	0.95	0.85
Mn	0.50	**0.94**	1.09	1.45	1.25
Ni	0.69	**0.91**	0.80	0.77	0.86
Pb	3.46	**5.24**	4.26	3.83	4.35
Zn	2.62	**4.09**	1.98	1.92	2.87
Al	1.24	**0.94**	0.78	1.27	
As	9.13	**15.61**		3.61	
Ce	1.88	**2.21**		2.41	
Co	0.87	**2.13**	1.74	1.17	
Cs	2.99	**3.54**		1.87	
Eu	1.83	**2.16**		2.56	
Hf	6.77	**7.48**		3.79	
Sb	10.64	**24.41**		3.19	
Ti	0.94	**1.05**		1.21	
U	3.10	**2.32**		1.64	
V	0.78	**0.85**	1.09	1.00	

Enrichment Factors

Average Enrichment Factors (EF0 of select metal for fresh water reservoirs in Maryland. EFs are based on Fe as normalization element.

$$EF_{(X)} = \frac{(X/Fe)_{sample}}{(X/Fe)_{reference}}$$

where:
***EF(x)* is the enrichment factor for the metal X;**
***X/Fe(sample)* is the ratio of the concentrations of metal X to Fe in the sample;**
***X/Fe(reference)* is the ratio of the concentrations of metal X to Fe in a reference material, such as an average crustal rock**

Reference is Taylor's 1964 average continental crust element abundance

Summary

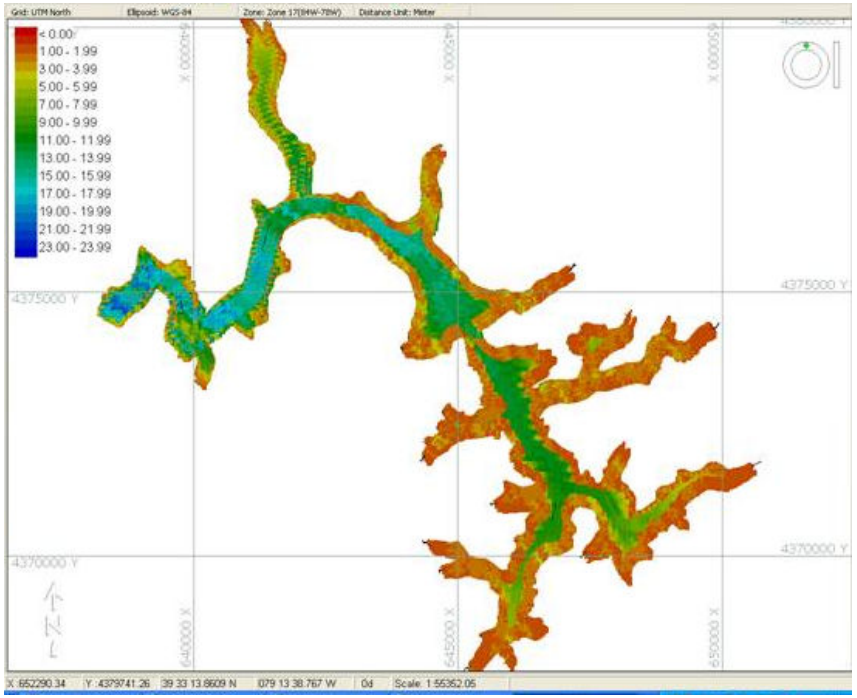
- Surficial sediments are primarily fine-grained, ranging for silty clays to clayey silts
- N and P appear average for lacustrine sediments
- Reactive carbon accounts for 70% of total carbon;
- Source of reactive carbon may be from primary productivity based on Redfield ratios with N and P
- Sulfur is high in some sediments, which may contribute to increase release of P from sediments, which, in turn, may increase primary productivity
- Concentration and enrichment of most metals are within normal range given geology

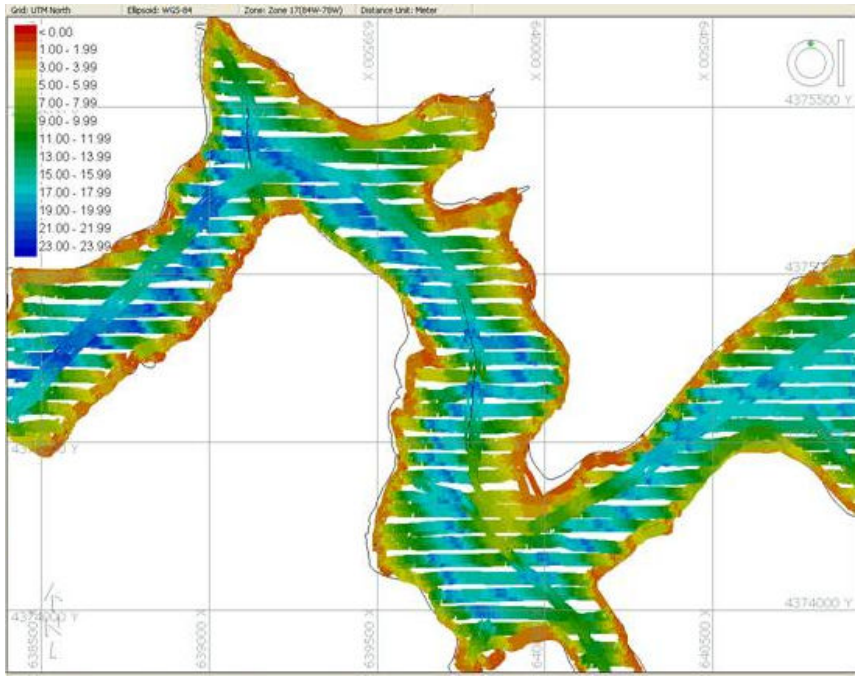
Sediment Mapping

Garrett County, MD
April 2012

Deep Creek Lake Sediment

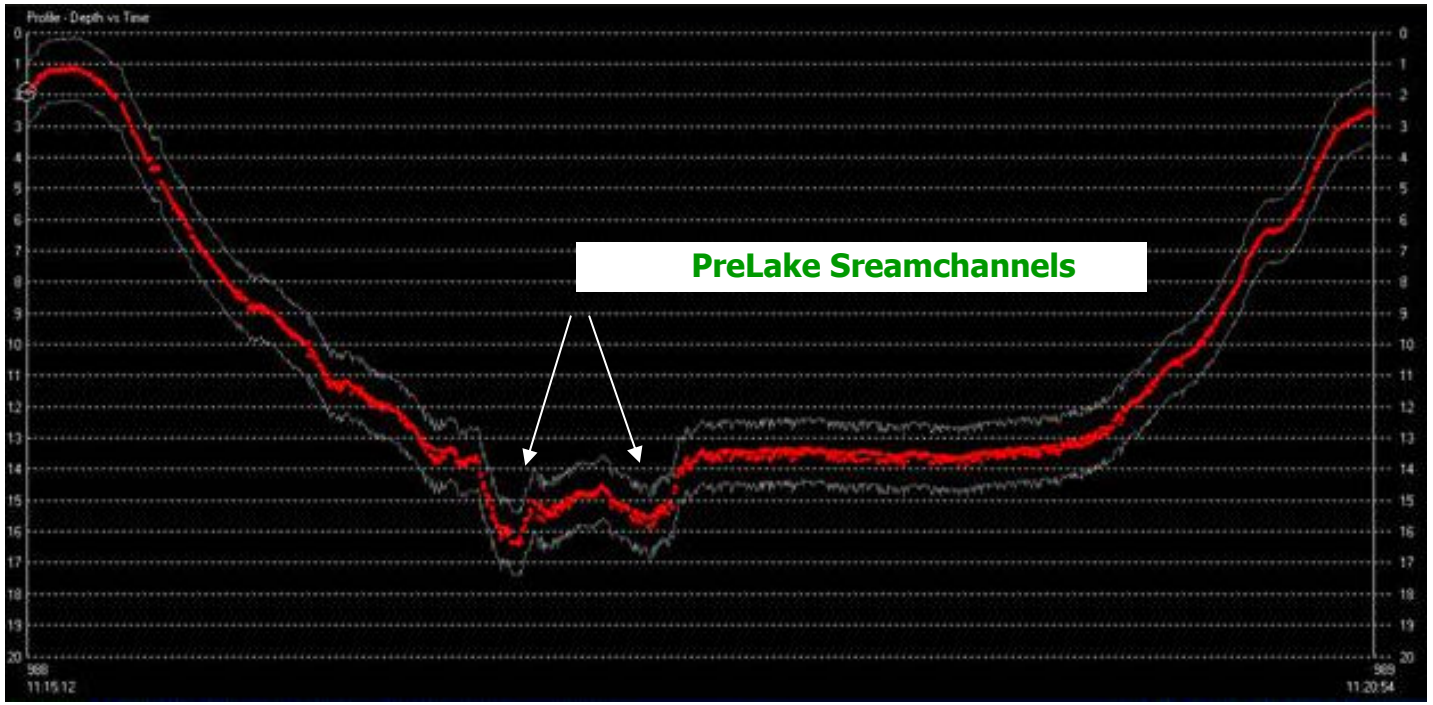
Sub-Bottom Seismic and Bathymetry Survey Coverage





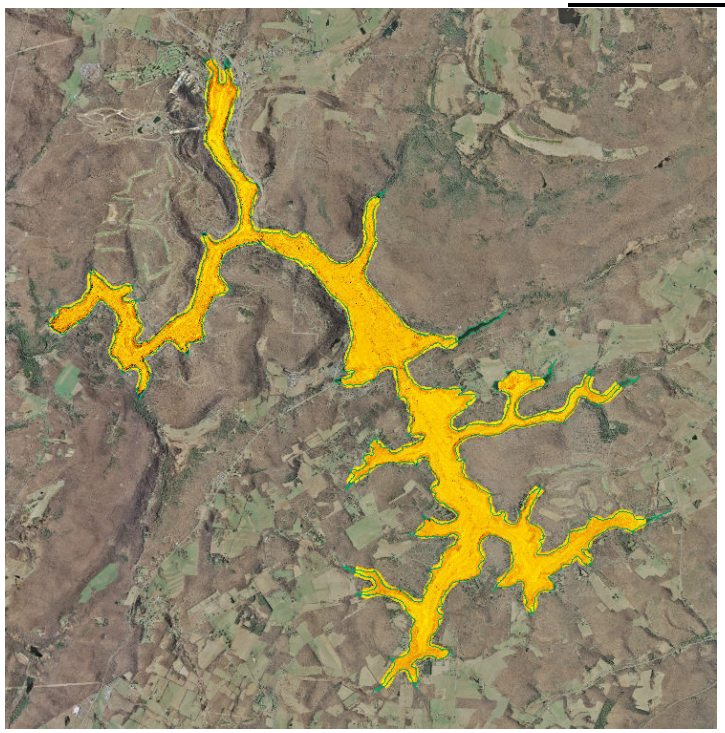
- **Transects were collected every 50 meters shoreline to shoreline**
- **Cross transects were run to validate data**
- **Shoreline runs were collected to obtain shallow water coverage and to tie in the shoreline areas between transects**

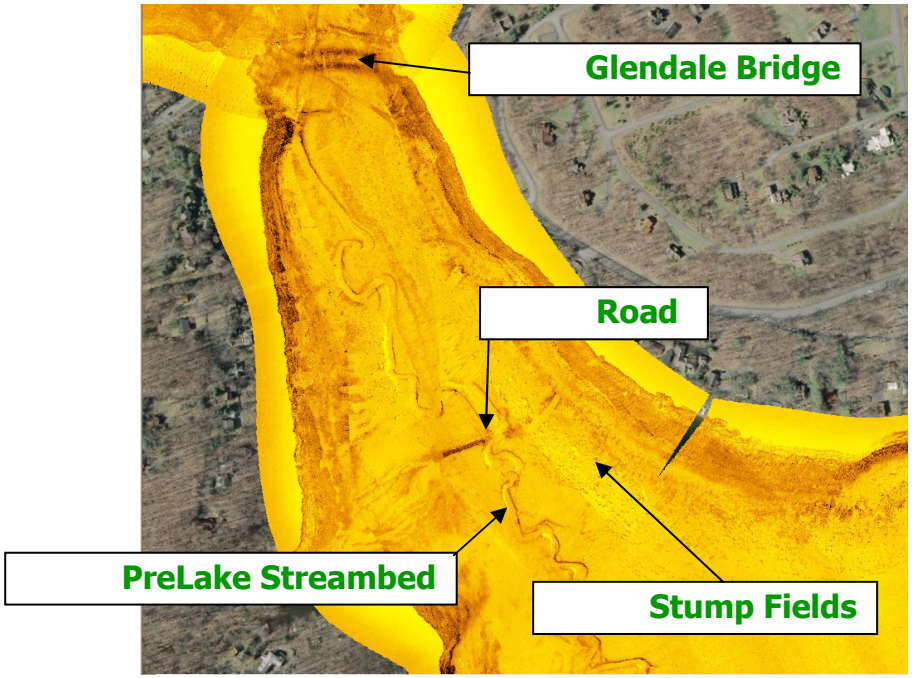
Bathymetry



- Soundings were taken twice a second
- Soundings have been adjusted for speed of sound in water, transducer offset, and lake level changes.
- Over 600,000 data points remain after QA/QC.
- Data has been used to create a three dimensional model of the current lake bottom for comparison with historical data

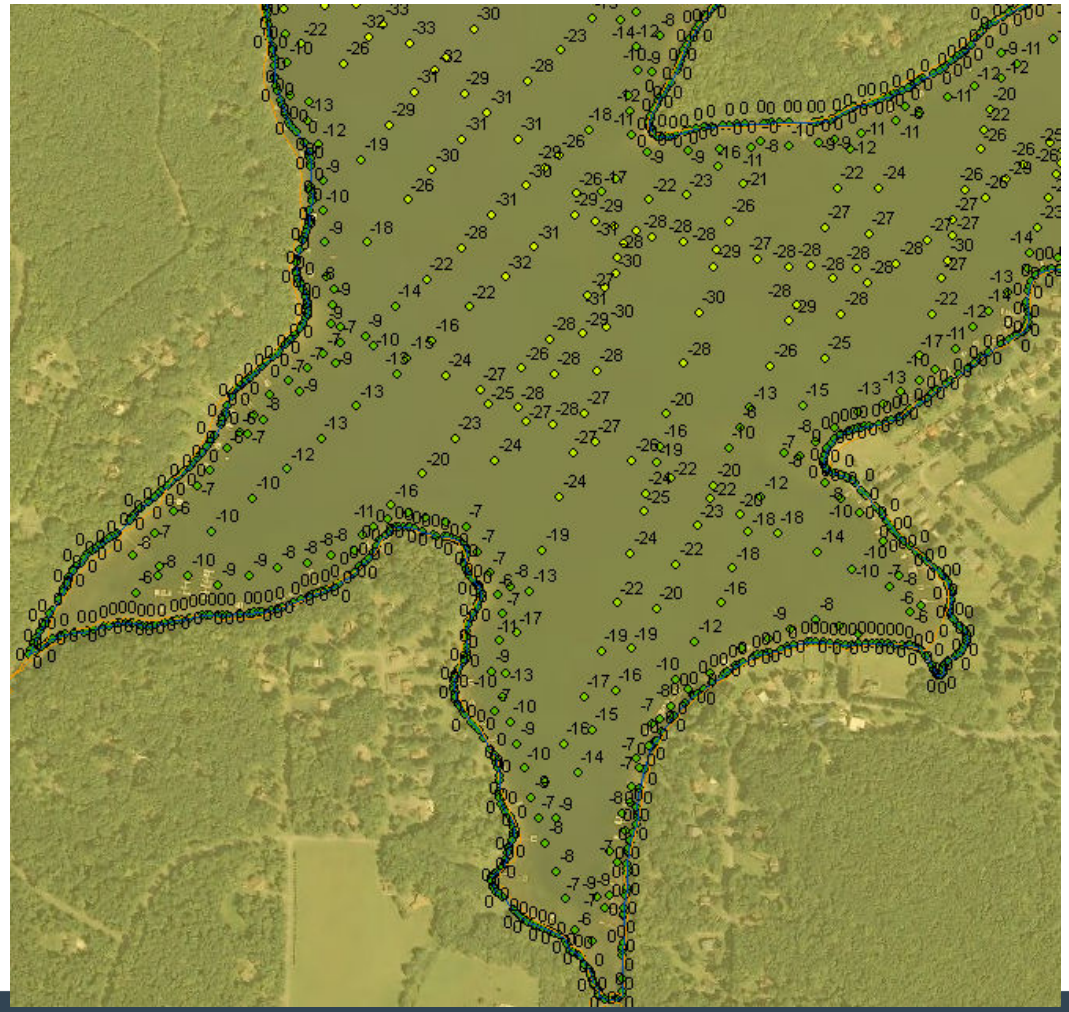
Sidescan Imagery





- 99.5% coverage of Lake was collected
- Original stream meanders/oxbows, stump fields, foundations, bridges, roads, etc. are visible.
- Divers have visited several sites to measure sediment buildup on foundations and roadbeds.

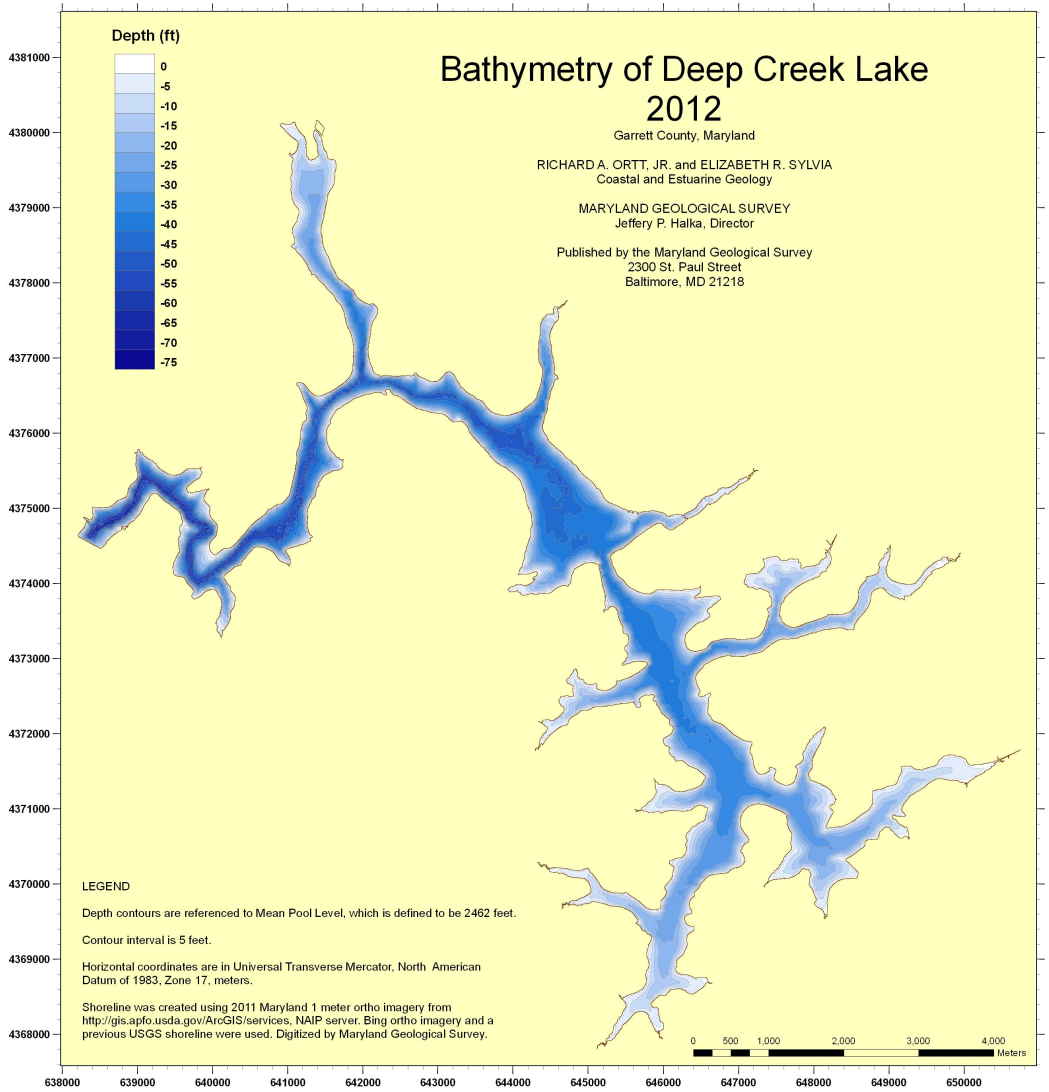
GIS/Historical Maps



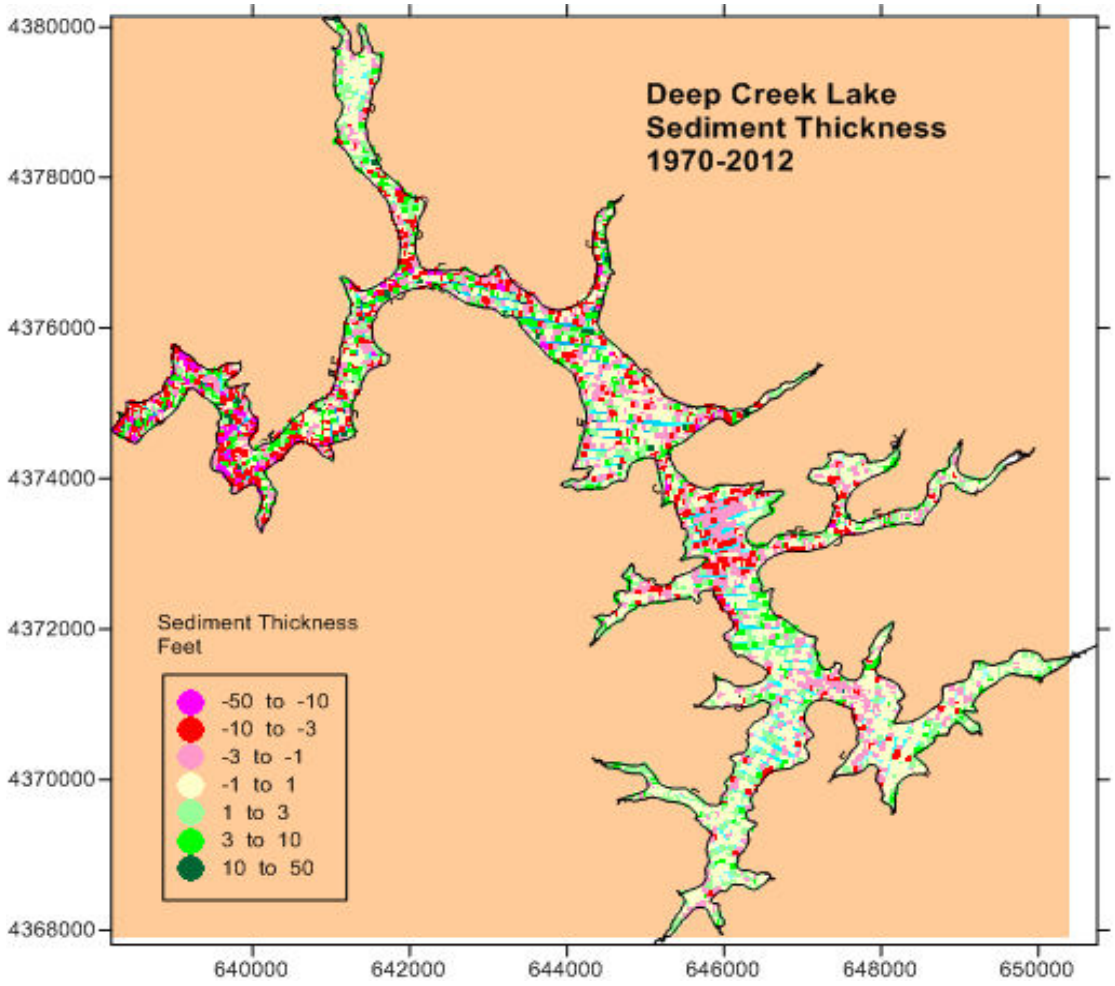
- **Historical Data has been georeferenced and digitized**
- **Data has been made into a three dimensional model for further comparison**
- **Historical Aerial photography of the lake and surrounding watershed has been incorporated into a GIS to observe changes (1938, 1946, 1952, and 1962)**

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Deep Creek Lake Sediment

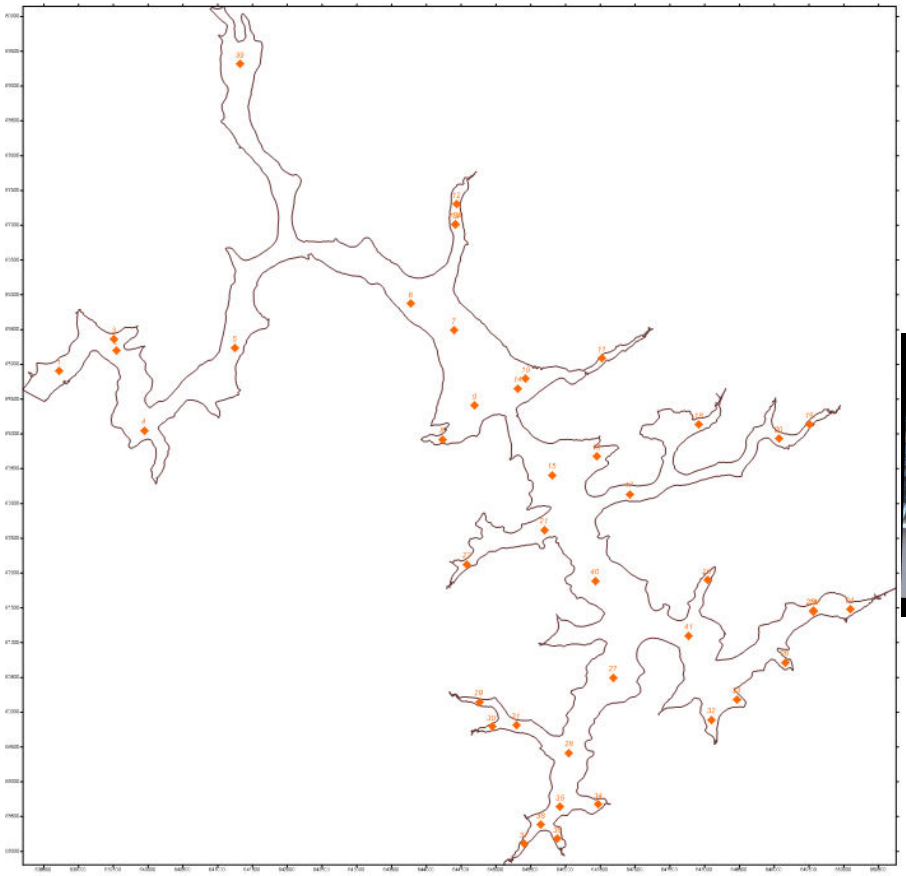


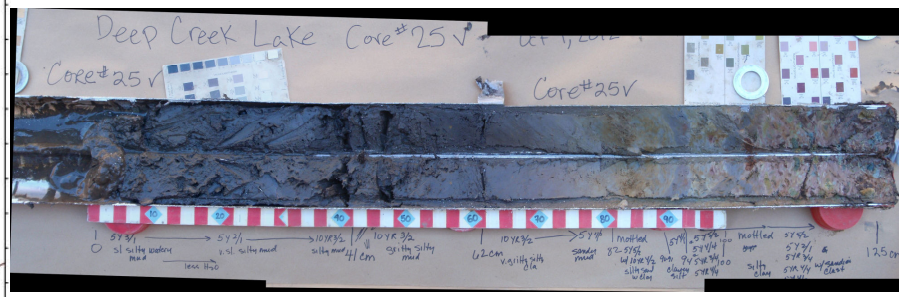
Deep Creek Lake Sediment



- Spatially mapped sediment distribution created from bathymetry, coring, sub-bottom seismics, and sidescan sonar imagery
- Southern end of Lake displays greater sediment deposition, generally in the 1 to 2.5 foot range.

Sediment Cores





- 42 Cores collected throughout lake
- Core lengths ranged from 0 (Rock confirmation) to 7 feet in length. The average collected length of each core was 3 feet.
- Cores were described, photographed, and sampled. Select samples were analyzed for pollutants, chemical properties, and physical properties.
- No pollutants were detected in samples.

Measured Sediment Accumulation

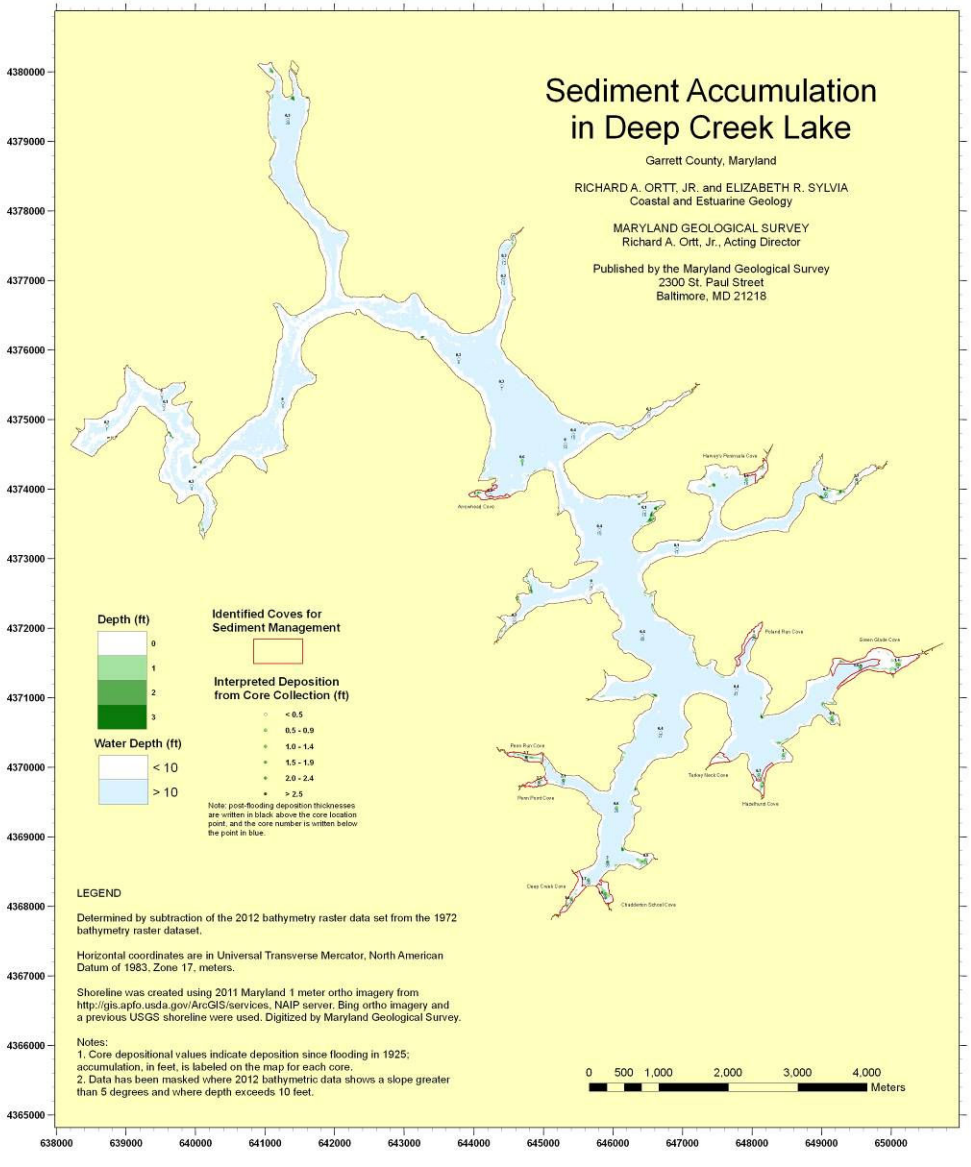
- 42 Cores were collected throughout the Lake
- **Accumulated Sediment thicknesses from Lake construction to 2012 varied from 0 feet to 2.7 ft with an average of 0.5 feet.**
- Typically accumulated sediment depths were greater in southern coves.

RadioDating of Sediments (UMD)

- To confirm and have a second authoritative source of sediment depth we contracted with UMD to test four cores.

Core #	MGS Mapping Accumulation Est. (ft)	MGS Measured Accumulation (ft)	UMD Measured Accumulation (ft)	
19	2.2	2.1	0.9	
25V	2.6	2.0	2.0	
29	2.7	2.7	1.6	
37	1.6	1.4	1.4	

Deep Creek Lake Sediment



Ten Coves Identified as having sediment accumulations greater than 1 foot in areas shallower than 10 ft water depth at full pool level.

- Pawn Run (2.7 ft)
- Penn (2.3 ft)
- Green Glade (1.4 ft –2.0 at Depth)
- Chatterton Schoolhouse (1.8 ft)
- Deep Creek (1.6 ft)
- Harvey's Peninsula (1.3 ft)
- Arrowhead (1.0 ft)
- Poland Run (1.0 ft)
- Turkey Neck (1.0 ft)
- Hazelhurst (1.0 ft)

- No other areas identified as 1.0 feet or greater sediment accumulation

Alternatives Analysis

- Analysis of no dredging, mechanical dredging (wet and dry), and hydraulic dredging was performed.

- Criteria evaluated included:
  - recreational use benefits/cost
  - environmental costs/benefits
  - economic costs/benefits
  - community costs/benefits

DEEP CREEK LAKE SEDIMENT STUDY - DECISION MATRIX

Environmental Impacts - Fish, Benthic, SAV, and Invasive were examined specifically. There are many species contained in each of these.

Economy - Economic Impact to Tourism, Hotel Occupancy, Service Industry, Rental Property, Property Value, and Local Economy

Recreation - The ability for Recreational Boating, Fishing, Whitewater Rafting, and Swimming to continue

Construction Cost - The relative cost compared to the other construction costs within the study which includes cost of ROW and Permitting

Impacts	Weighing Factor	Impacts of Hydraulic Dredging		Impacts of Mechanical (Wet) Dredging		Impacts of Mechanical (Dry) Dredging		No Dredging
		March to Memorial Day	Labor Day to December	March to Memorial Day	Labor Day to December	March to Memorial Day	Labor Day to December	
Environmental Impacts	**20**							
Fish	5	1	1	3	2	2	1	5
Benthic	5	1	1	3	2	2	1	5
SAV	5	1	1	3	2	2	1	5
Invasive	5	1	1	3	2	2	1	5
Economy	**20**							
Economic Impact	10	5	5	5	5	4	4	1
Stimulate Local Economy	10	3	3	3	3	5	5	1
Recreational Impact	**20**							
Recreational Boating	5	4	4	2	2	1	1	5
Fishing	5	4	4	2	2	1	1	5
Whitewater Rafting	5	4	4	2	2	1	1	5
Swimming	5	4	4	2	2	1	1	5
Construction Cost	**20**							
Capital Costs	15	3	3	1	1	2	2	5
ROW	5	2	2	1	1	1	1	5
Permitting	0	1	1	3	2	2	1	5
TOTAL		**235**	**235**	**200**	**180**	**185**	**165**	**320**

High Score = Best Case Scenario, Scoring as follows: 1 = Worst Negative Impact, 2 = Negative Impact, 3 = Neutral, 4 = Minimal/Positive Impact, 5 = No/Best Impact

Results

- DNR supports the findings of our independent contractor to not perform any mitigation on accumulated sediment.

- DNR is committed to work with the citizen-led Watershed management team to continue monitoring, restore streams, and to reduce sediment and nutrients to the Lake.

- Deep Creek Lake is a spectacular resource and DNR is committed to preserving this legacy.

No Dredging does not mean Do Nothing

- A Watershed Management Plan and various citizen-led committees have been assembled to identify and actively address many issues facing the Deep Creek Lake watershed. Results from this deliberate planning process will guide planning, restoration, and management decisions.

- DNR is committed to working with its partners to implement the recommendations related to sediment reduction strategies proposed for the Watershed Management Plan..

- DNR is committed to continue monitoring sediment within the Lake. Studies researching sediment load began last fall and shoreline erosion documentation will begin this summer.

- DNR will continue to monitor the Lake for SAV, fisheries, recreational use, sediment, water quality, and wildlife.