GIS Support to Monitoring an Estuarine Environment in Georgia

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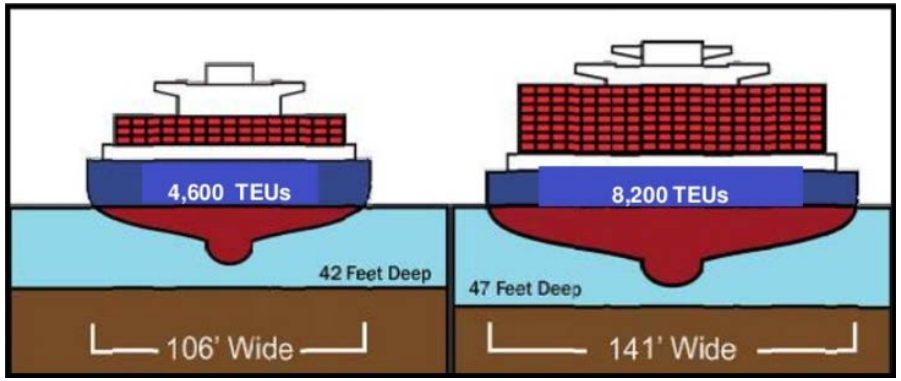
UNIVERSITY OF GEORGIA

US Army Corps of Engineers

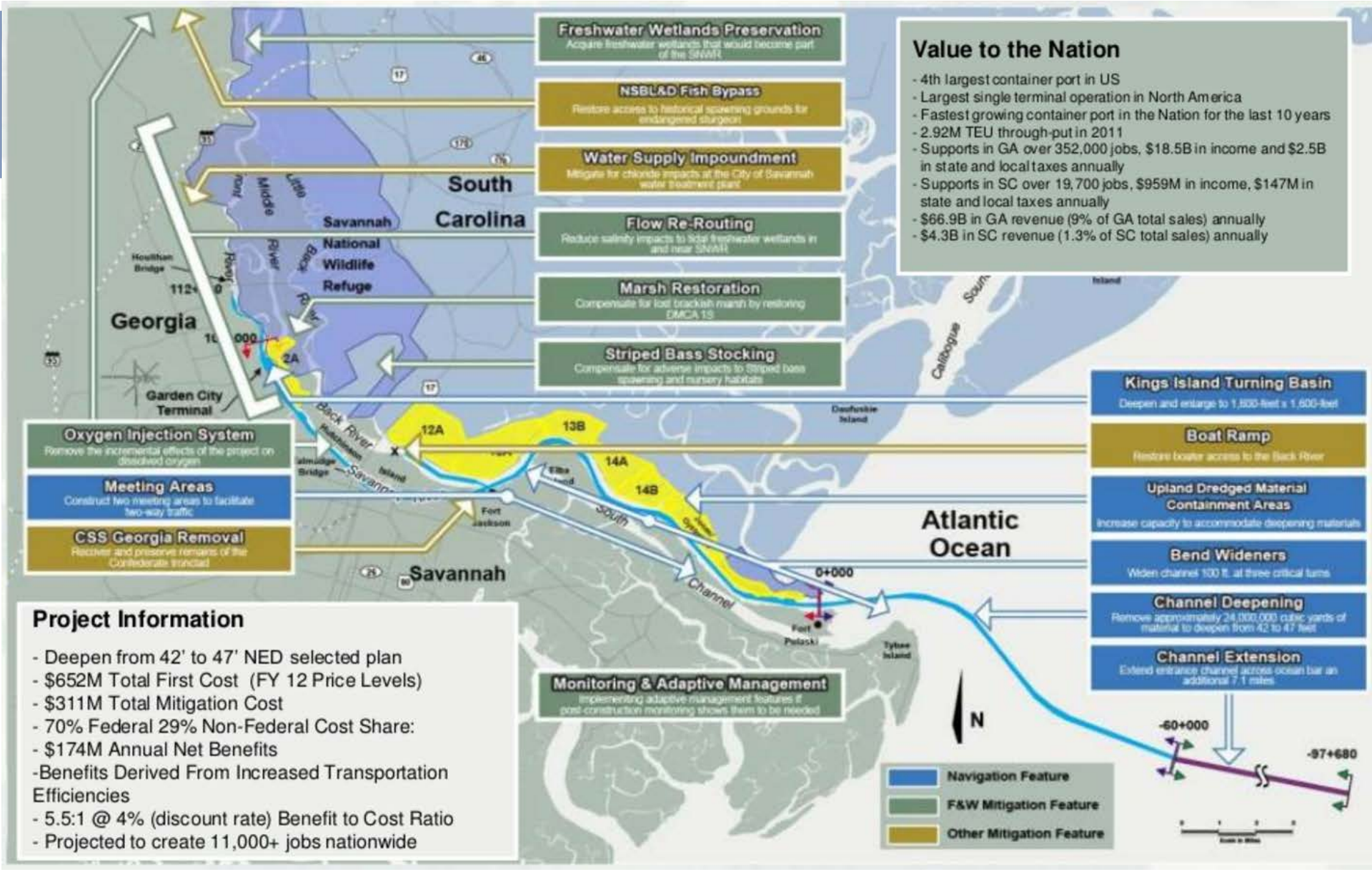
CGR Center for Geospatial Research

The Savavannah Harbor Expansion Project (SHEP)

- Garden City Terminal
  - 4th largest container port in US
  - 2nd largest container port on East Coast US
  - Largest single terminal in North America
  - Fastest growing container port in the Nation since 2001
- Deepen the Savannah Harbor shipping channel: from -42 feet to -47 feet
- Enables larger and more heavily-loaded vessels to call on the harbor
- Fewer tidal delays
- Panama Canal expansion



http://www.sas.usace.army.mil/Missions/Civil-Works/Savannah-Harbor-Expansion/


Freshwater Wetlands Preservation
Acquire freshwater wetlands that would become part of the SNWR
NSBL&D Fish Bypass
Restore access to historical spawning grounds for endangered sturgeon
Water Supply Impoundment
Mitigate for chloride impacts at the City of Savannah water treatment plant
Flow Re-Routing
Reduce salinity impacts to tidal freshwater wetlands in and near SNWR
Marsh Restoration
Compensate for lost brackish marsh by restoring DMCA 1S
Striped Bass Stocking
Compensate for adverse impacts to Striped bass spawning and nursery habitats
Value to the Nation
- 4th largest container port in US
- Largest single terminal operation in North America
- Fastest growing container port in the Nation for the last 10 years
- 2.92M TEU through-put in 2011
- Supports in GA over 352,000 jobs, $18.5B in income and $2.5B in state and local taxes annually
- Supports in SC over 19,700 jobs, $959M in income, $147M in state and local taxes annually
- $66.9B in GA revenue (9% of GA total sales) annually
- $4.3B in SC revenue (1.3% of SC total sales) annually
South Carolina
Georgia
Savannah National Wildlife Refuge
Houlihan Bridge
Garden City Terminal
Oxygen Injection System
Remove the incremental effects of the project on dissolved oxygen
Meeting Areas
Construct two meeting areas to facilitate two-way traffic
CSS Georgia Removal
Recover and preserve remains of the Confederate ironclad
Kings Island Turning Basin
Deepen and enlarge to 1,600-feet x 1,600-feet
Boat Ramp
Restore boater access to the Back River
Upland Dredged Material Containment Areas
Increase capacity to accommodate deepening materials
Bend Wideners
Widen channel 100 ft. at three critical turns
Channel Deepening
Remove approximately 24,000,000 cubic yards of material to deepen from 42 to 47 feet
Channel Extension
Extend entrance channel across ocean bar an additional 7.1 miles
Monitoring & Adaptive Management
Implementing adaptive management features if post-construction monitoring shows them to be needed
Atlantic Ocean
Savannah
Back River
South Channel
12A
13B
14A
14B
2A
0+000
-60+000
-97+680
N
Navigation Feature
F&W Mitigation Feature
Other Mitigation Feature
Project Information
- Deepen from 42' to 47' NED selected plan
- $652M Total First Cost (FY 12 Price Levels)
- $311M Total Mitigation Cost
- 70% Federal 29% Non-Federal Cost Share:
- $174M Annual Net Benefits
-Benefits Derived From Increased Transportation Efficiencies
- 5.5:1 @ 4% (discount rate) Benefit to Cost Ratio
- Projected to create 11,000+ jobs nationwide

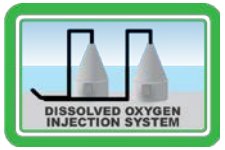
Environmental Effects

- Loss of 16 AC brackish marsh
- Conversion of tidal marshes
  - 223 AC freshwater marsh to brackish marsh
  - 740 AC salt marsh to brackish marsh
- Loss of fish habitats
  - 7% loss in shortnose sturgeon winter habitat
  - 10% loss in striped bass spawning habitat
- Impacts to dissolved oxygen
- Impacts to drinking water

- 57% gain southern flounder habitat
- Gain in dissolved oxygen

Need for mitigation and environmental monitoring

CSS Georgia Recovery Effort



Dissolved Oxygen Injection System

Raw Water Storage Impoundment

Flow Re-routing

New Savannah Bluff Lock and Dam Fish Passage

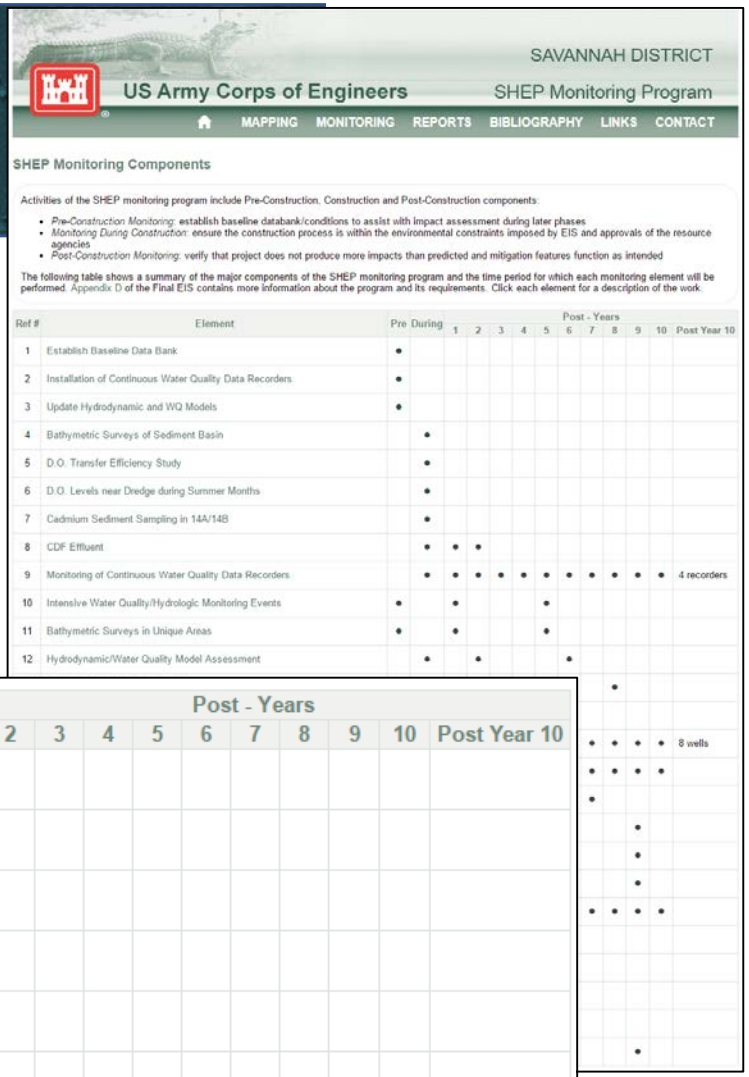
The Center for Geospatial Research University of Georgia

- Created in 1985 as part of the Department of Geography at UGA
- Remote sensing, mapping, environmental projects, geospatial analysis/technologies:
  - Army Corps of Engineers / Forest Service / National Park Service / NASA / NOAA / The Carter Center / USGS and others
  - MSc and PhD students
- NASA Center of Excelence 1998, ESRI Special Achievement in GIS Award (2009 and 2015)

The academically diverse interests that exist at CGR are linked by the need to understand and interpret the geospatial data that are unique to each interest

CGR and SHEP

- CGR tasked in 2013 to collect, organize, distribute and visualize monitoring data linked to SHEP
- Multi-year project involving: pre-construction, construction and post-construction monitoring



SAVANNAH DISTRICT

US Army Corps of Engineers — SHEP Monitoring Program

MAPPING | MONITORING | REPORTS | BIBLIOGRAPHY | LINKS | CONTACT

SHEP Monitoring Components

Activities of the SHEP monitoring program include Pre-Construction, Construction and Post-Construction components:

- *Pre-Construction Monitoring*: establish baseline databank/conditions to assist with impact assessment during later phases
- *Monitoring During Construction*: ensure the construction process is within the environmental constraints imposed by EIS and approvals of the resource agencies
- *Post-Construction Monitoring*: verify that project does not produce more impacts than predicted and mitigation features function as intended

The following table shows a summary of the major components of the SHEP monitoring program and the time period for which each monitoring element will be performed. Appendix D of the Final EIS contains more information about the program and its requirements. Click each element for a description of the work.

Ref #	Element	Pre	During	Post - Years 1	2	3	4	5	6	7	8	9	10	Post Year 10
1	Establish Baseline Data Bank	•												
2	Installation of Continuous Water Quality Data Recorders	•												
3	Update Hydrodynamic and WQ Models	•												
4	Bathymetric Surveys of Sediment Basin		•											
5	D.O. Transfer Efficiency Study		•											
6	D.O. Levels near Dredge during Summer Months		•											
7	Cadmium Sediment Sampling in 14A/14B		•											
8	CDF Effluent		•	•	•									
9	Monitoring of Continuous Water Quality Data Recorders		•	•	•	•	•	•	•	•	•	•	•	4 recorders
10	Intensive Water Quality/Hydrologic Monitoring Events	•		•				•						
11	Bathymetric Surveys in Unique Areas	•		•				•						
12	Hydrodynamic/Water Quality Model Assessment		•		•				•					

Ref #	Element	Pre	During	Post - Years 1	2	3	4	5	6	7	8	9	10	Post Year 10
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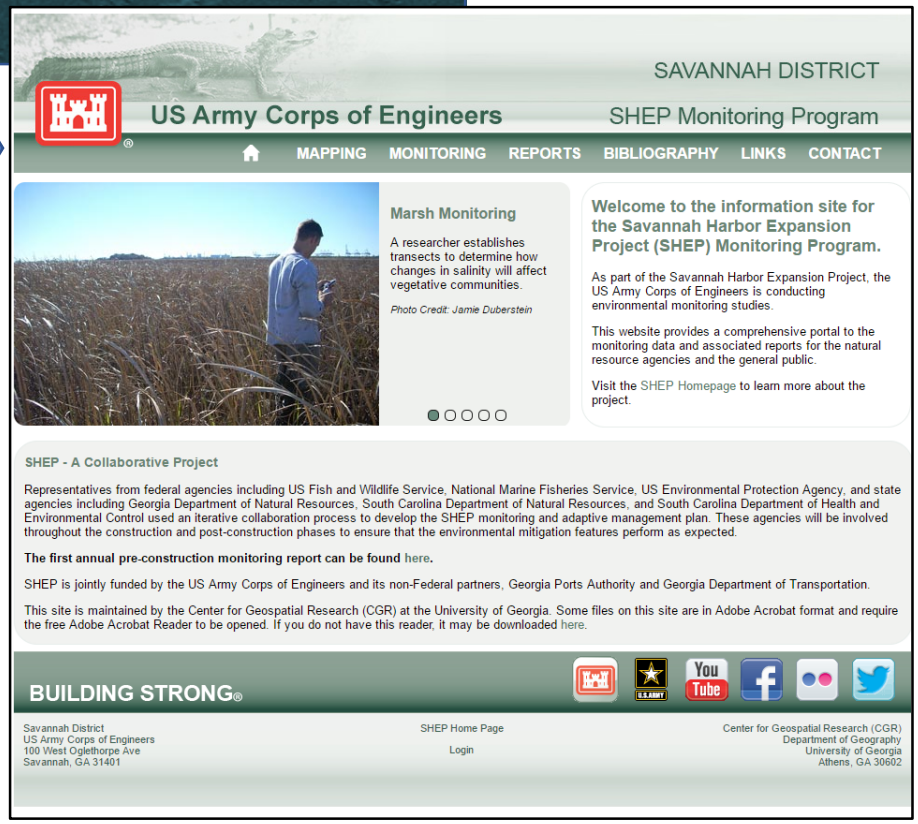
8	CDF Effluent		•	•	•									
9	Monitoring of Continuous Water Quality Data Recorders		•	•	•	•	•	•	•	•	•	•	•	4 recorders
10	Intensive Water Quality/Hydrologic Monitoring Events	•		•				•						

CGR Contribution: Overview

- Develop a web portal to facilitate public access to the pertinent data
- Research, identify and catalogue study documents for the major areas
  - e.g., hydrodynamic conditions, water quality, dissolved oxygen, chloride, marsh, fisheries).
  - bibliography and datasets have been integrated into the web portal
- Determine appropriate attributes for the GIS
- Develop a Standard Operating Procedure
  - E.g., a spreadsheet data entry form and accompanying instructions) for each major resource type to ensure researchers collect data in a standardized manner that is compatible with the GIS

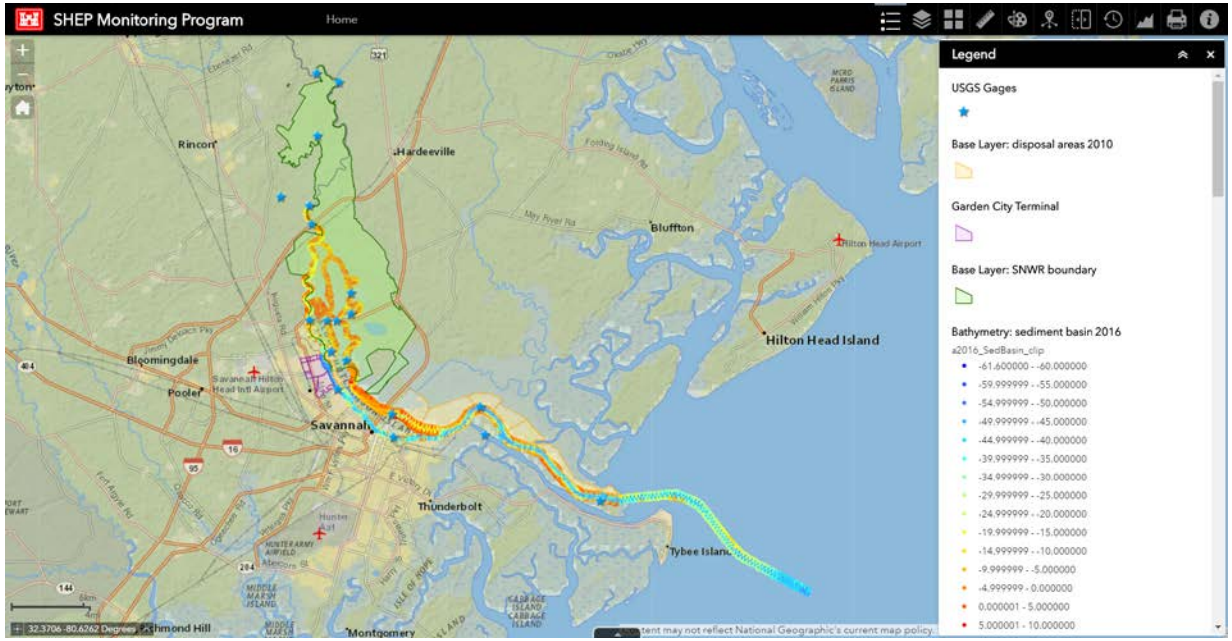


www.shep.uga.edu

CGR Contribution

- Web portal preparation and hosting:
  - Hardware
    - *Dell PowerEdge R715 rack-mounted web/data server (with 96 GB memory and 7.2 TB disk array)*
    - *3 DELL Inspiron Workstation*
    - *1 UPS*
    - *Terastation and multiple hard drive for data backup*
  - Hosting service supported by the University of Georgia Determine appropriate attributes for the GIS
- Data preparation, processing and analysis
  - standardization of mapping coordinates
    - Georgia State Plane, East Zone, NAD83
    - Vertical: NAVD88 and MLLW
  - Time series manipulation and summaries

SHEP Monitoring Program Map Portal

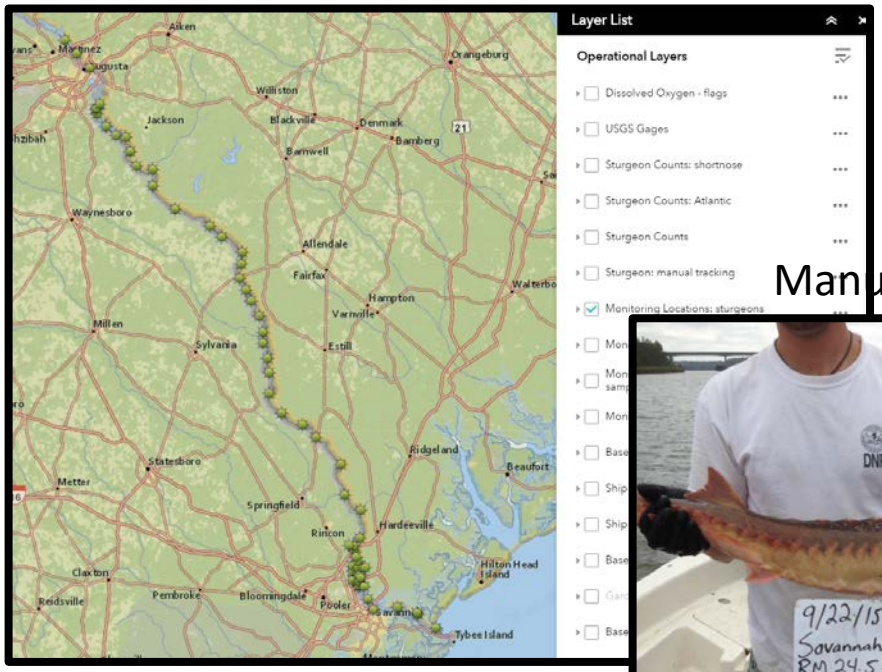


Solution uses: local web server + AGOL

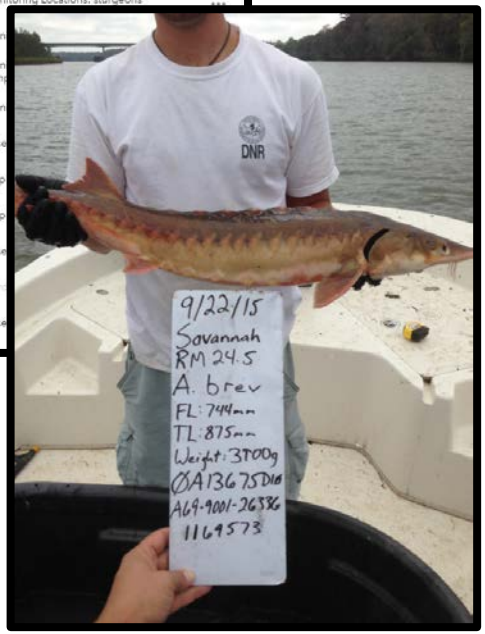
- Base layers:
  - Garden City Terminal
  - Disposal areas
  - Ship channel
- Monitoring areas/resources:
  - Sturgeon
  - Bird tissue
  - Marsh sites
  - Water quality
- Bathymetry: annual for different areas in the region (2012-2015)

SHEP Monitoring Program Map Portal

Location of automatic tracking receivers



Manual tracking



Sturgeon monitoring

- Automatic tracking
- Manual tracking

Species

- Shortnose
- Atlantic

Functionalities

- Sturgeon count time-enabled layer
- Access to attribute table and filter

SHEP Monitoring Program Map Portal

Location of gages

Water Quality

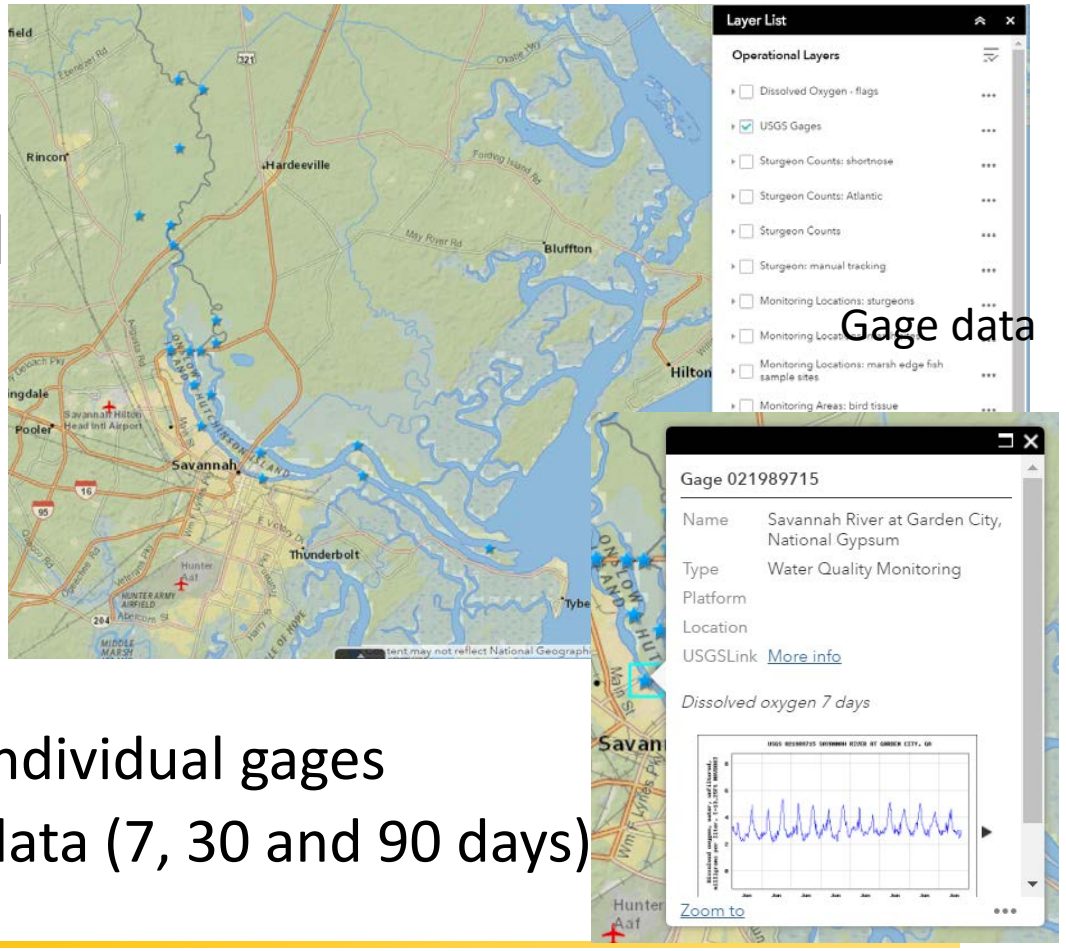
- USGS data
- Near-real time retrieval

Variables

- Dissolved oxygen
- Conductance

Functionalities

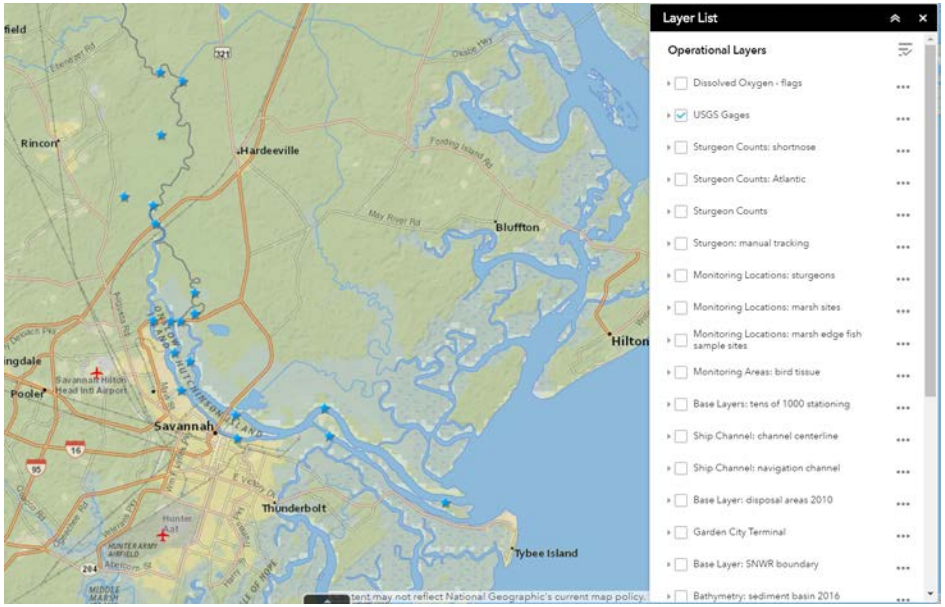
- Retrieval of data from individual gages
- Graphs: time series of data (7, 30 and 90 days)



Gage data

SHEP Monitoring Program Map Portal

Location of gages



Water Quality

- Near-real time flagging
- Email alert to USACE and stakeholders

- Dissolved oxygen: < 4
- Conductance: > 6

SHEP Monitoring Program Map Portal

- Web Map
  - AGOL
  - Local Server
- Why we picked AGOL
  - Other options

ArcGIS Online

+

Local Server

Other functionalities

- Scale bar (lower left corner) presents scale using metric and English system
- Cursor coordinates (lat/long) are updated as user interacts with interface
- Coordinates of a point can be retrieved by enabling "Click on maps" tool
- A pane at the bottom of the map can be opened to show data for different layers.
- Using that pane users can interact with the data and features displayed on the map:
- Displayed data records can be filtered by map extent
- Specific features/data records can be zoomed into
- Selecting data records selects the feature on the map
- Data can be exported as csv files
- Users can select what data columns (fields) to show
- Side panes (to the right) can be turned on and off.
- Pop-up windows (tooltips) can be disabled

Other functionalities (cont.)

- Layers can be moved up and down controlling layer stacking and the layout of the map
- Attribute table with values for particular layer can be opened and users can use data values to analyze map
- Users can disable pop-up windows (tooltips)
- Users can use a drawing tool to add markers, lines, polygons and text to the map.
- Drawing tool allows for the selection of color, style, transparency, width for the features being drawn. Measurements can be retrieved from drawings.
- An Info Summary tool allows for the display of a list of gages or stations (features) as they are presented by the map.
- Only features displayed are listed by the Info summary, so users can target specific features
- Clicking one instance of a feature locates that feature on the map and presents a tooltip with information on the feature
- Swipe tool allows for the selection of a layer for change in condition analysis. (e.g., change in bathymetry values)
- Time slider tool: allows for the display of changes in values over time. This functionality has been incorporated into the map and we are currently preparing layers to show change over time.
- Printing maps: allows for creation of PDF versions of the map being displayed for printing or storage.
- About tool: provides information on what the map is and on the Savannah Harbor Expansion Project.
- USGS gage tooltip: clicking on a USGS gage opens a tooltip showing previews for graphs for dissolved oxygen and specific conductance based on data provided by USGS.
- Graphs are created for three time periods: 7 days, 30 days and 90 days.
- Clicking on graphs will take the user to the full resolution version of the graph.
- Clicking on a feature opens a tooltip that allows users to pan to that feature and to open the attribute table to consult values for analyses.

SHEP Monitoring Program - Functionalities

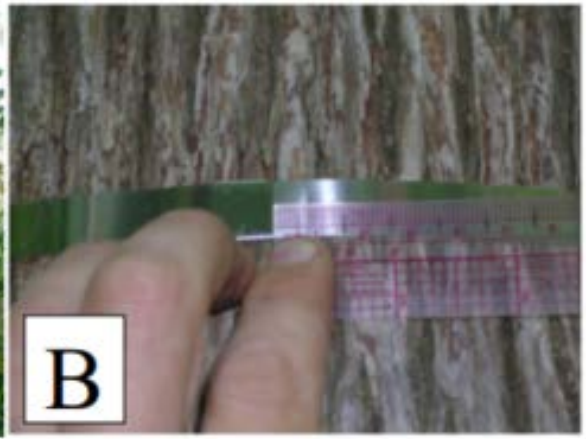
- Current Data Layers
  - Sources
  - Data Types

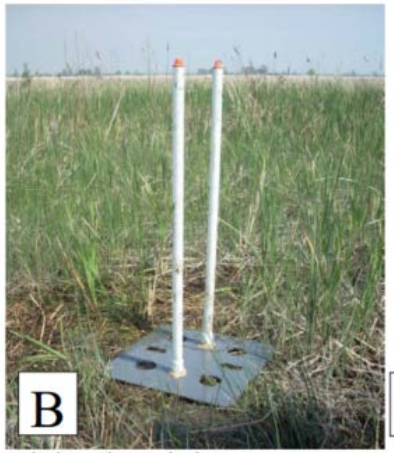
- Bird tissue
- Water quality
- Bathymetry
- GIS Database/Web portal
- Groundwater monitoring
- Marsh vegetation
- Sturgeon

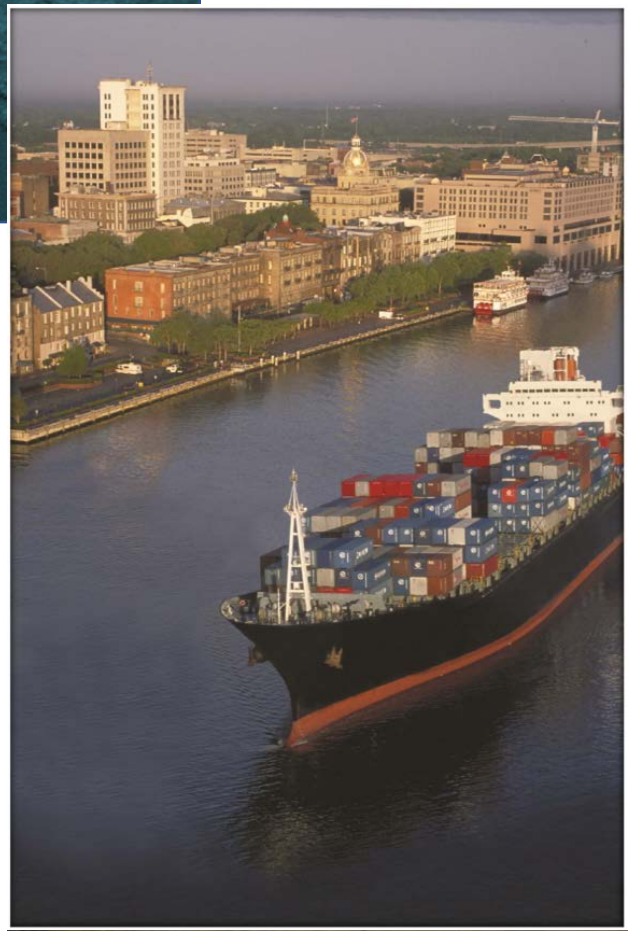
Summary and Conclusions

- Map and data portal (information site) to store results from environmental monitoring studies: data and map portal (www.shep.uga.edu)
- Implementation: local server+AGOL
- Serving: reports, historical data, georeferenced data, results from analyses
- Near-real time data access
- Periodical update of data collected in the field (sturgeon, marsh, bathymetry, water quality)
- Data access and manipulation through web platform (logical operation, single vs. Multiple expressions).
- Flagging and alert system

Thank You







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Backup Slides

Project Status

SHEP Progression Chart

PROJECT FEATURE	AWARDED	UNDER CONSTRUCTION	COMPLETE
CSS Georgia Recovery	Dial Cordy, Panamerican, Navy	January 2015	80%
Outer Harbor Dredging (view map)	Great Lakes Dredge & Dock Company	September 2015	59%
Dissolved Oxygen Injection System	CDM Constructors Inc.	February 2016	31%
Raw Water Storage Impoundment (View progress)	Thalle Construction Company	March 2016	79%
First Dike Raising	Herve Cody Construction	May 2016	70%
Sediment Basin Tidegate Removal (View progress)	De Moya/Continental Joint Venture	November 2016	58%
Freshwater Wetlands Acquisition	N/A	Pending Transfer to USFWS	100%
McCoy's Cut Area Work	Design phase		
Fish Passage	Design phase		
Inner Harbor Dredging	Design phase		
Marsh Restoration	Not advertised		