Guadalupe Delta and Estuary Bayou Flow

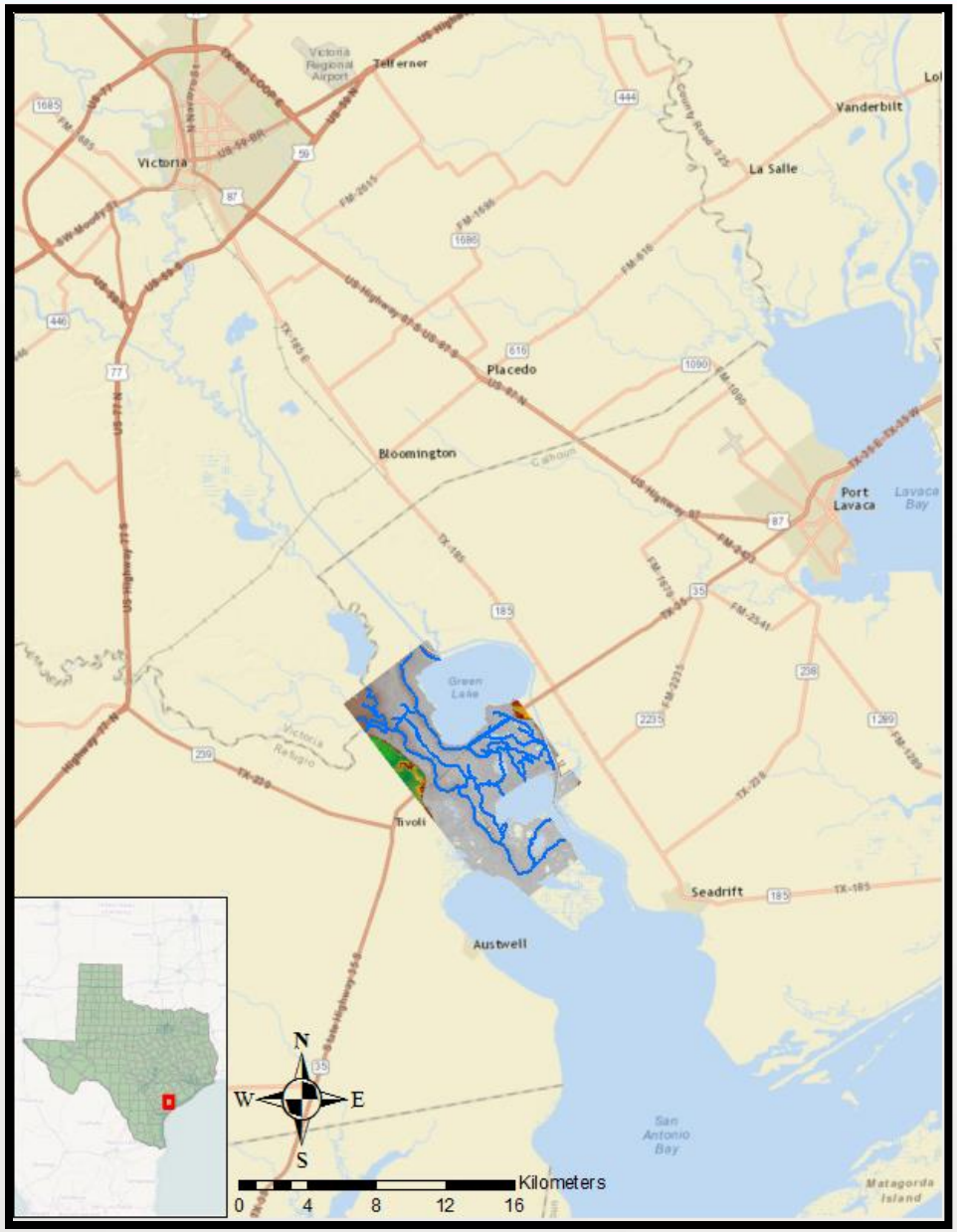
Richard Carothers
Dr. Ben R. Hodges
Dr. Paola Passalacqua

General Purpose

- Improve the understanding of inflows from the Guadalupe River into San Antonio Bay via the river and local bayous

Study Area Location

- 20 miles southeast of Victoria, TX
- 10 miles southwest of Port Lavaca
- Region south of the Guadalupe San Antonio River confluence to discharge at Mission Lake
- Special interest in understanding flows through 4 bayous within the Guadalupe Wildlife Management Area



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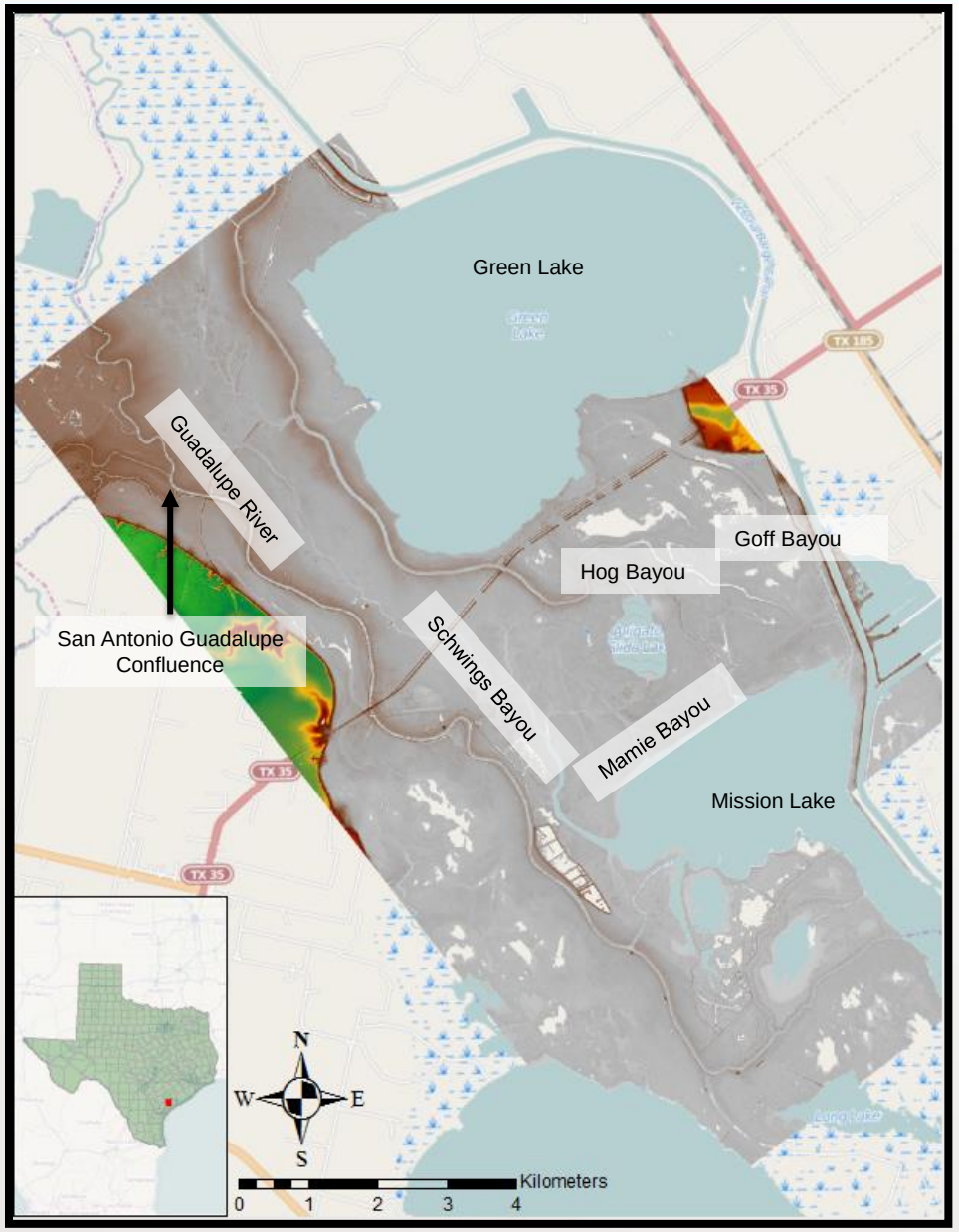
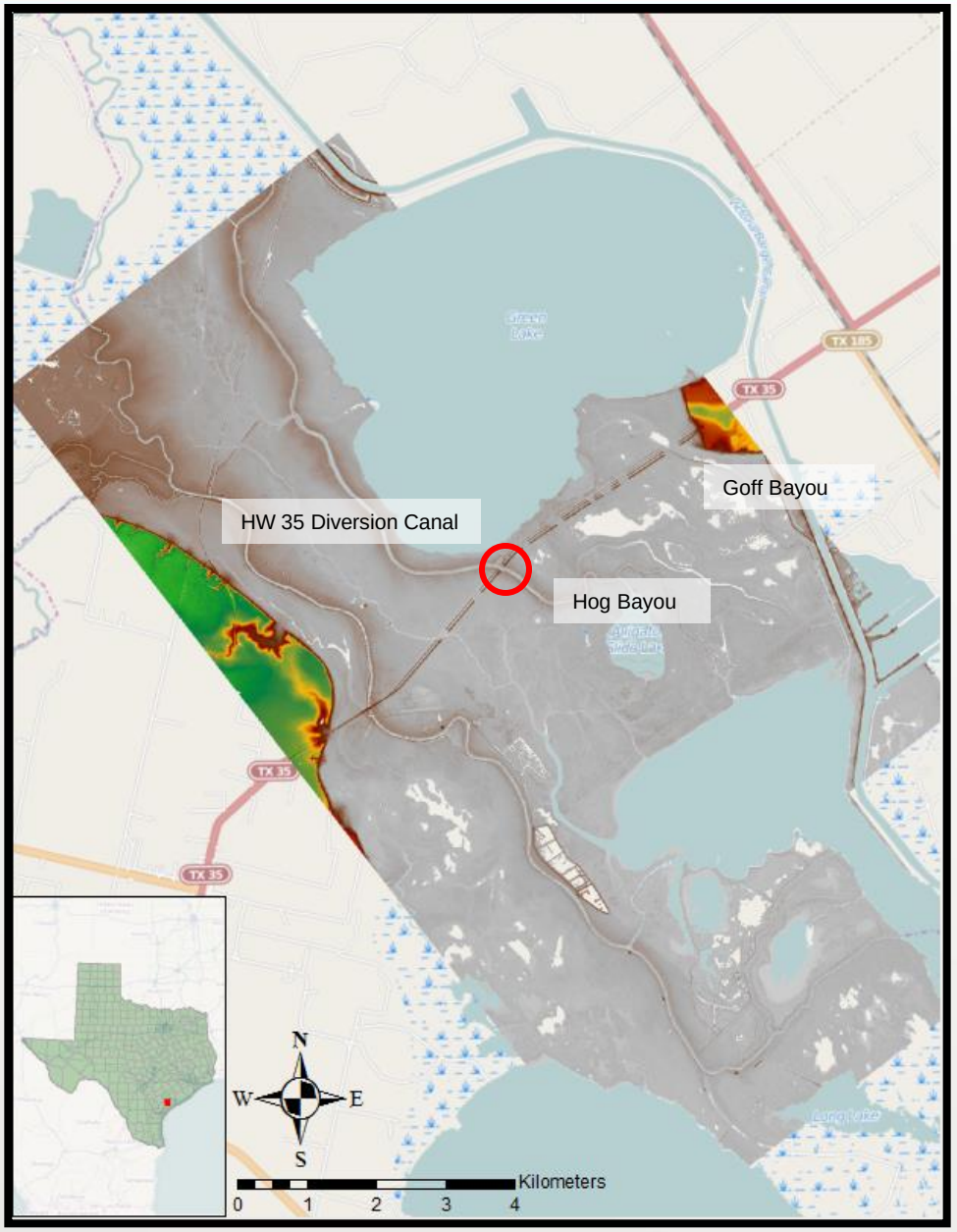


“UNIQUE” ASPECT OF STUDY

HW 35 Diversion Canal

- Diverts water from Hog Bayou to Goff Bayou for industrial use



HW 35 Diversion Canal
01/2013

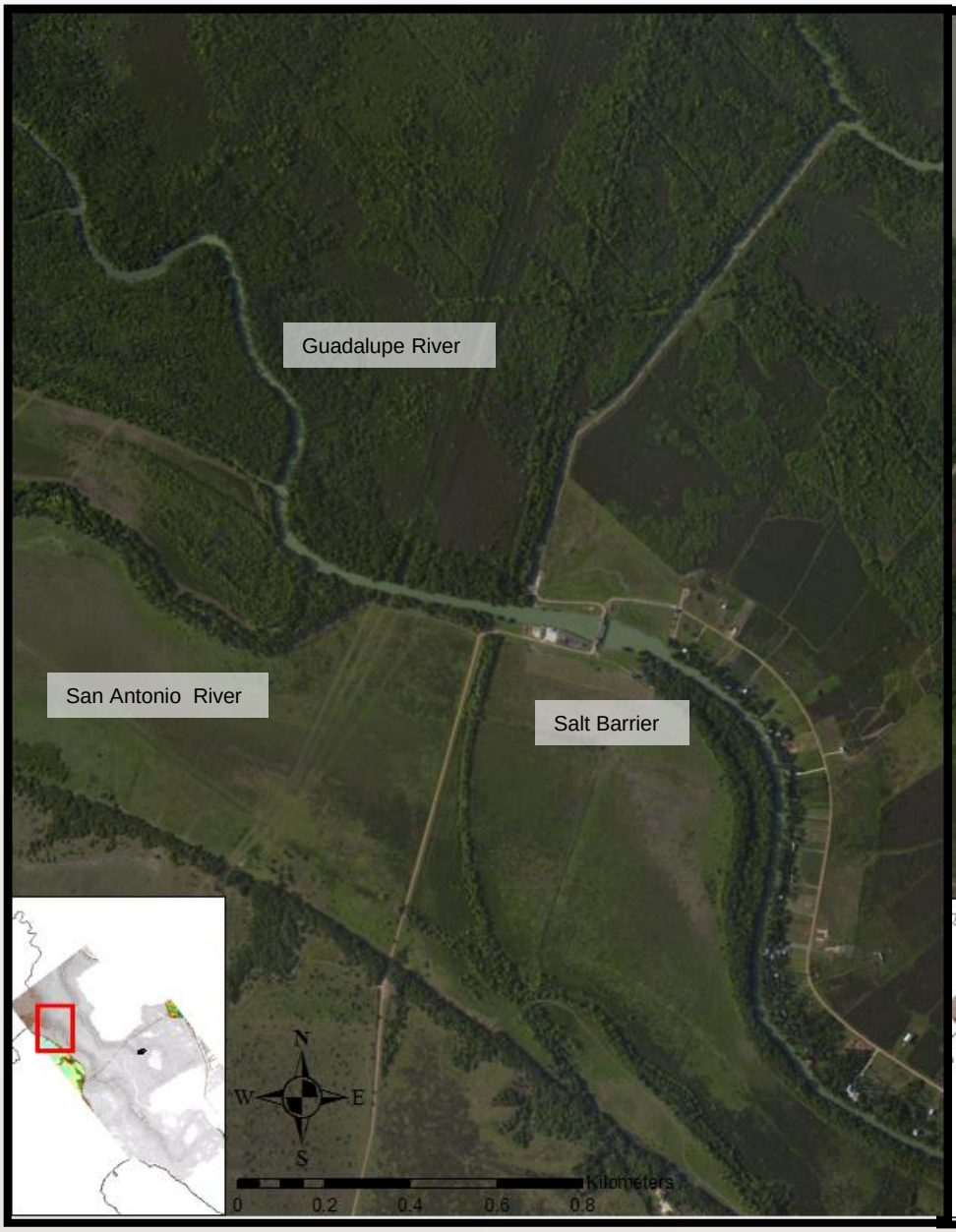
Upstream

Downstream

HW 35 Diversion Canal
11/2014

Upstream

Downstream


Guadalupe River
San Antonio River
Salt Barrier
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W
E
S
Kilometers
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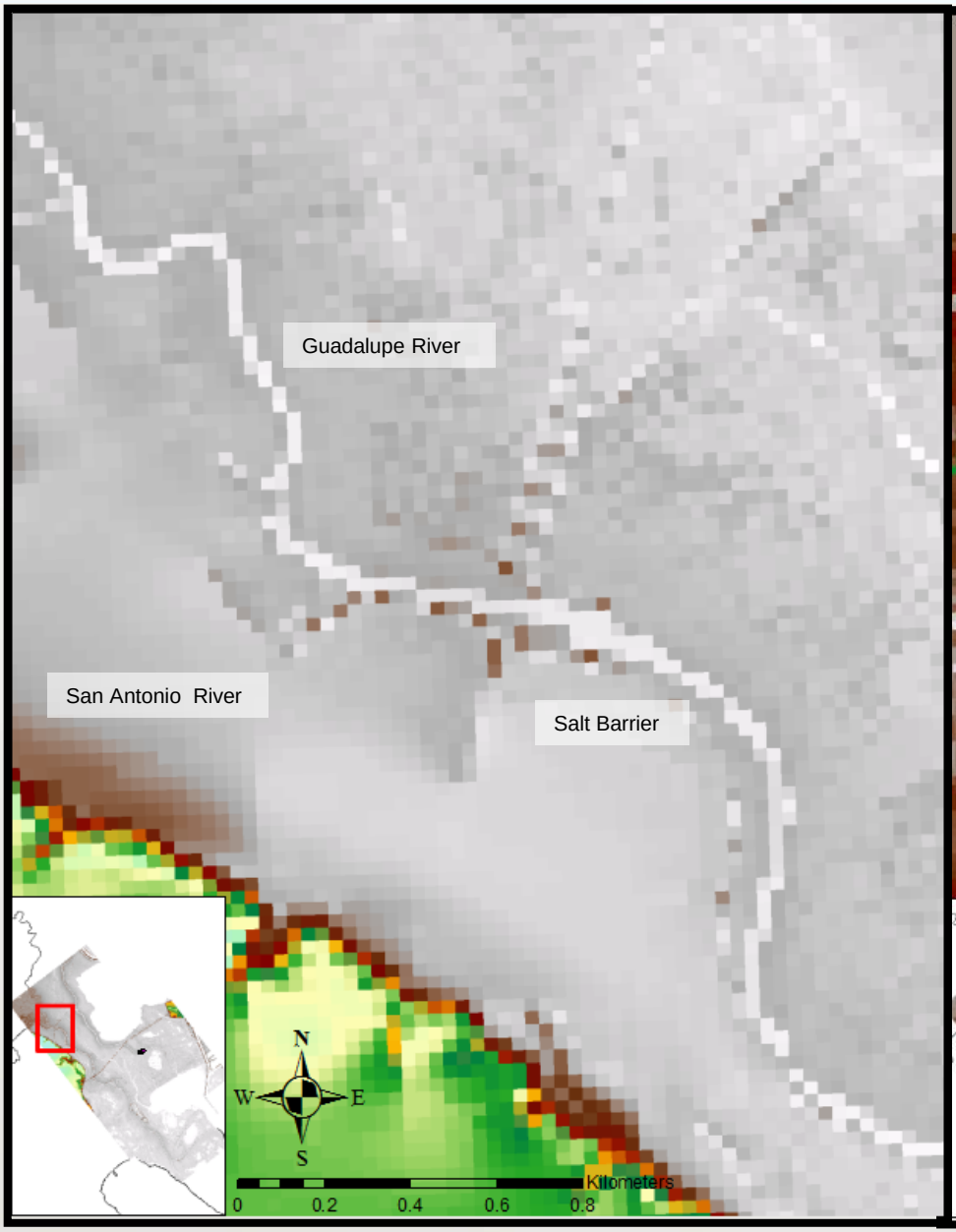
0.2
0.4
0.6
0.8


Alligator Slide Lake
Schwings Bayou
N
W
E
S
Kilometers
0
0.3
0.6
0.9
1.2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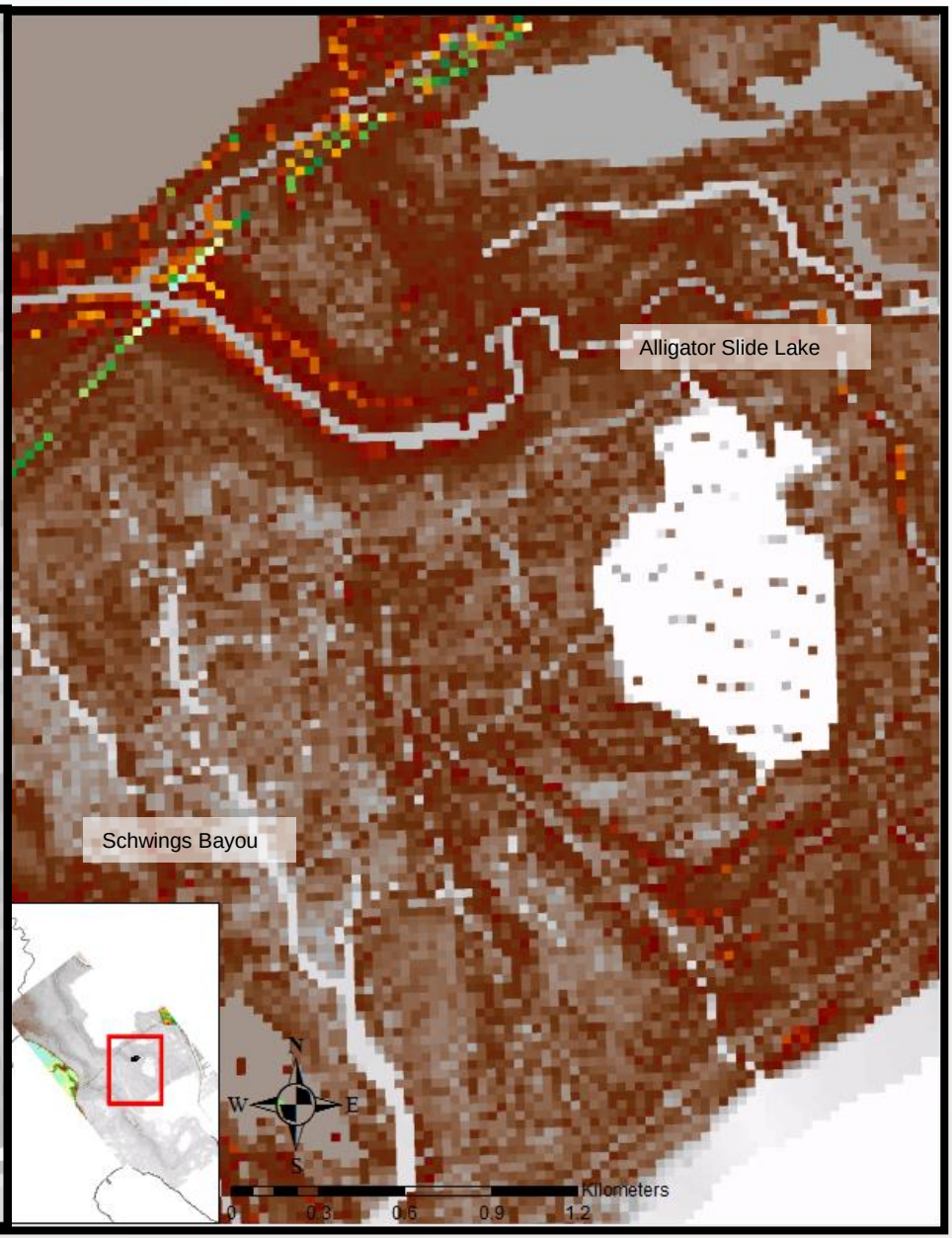
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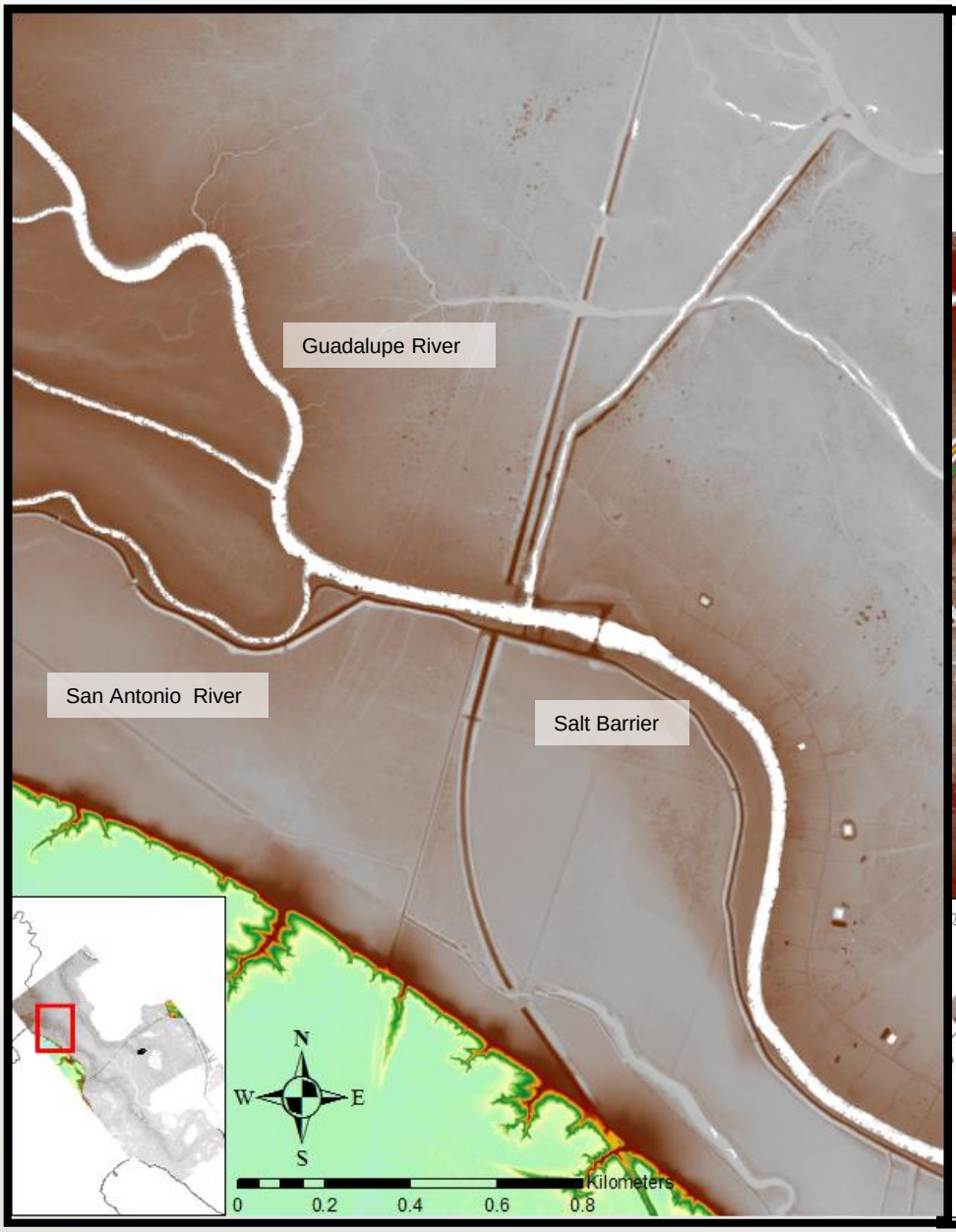
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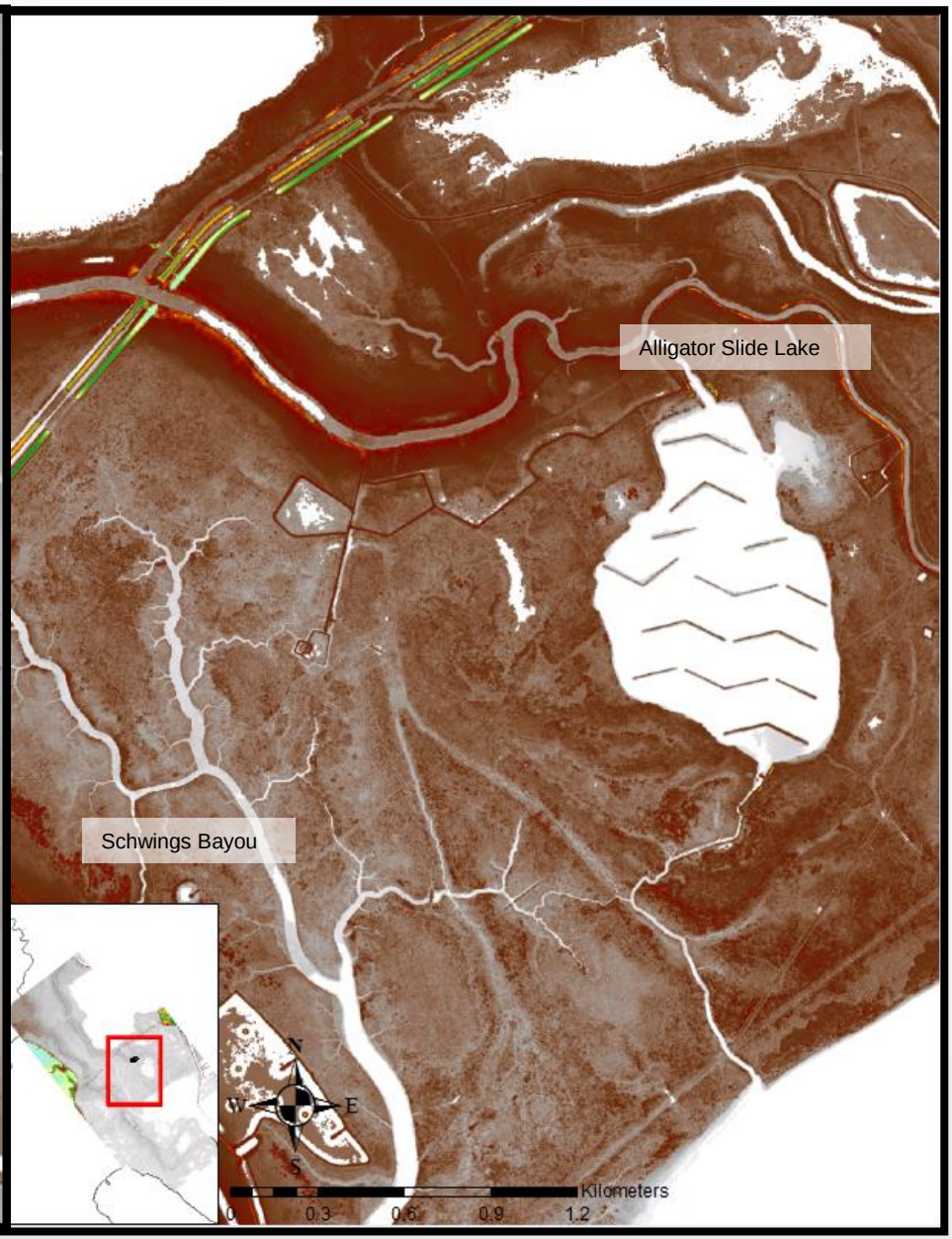
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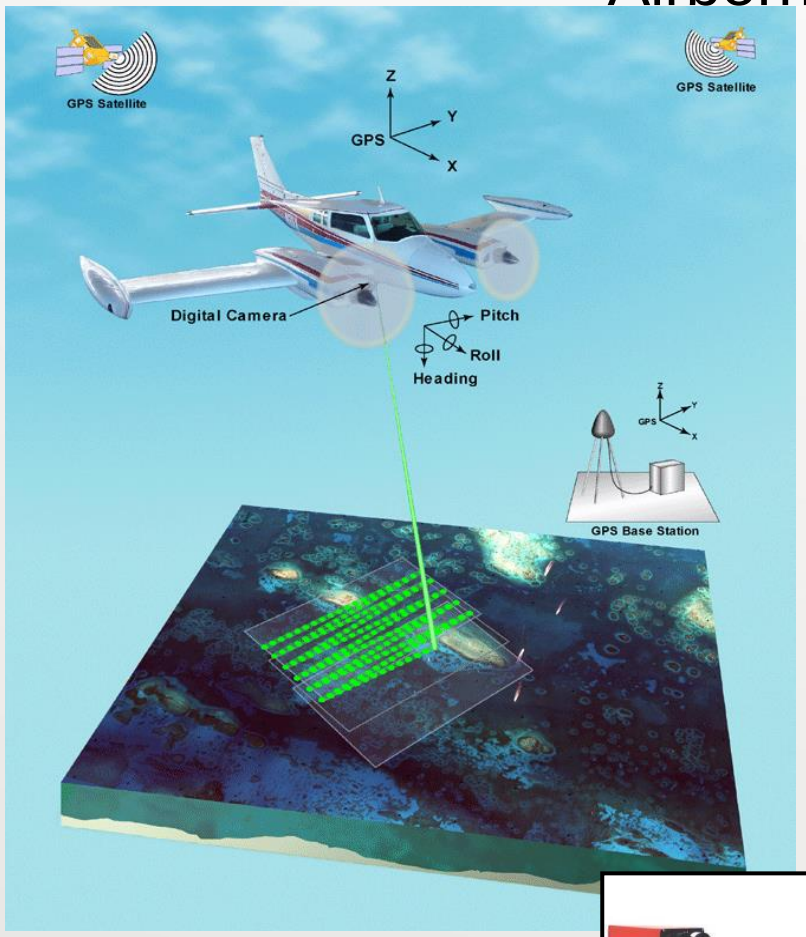
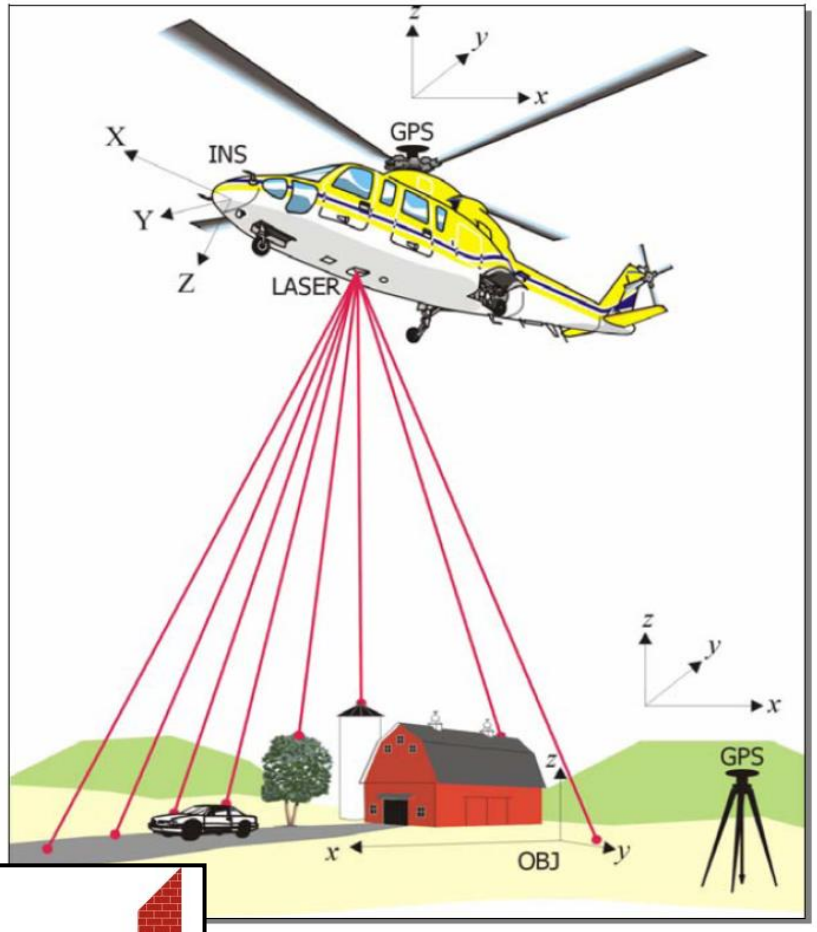
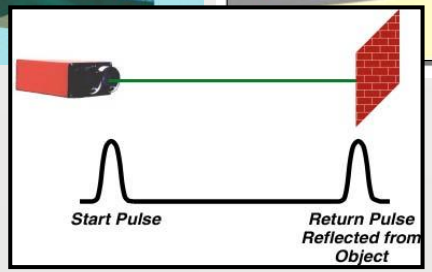
Airborne Lidar



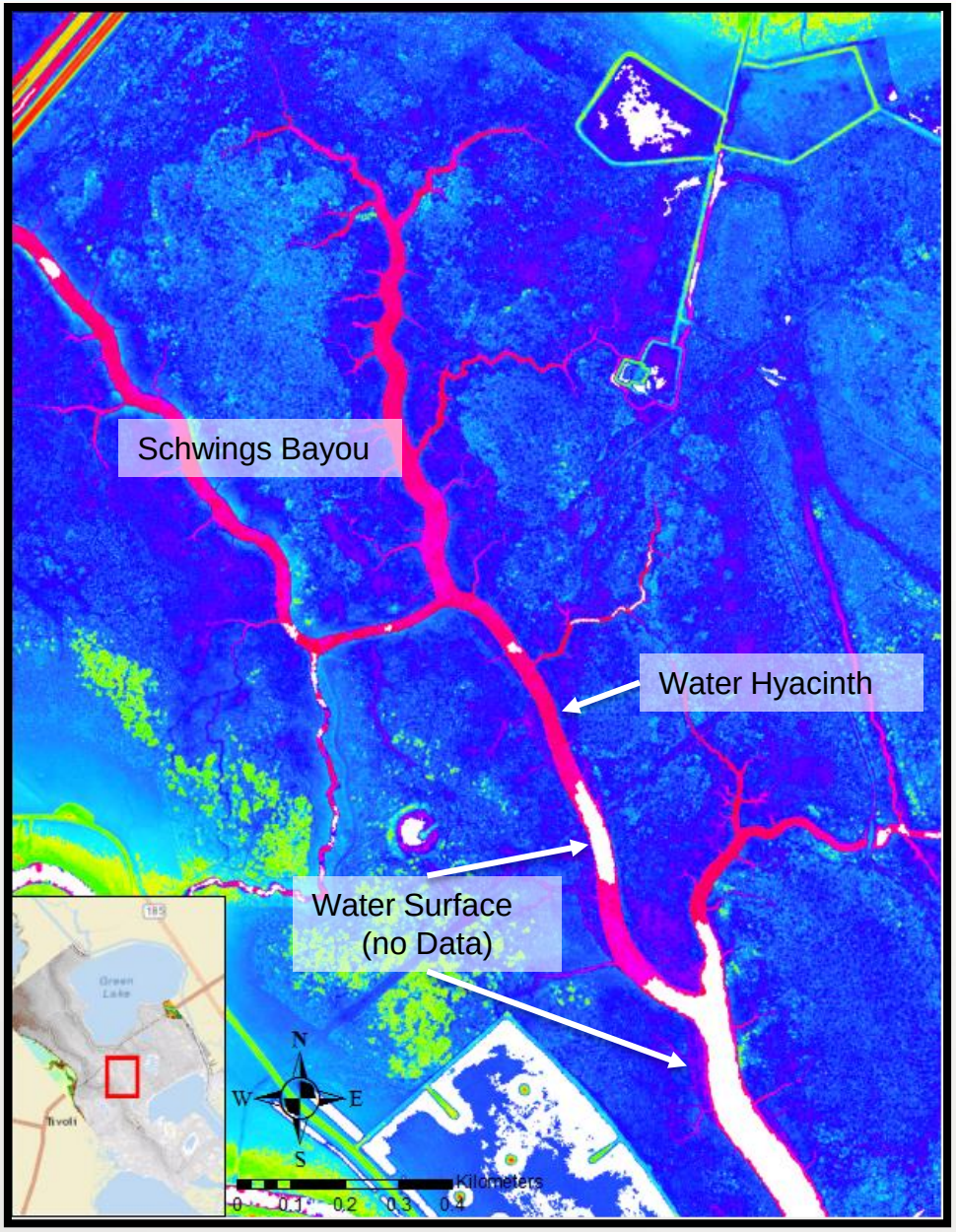




Slide courtesy of Dr. Paolo Tarolli, University of Padova, Italy

Lidar and Water Surfaces

- **Li**ght **D**etection **a**nd **R**anging
- Lidar returns no data when encountering water surfaces
- Convenient identification of water
- Pervasive aquatic vegetation (water hyacinth) masks water surface
- Channels identified easily visually, but automated extraction difficult



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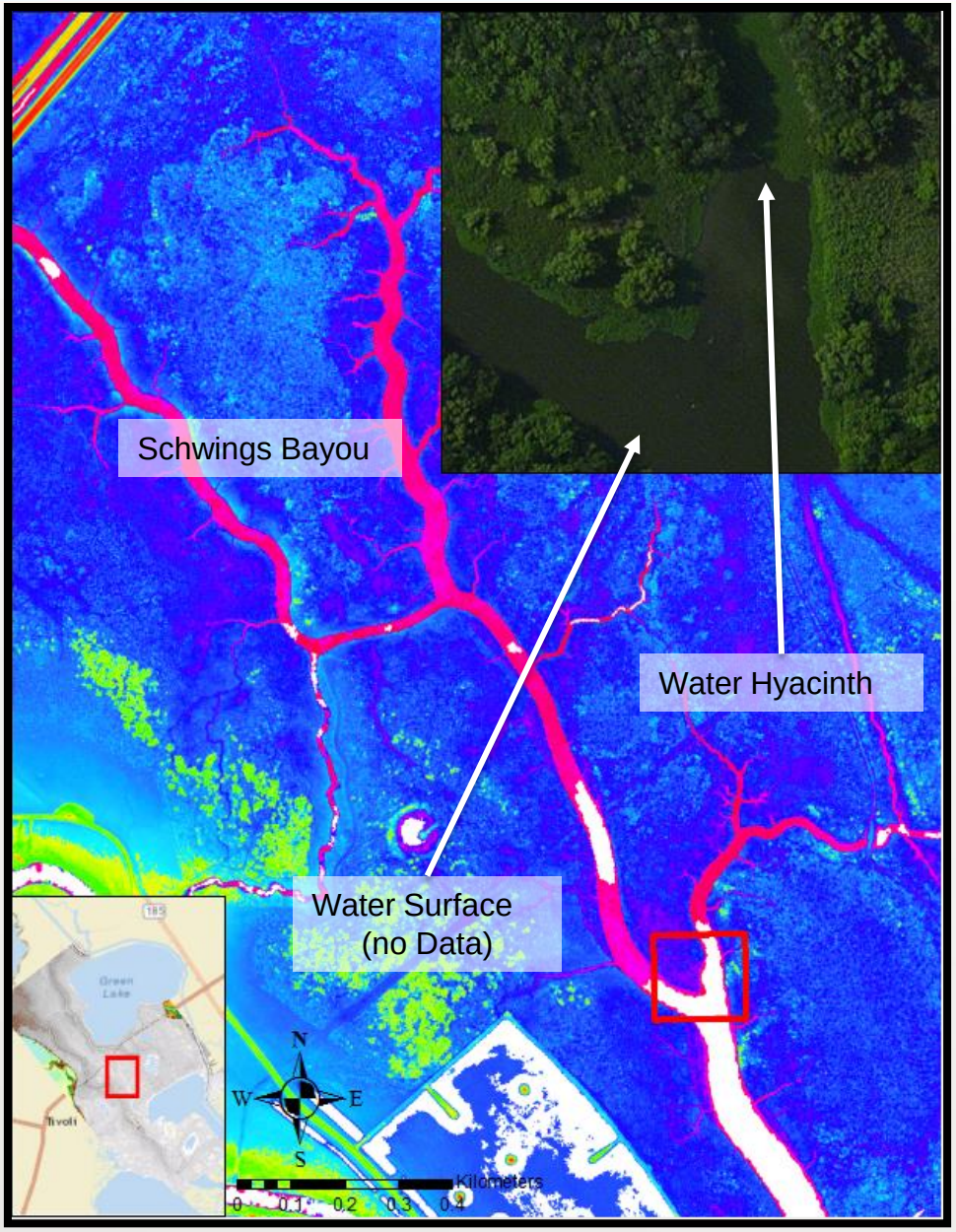


Project Objectives

Task 1

- Produce inundation maps to identify channel connectivity

Task 2

- Perform field work to identify potential flow restrictions and install sensors

Task 3

- Analyze system using Frehd model
  (http://www.crwr.utexas.edu/hodges/frehd/)

METHODOLOGY

Task 1

Inundation maps establishing connectivity

Steps

1) Classify water feature returns from lidar dataset

2) Identify primary system channelization

3) Establish maps of current water surface elevations

4) “Inundate” channels by increasing current water depths at different intervals and map channel connectivities at different depths

Task 2

In field sensor installation and recovery

Steps

1) Identify likely sensor locations from lidar data and satellite imagery

2) Perform field reconnaissance to comprehend field conditions and determine sensor placement feasibility

3) Install water level loggers and CTD sensors

4) Recover sensors

Task 3

Modeling of system hydrodynamics using Frehd

Steps

1) Prepare DEM and special restriction data for Frehd model input

2) Calibrate and run model

3) Verify model with measured water conditions under historical forcings

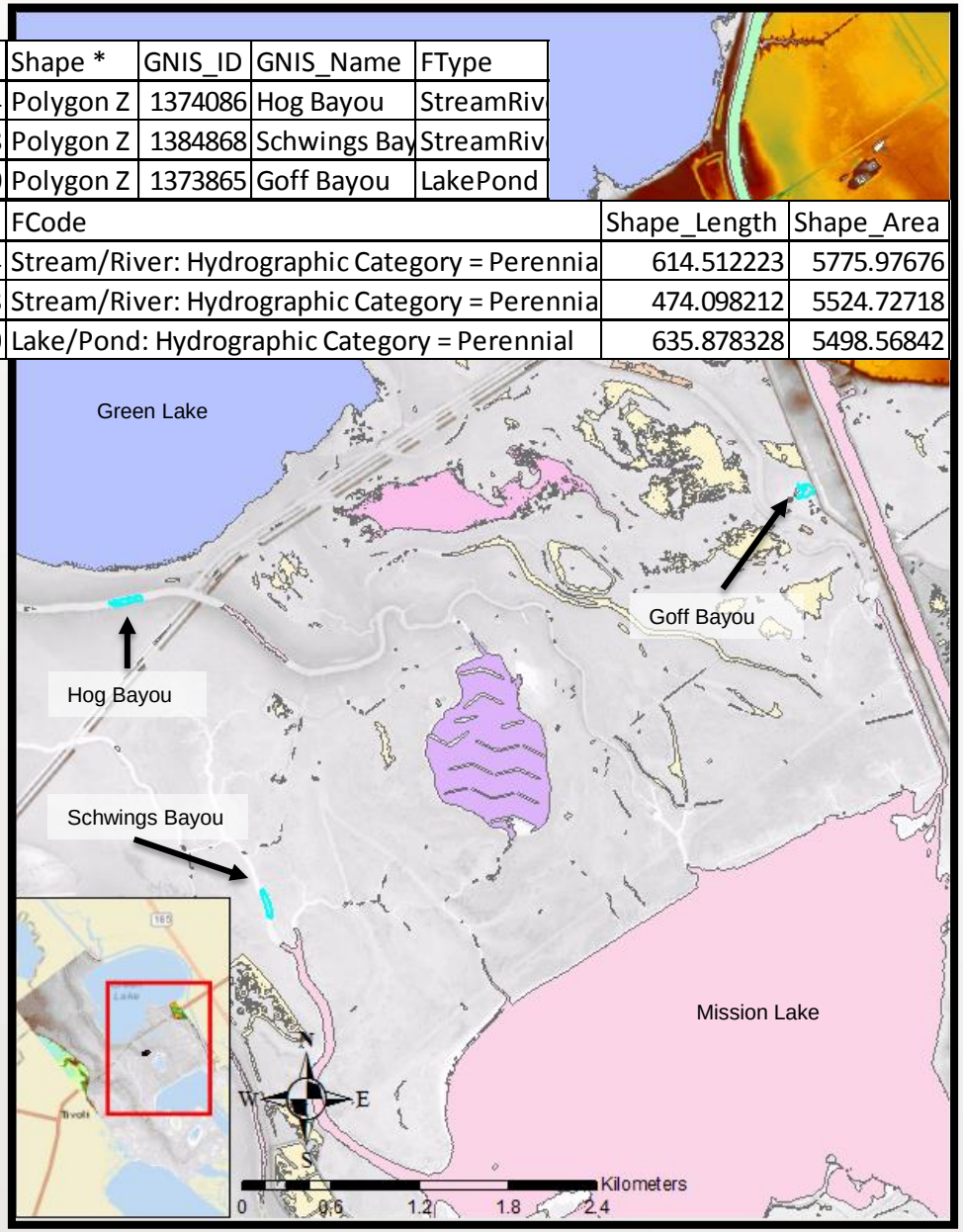
WORK TO DATE

Task 1.1
"Known" water feature classification

- Water features identified by no return on lidar dataset, thus clearly present in dataset
- Classified based on NHD Ftypes
- Sizes, areas, and names (where available) also cataloged

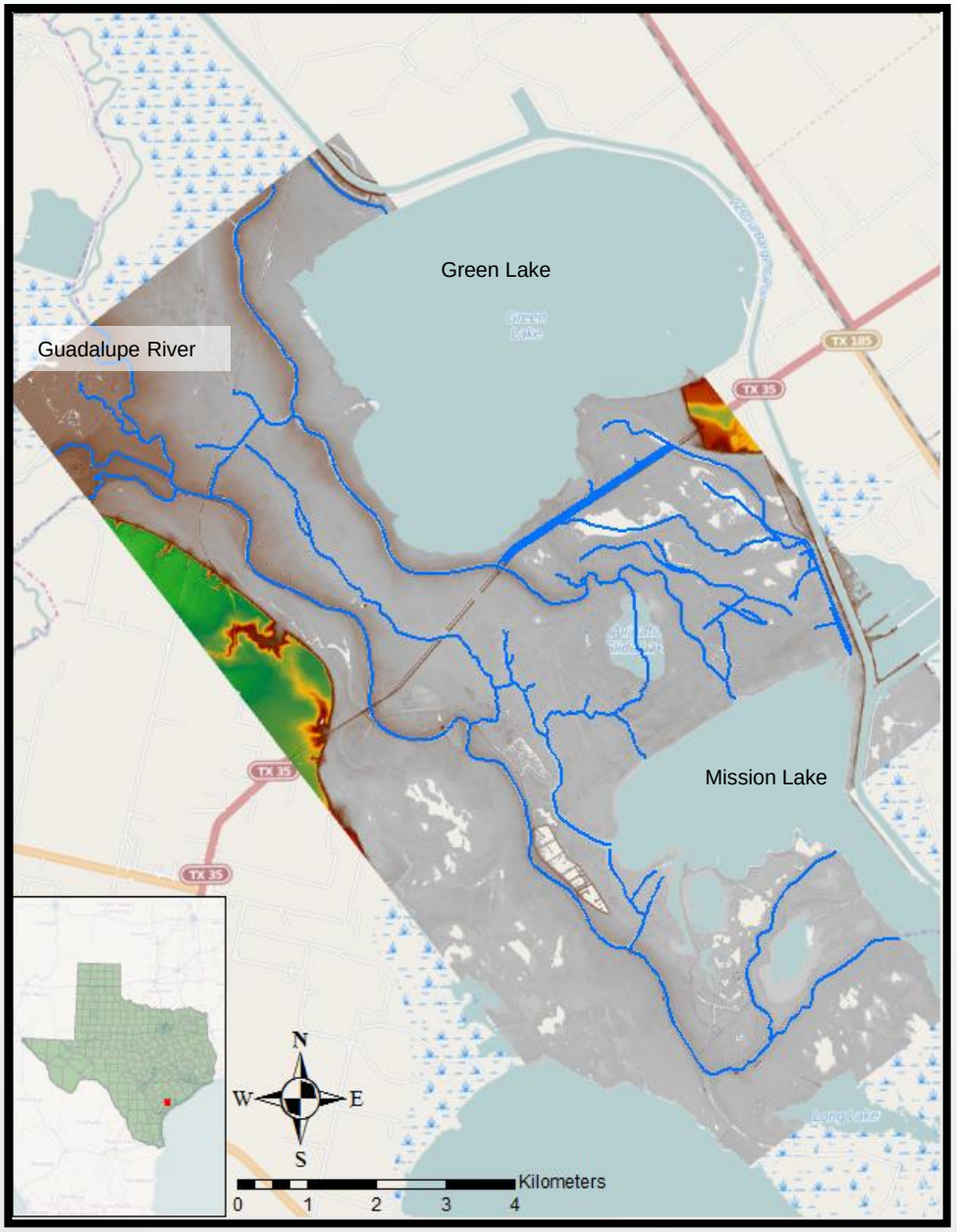
OBJECTID *	Shape *	GNIS_ID	GNIS_Name	FType
1984	Polygon Z	1374086	Hog Bayou	StreamRiv
2438	Polygon Z	1384868	Schwings Bay	StreamRiv
1420	Polygon Z	1373865	Goff Bayou	LakePond

OBJECTID *	FCode	Shape_Length	Shape_Area
1984	Stream/River: Hydrographic Category = Perennia	614.512223	5775.97676
2438	Stream/River: Hydrographic Category = Perennia	474.098212	5524.72718
1420	Lake/Pond: Hydrographic Category = Perennial	635.878328	5498.56842



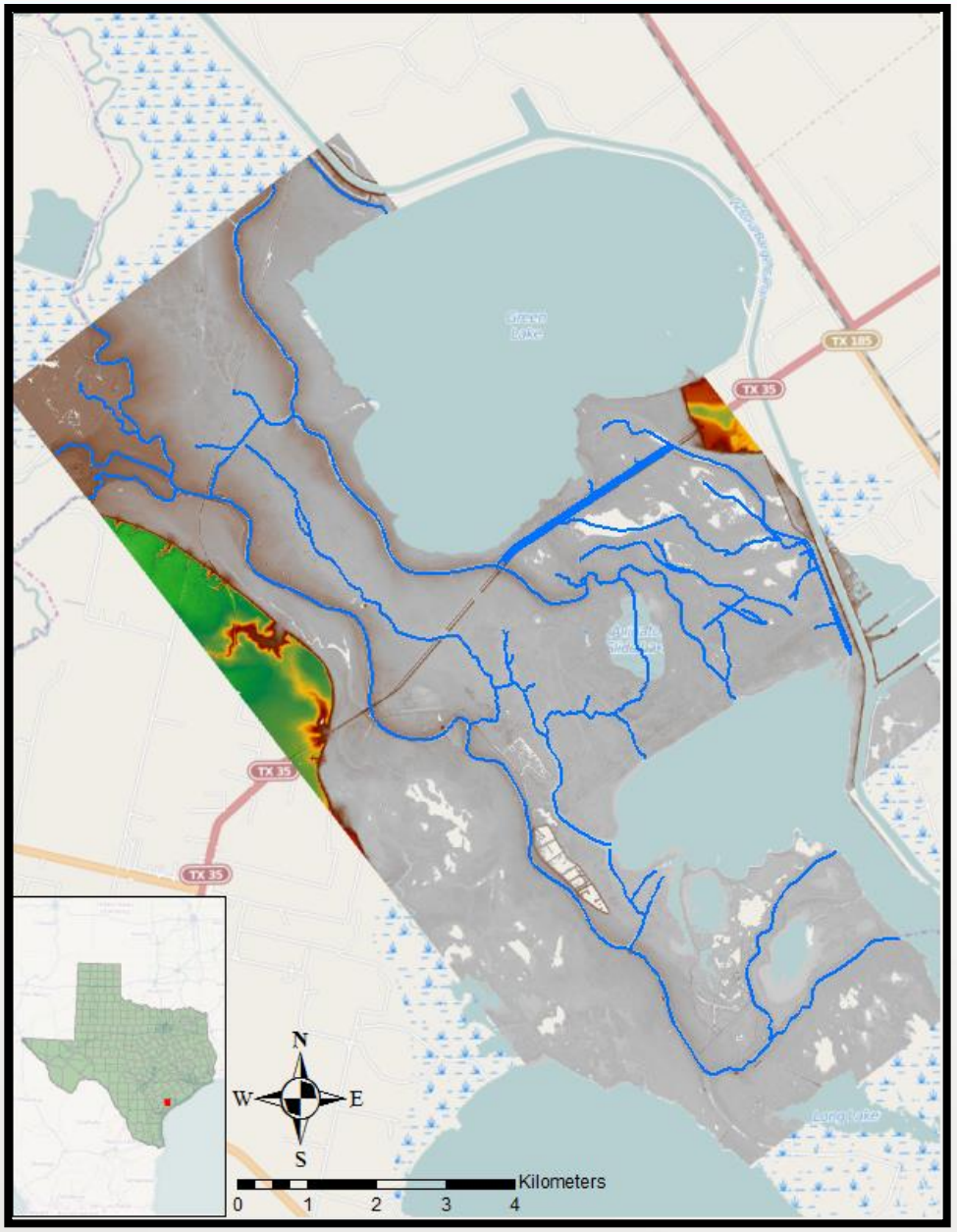
Task 1.2
Identify primary system channelization

- Based off manually edited NHD flow lines, water areas, and water bodies
- Establishes base level system connectivities



Task 1.3
Establish maps of current water surface elevations

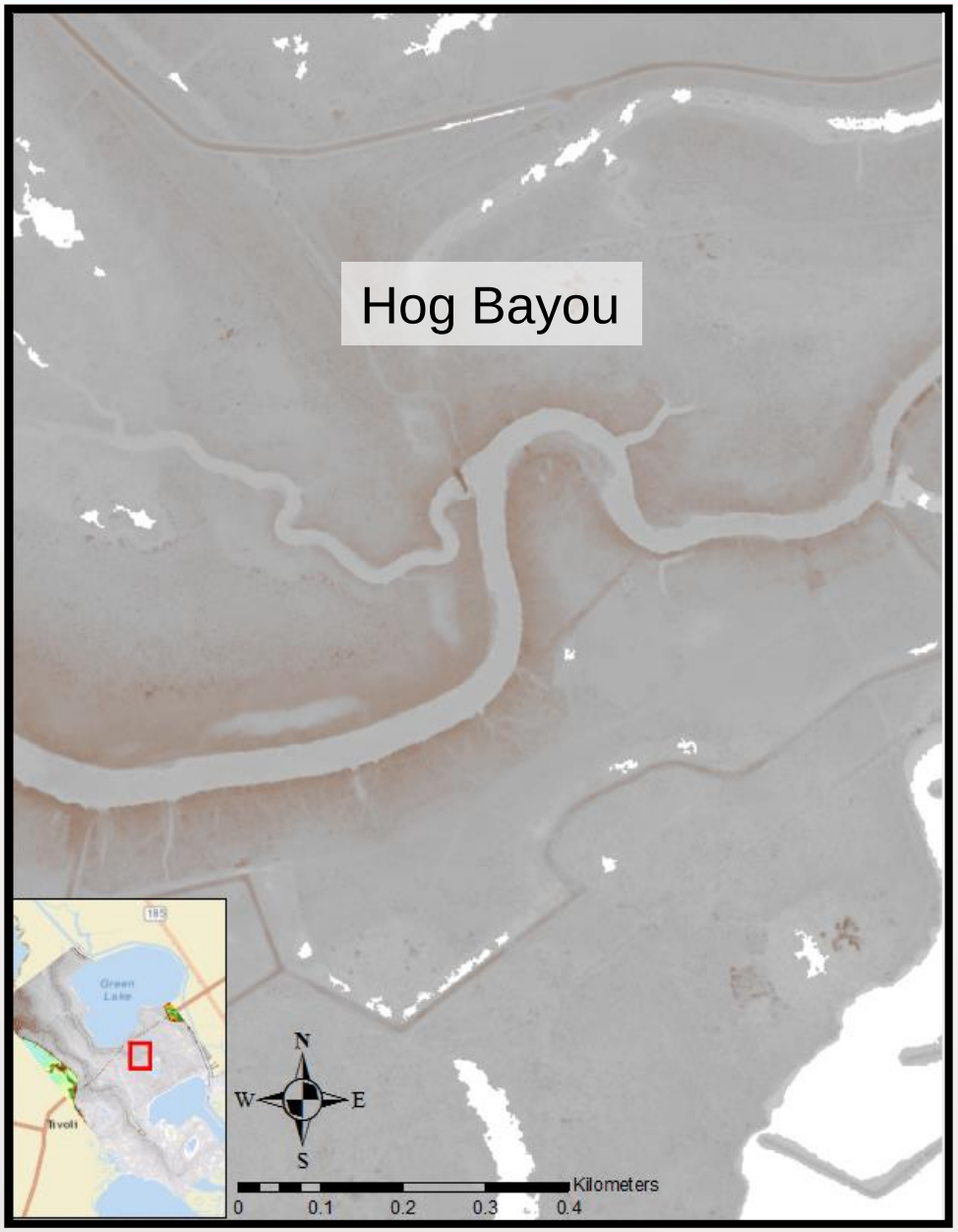
- Mapping channel extents difficult due to hyacinth masking water as terrain
- Manual water surface mapping possible, but there are numerous downsides
  - Time consuming
  - Subjective
  - Not reproducible
- Automated (or semi-automated) provides solutions to each of these problems



Task 1.3
Establish maps of current water surface elevations

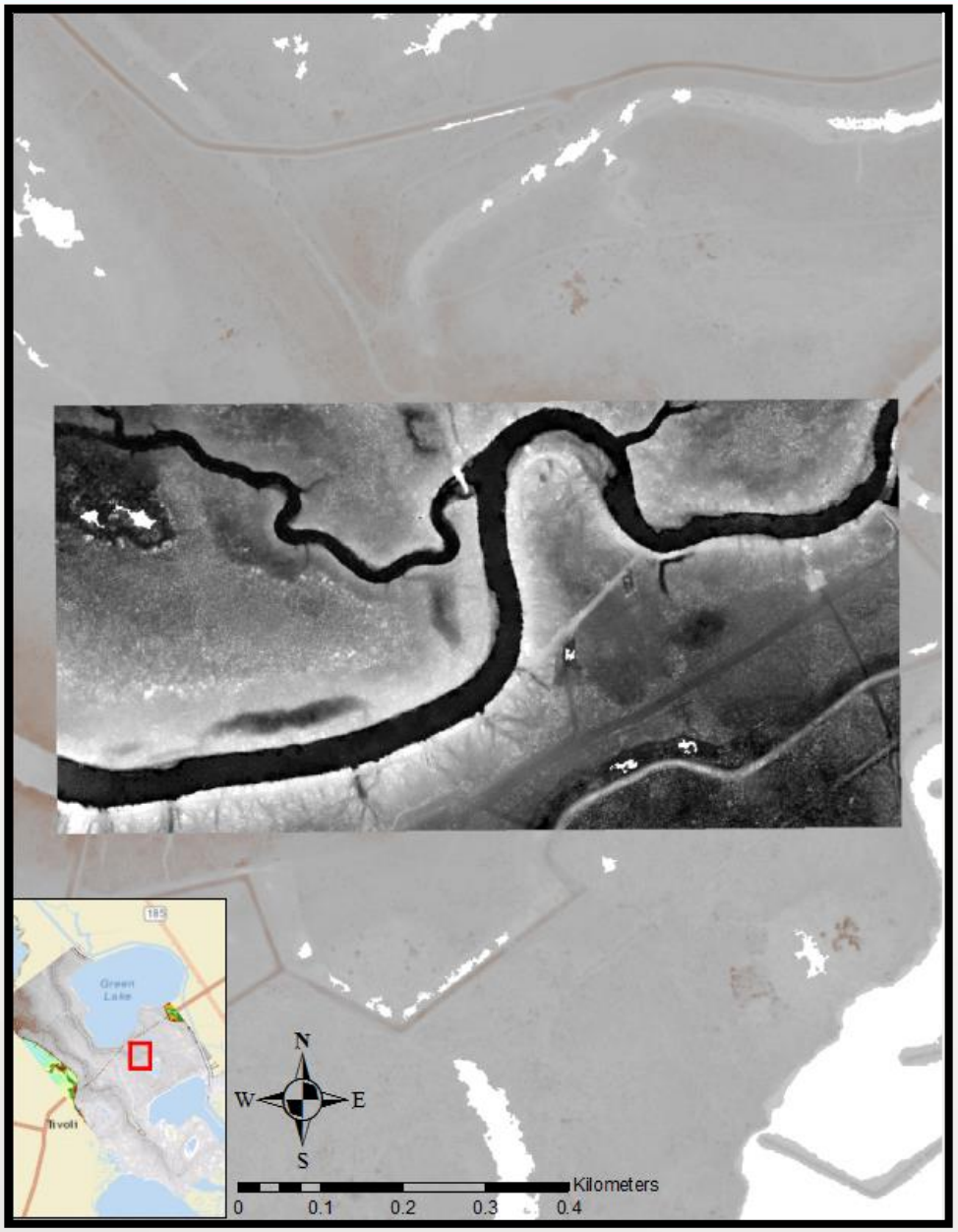
- Automated solution, GeoNet2.0 feature extraction toolbox

- Sample study on hyacinth covered reach of Hog bayou just above Alligator Slide



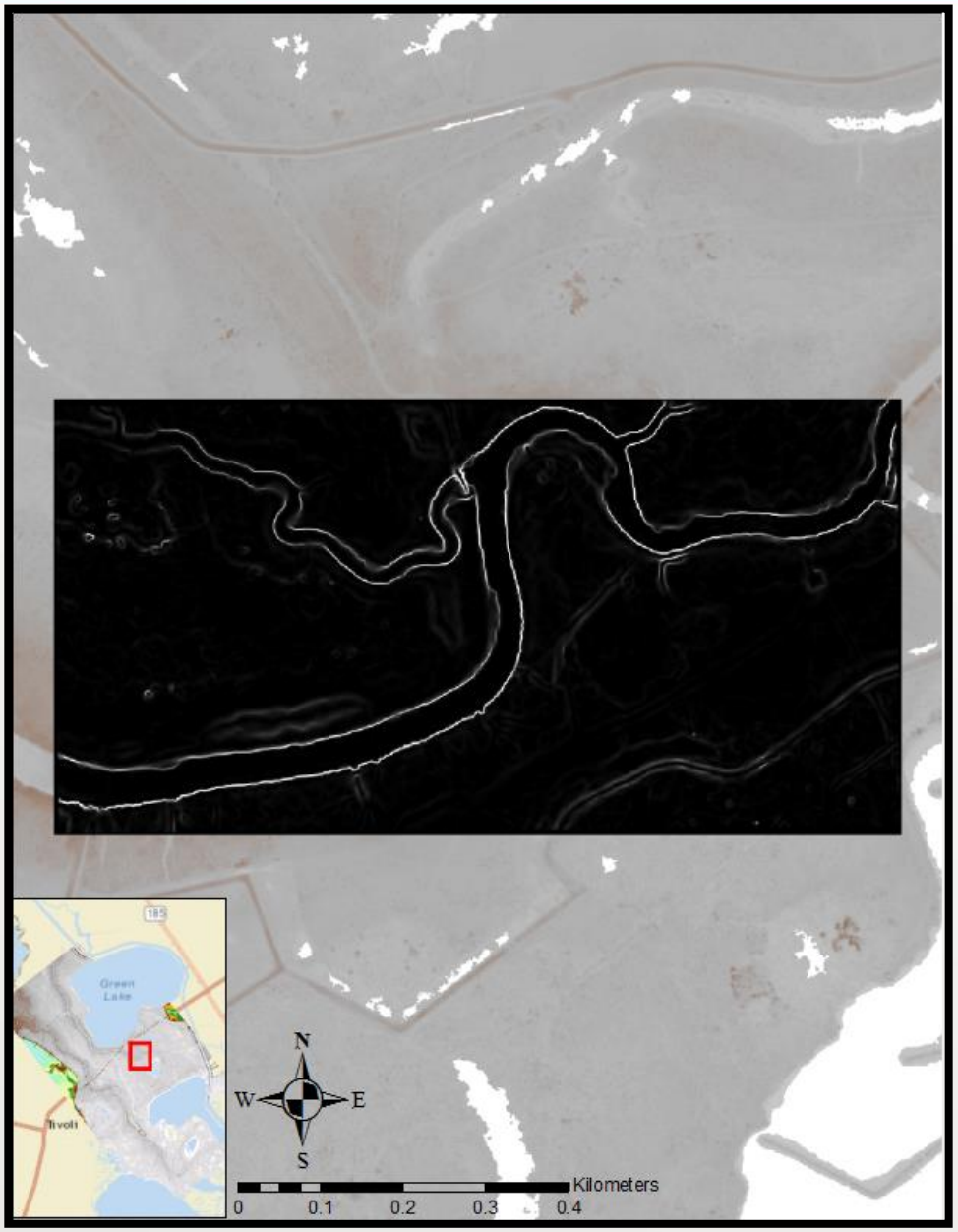
Task 1.3
Establish maps of current water surface elevations

- Import tiff to GeoNet2.0



Task 1.3
Establish maps of current water surface elevations

- Import tiff to GeoNet2.0
- GeoNet2.0
  - Extracts terrain slope



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Establish maps of current water surface elevations

- Import tiff to GeoNet2.0
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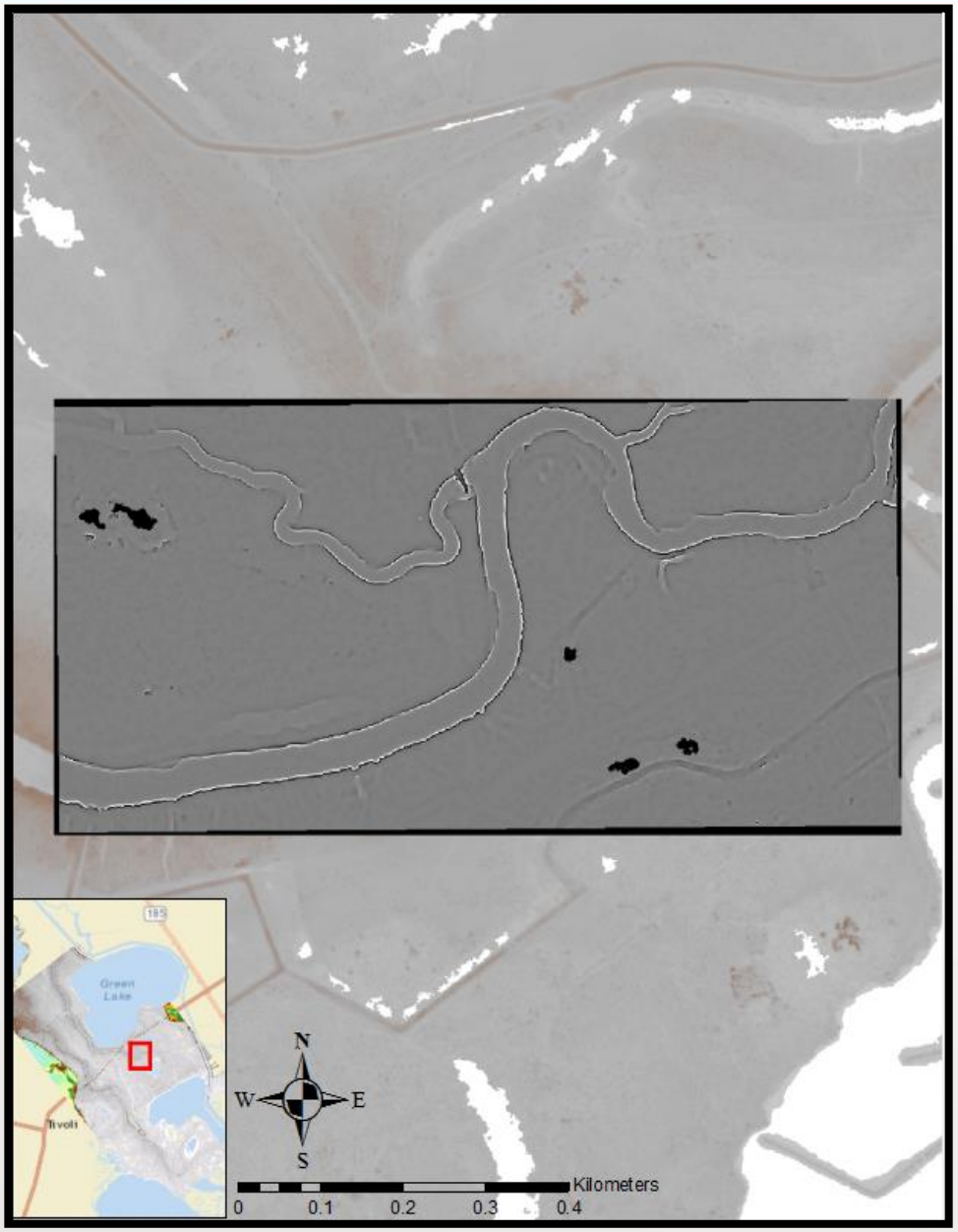
  - Extracts terrain slope
  - Determines convergent zones based on curvature



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- Import tiff to GeoNet2.0
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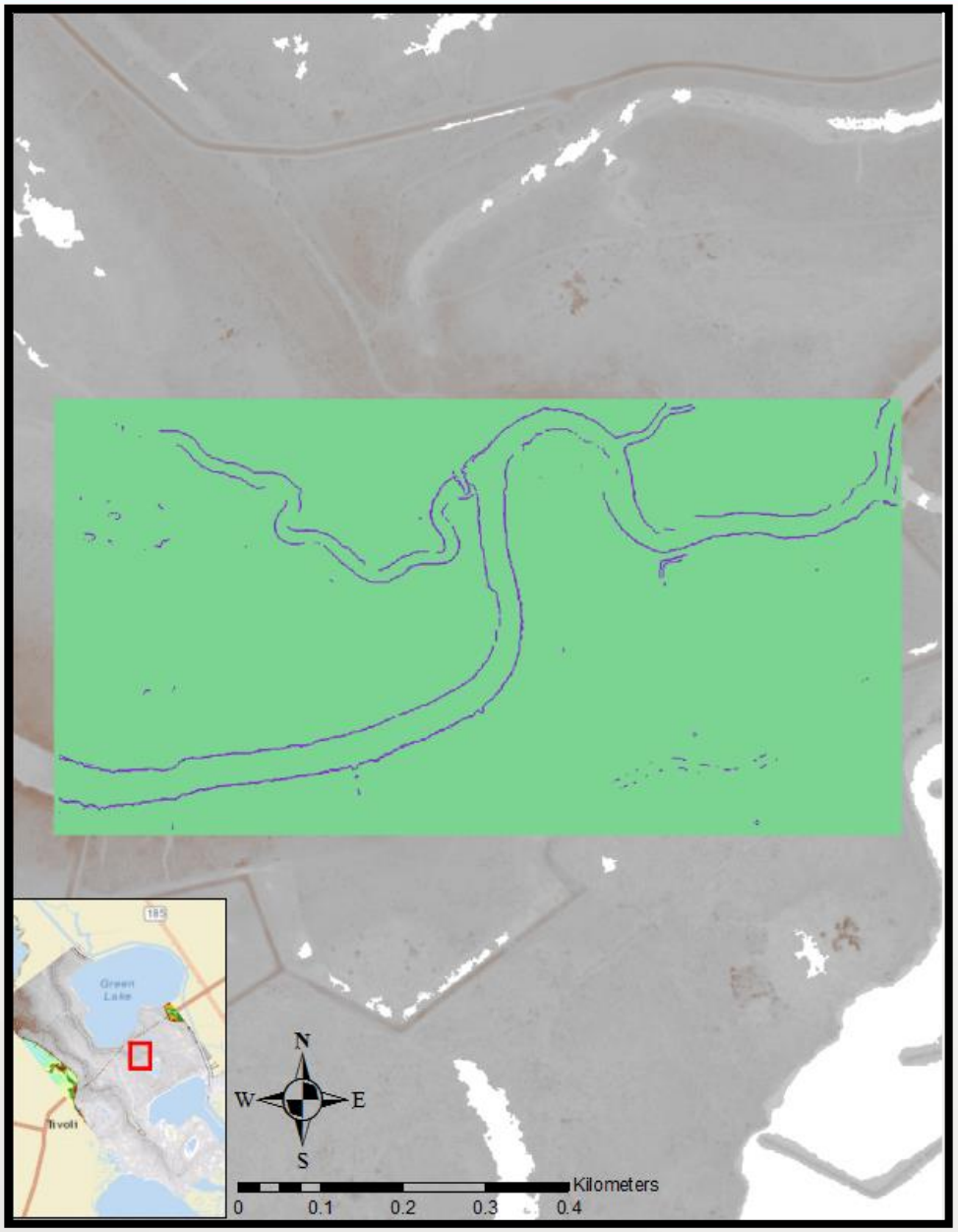
  - Determines likely bank locations



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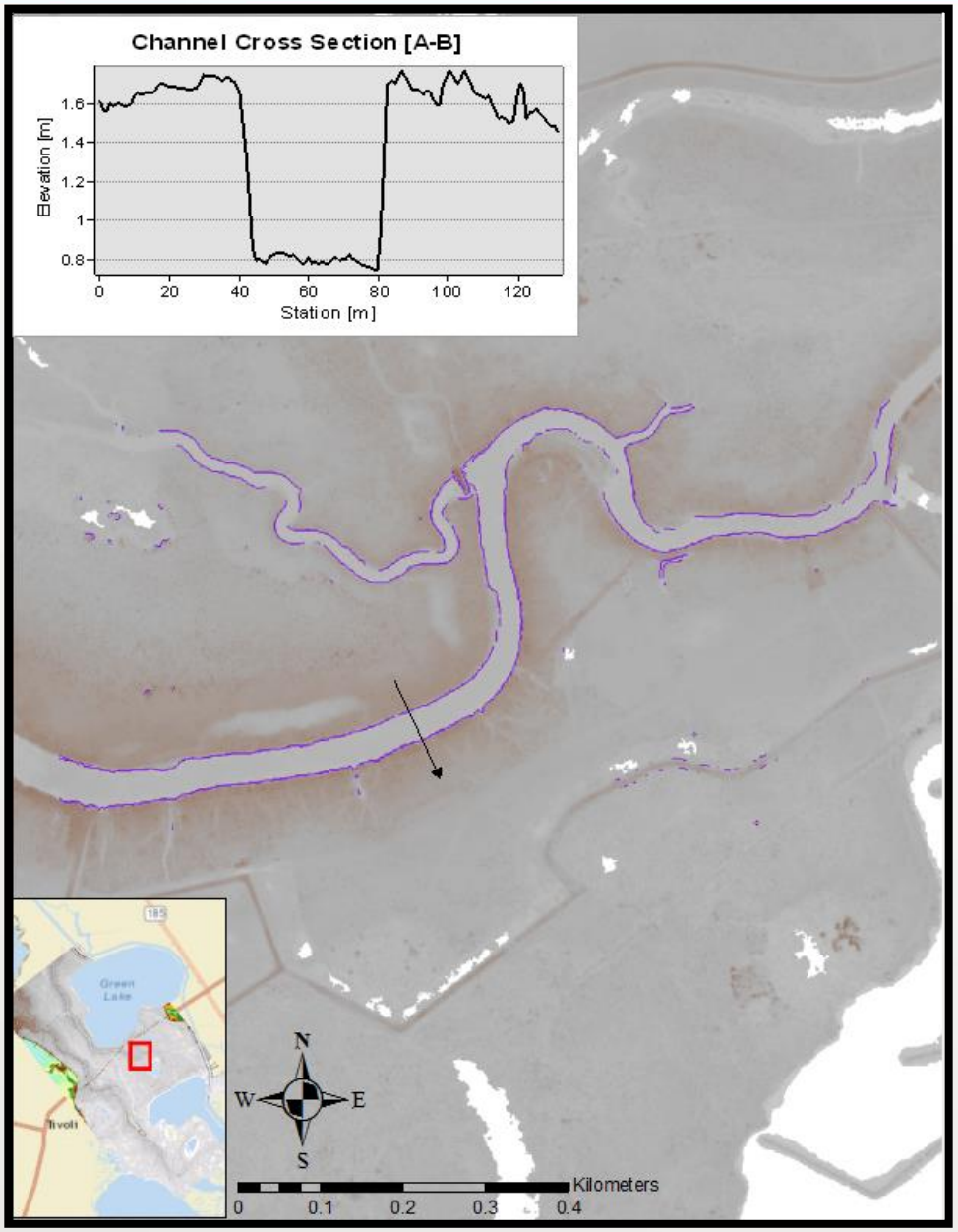
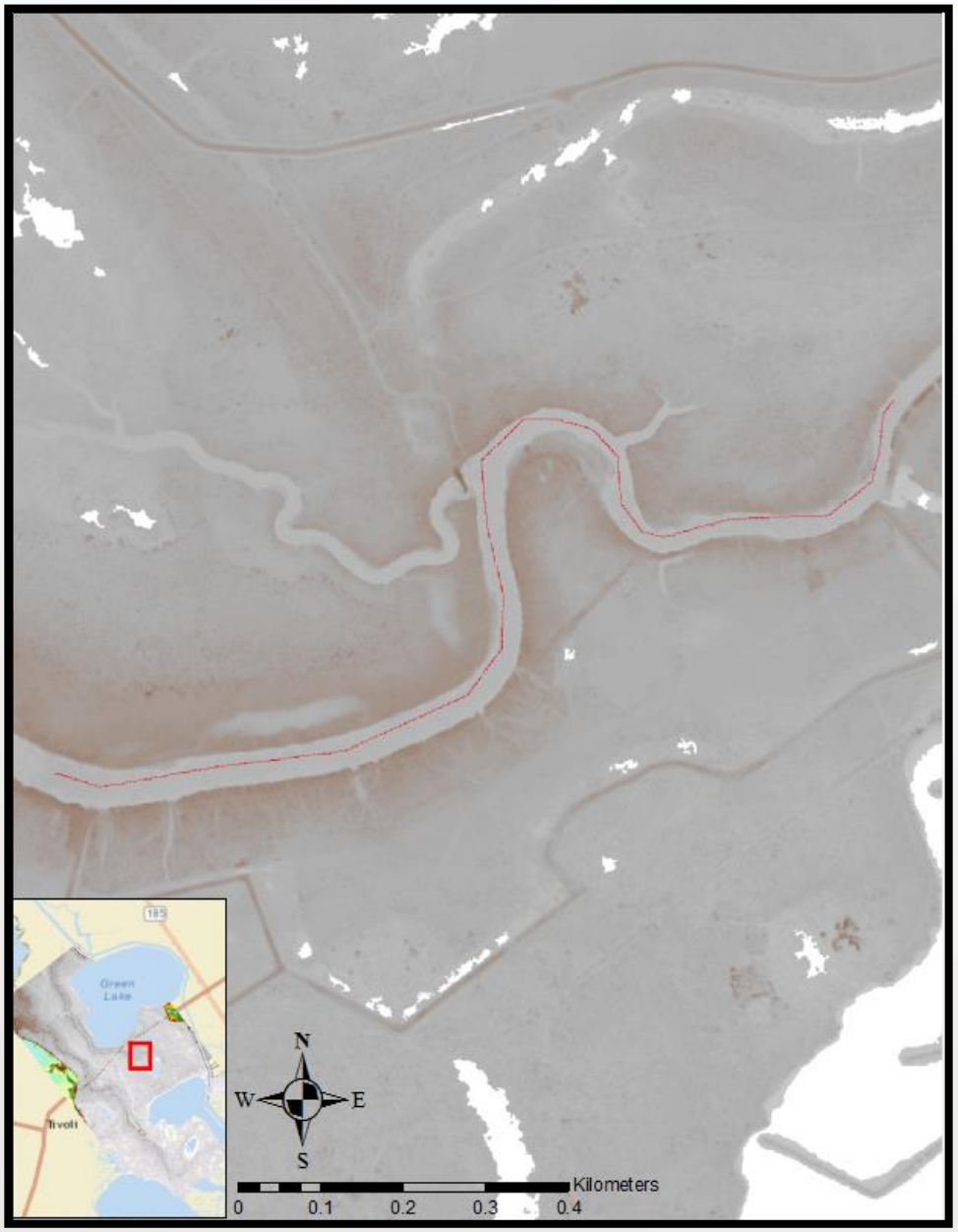
  - Extracts terrain slope
  - Determines convergent zones based on curvature
  - Determines likely bank locations
  - Identified bank edges show good agreement visually



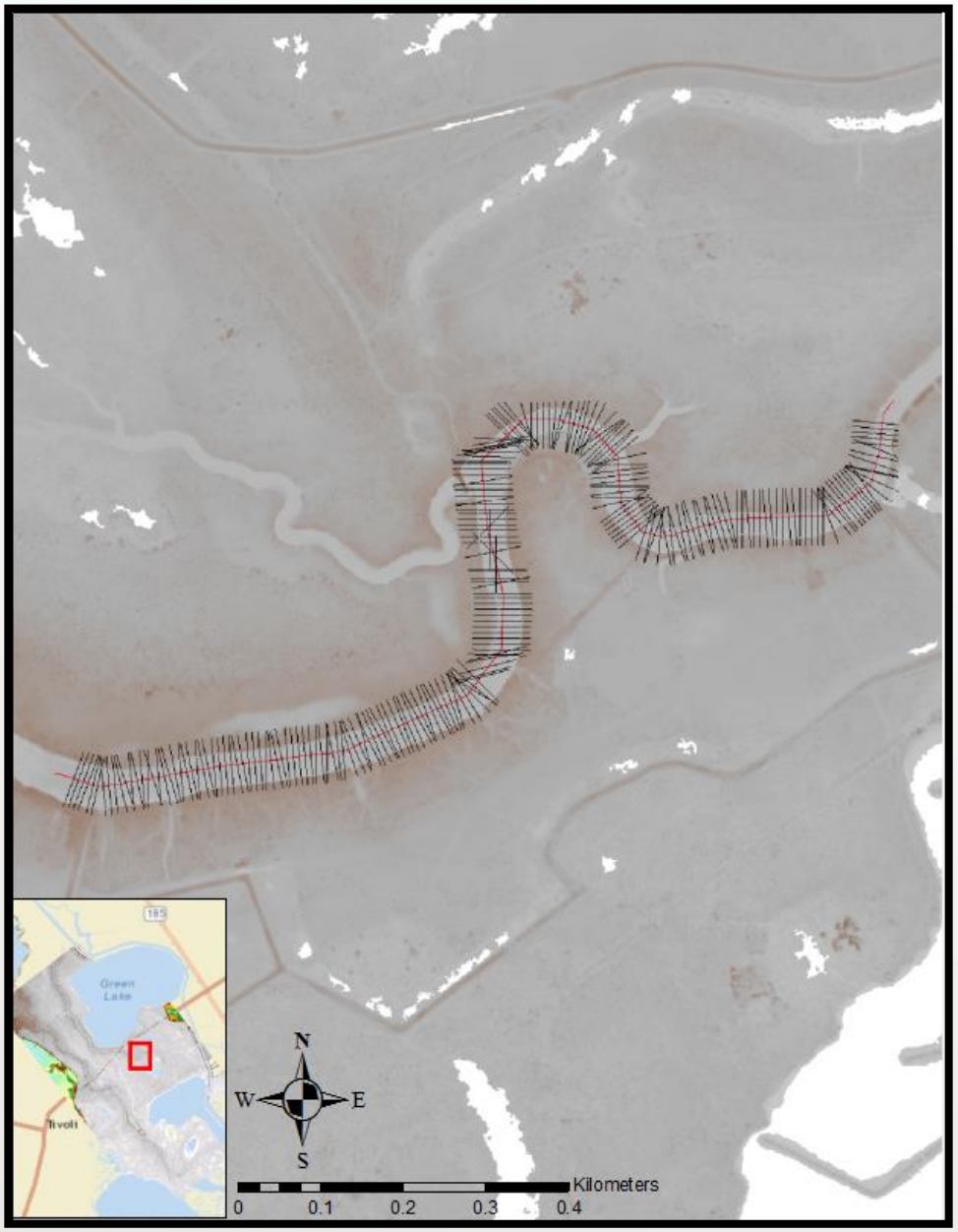
Task 1.3
Establish maps of current water surface elevations

- Continuing, the toolbox
  - Extracts channel centerline



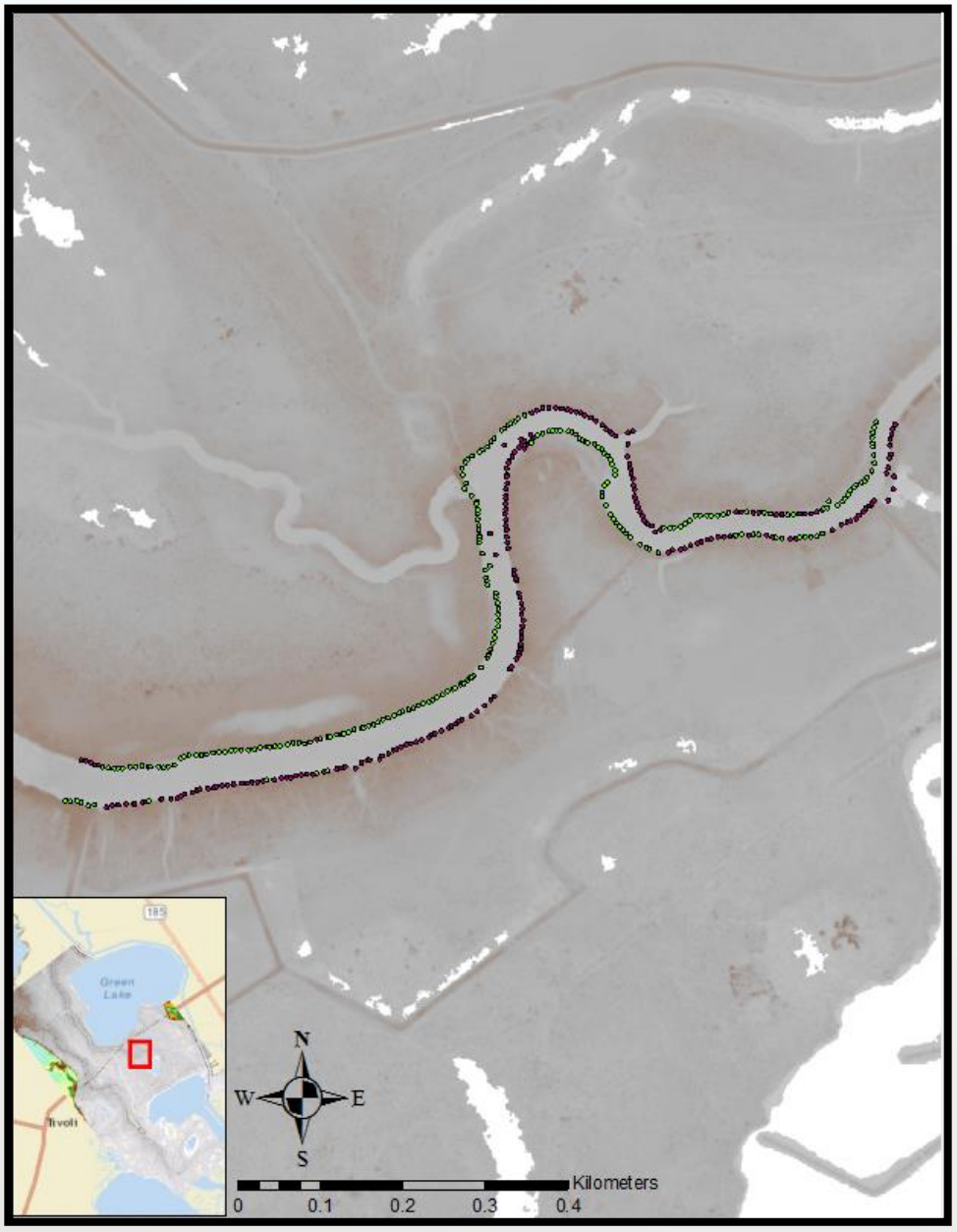
Task 1.3
Establish maps of current water surface elevations

- Continuing, the toolbox
  - Extracts channel centerline
  - Strikes cross sections



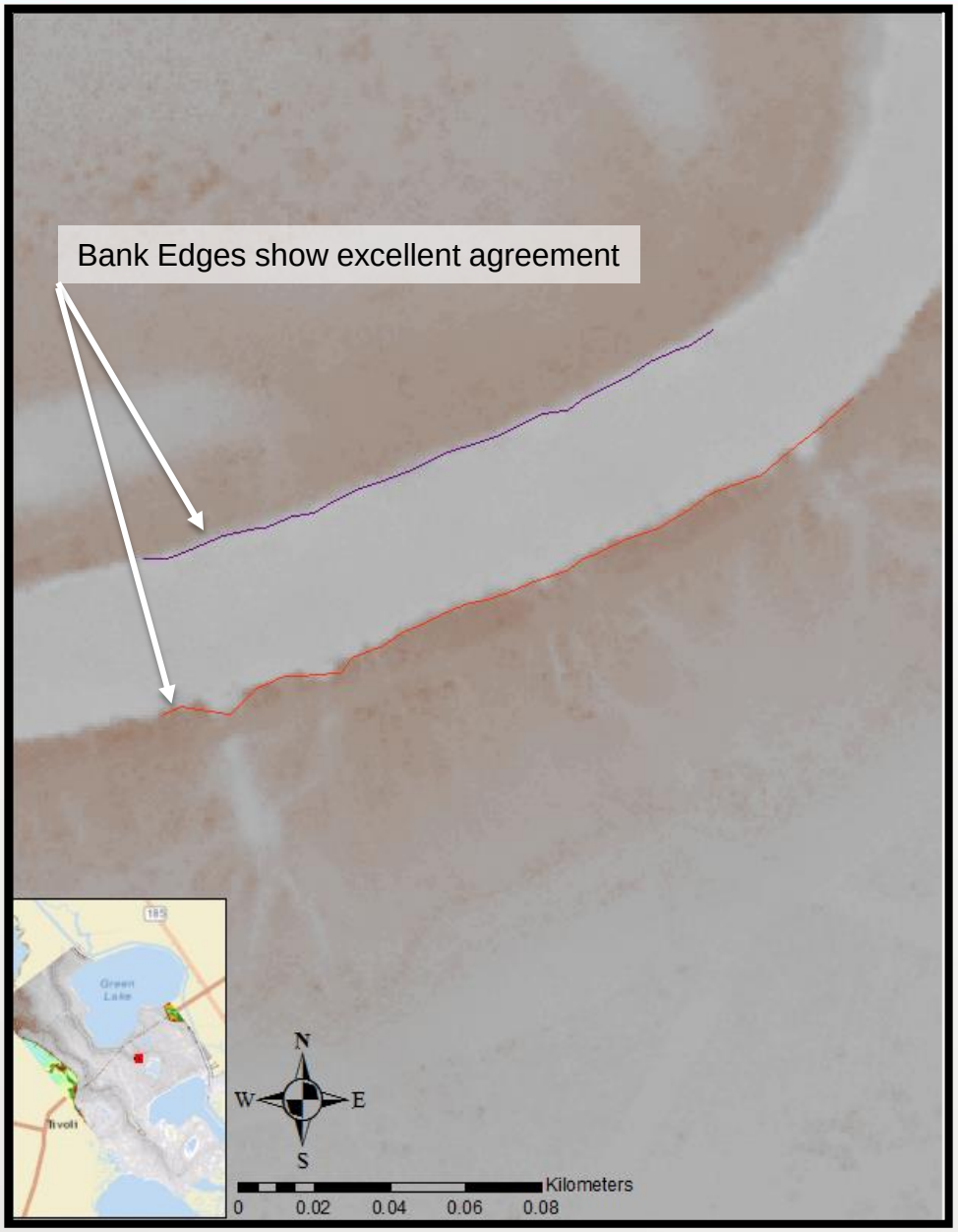
Task 1.3
Establish maps of current water surface elevations

- Continuing, the toolbox
  - Extracts channel centerline
  - Strikes cross sections
  - Identifies and extracts bank points in cross sections



Task 1.3
Establish maps of current water surface elevations

- Continuing, the toolbox
  - Extracts channel centerline
  - Strikes cross sections
  - Identifies bank points in cross sections
  - Extracts bank points
- Bank points can be connected to form a continuous line



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Establish maps of current water surface elevations

- Continuing, the toolbox
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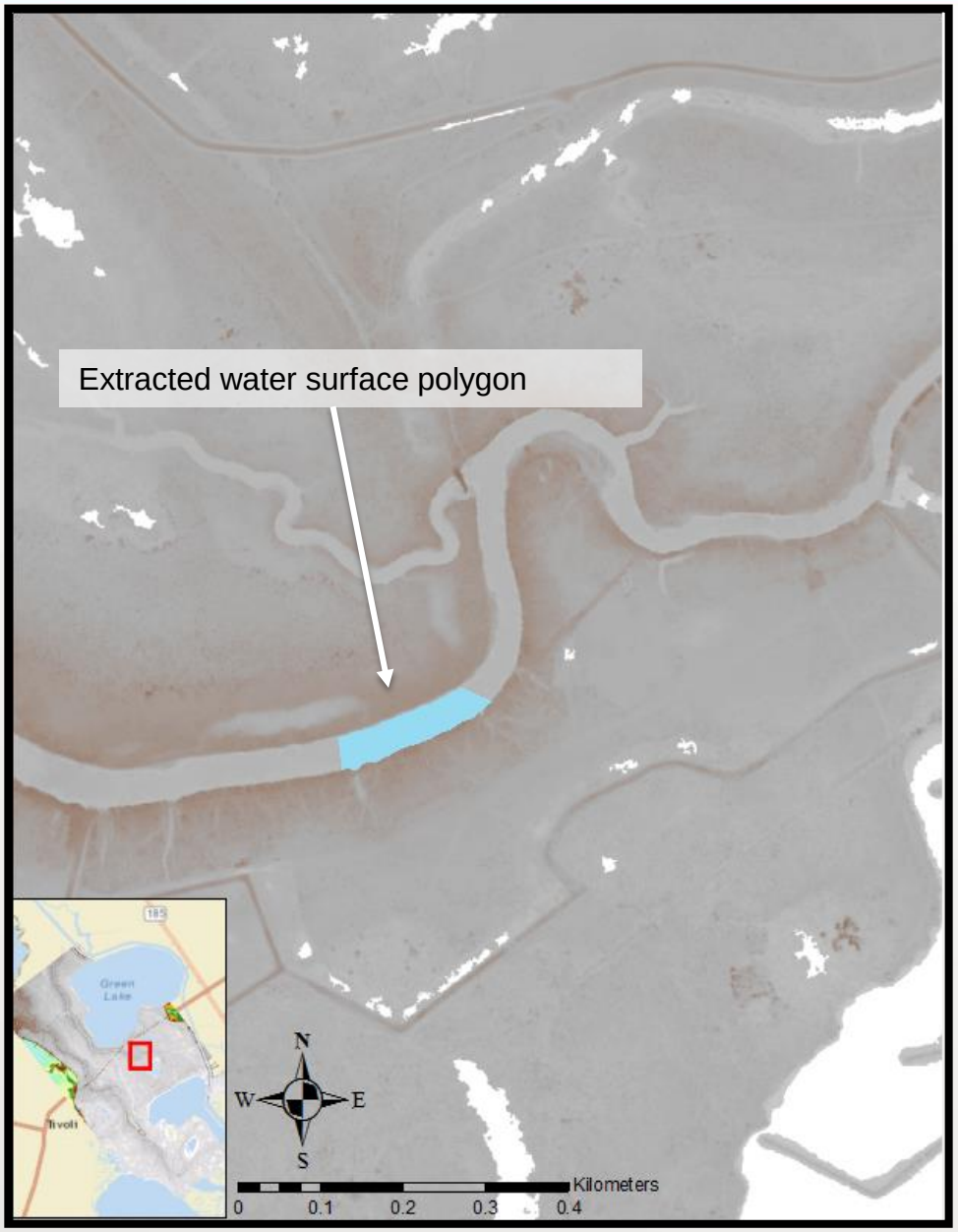
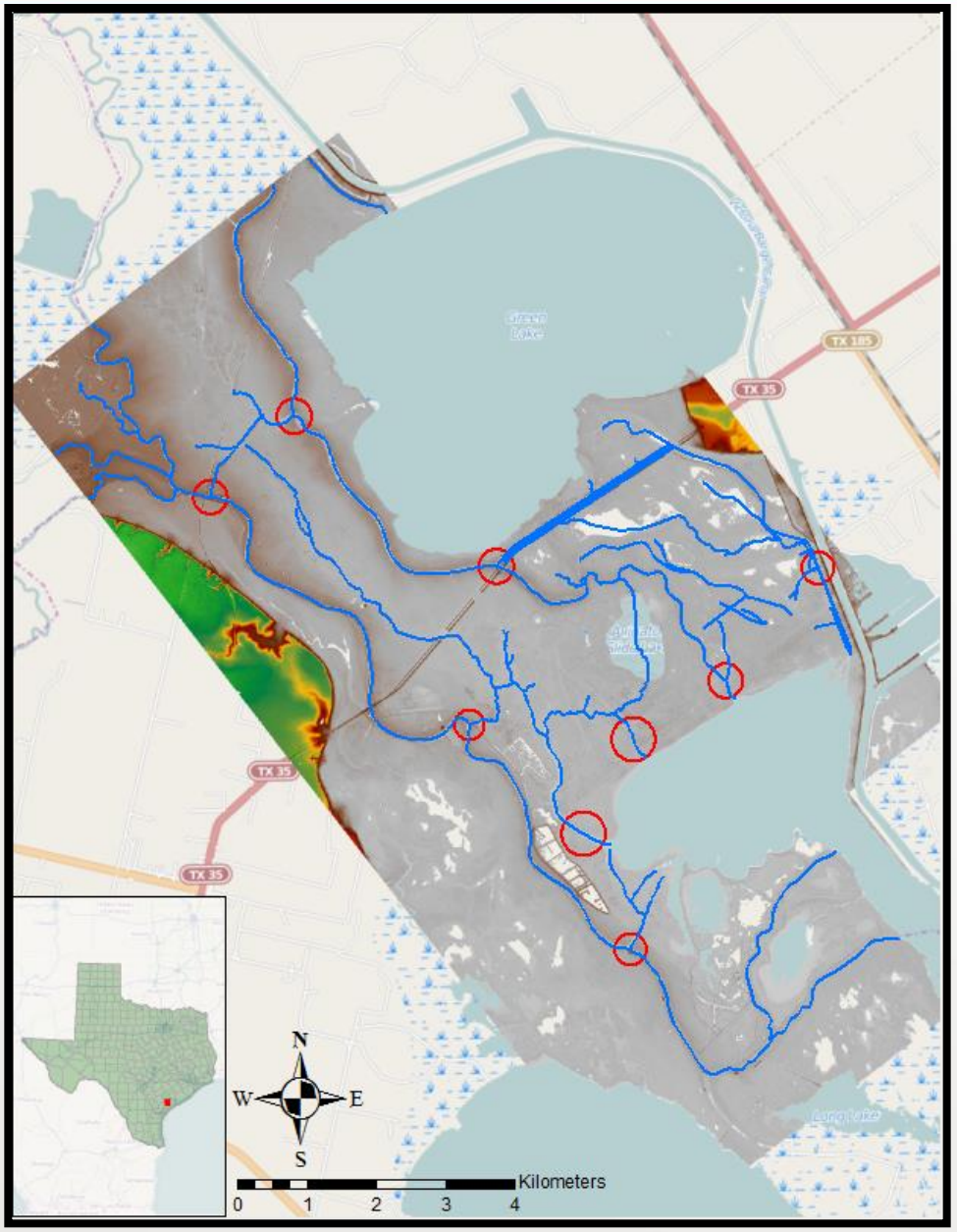
  - Identifies bank points in cross sections
  - Extracts bank points
- Bank points can be connected to form a continuous line
- Line can be formed into water surface polygon



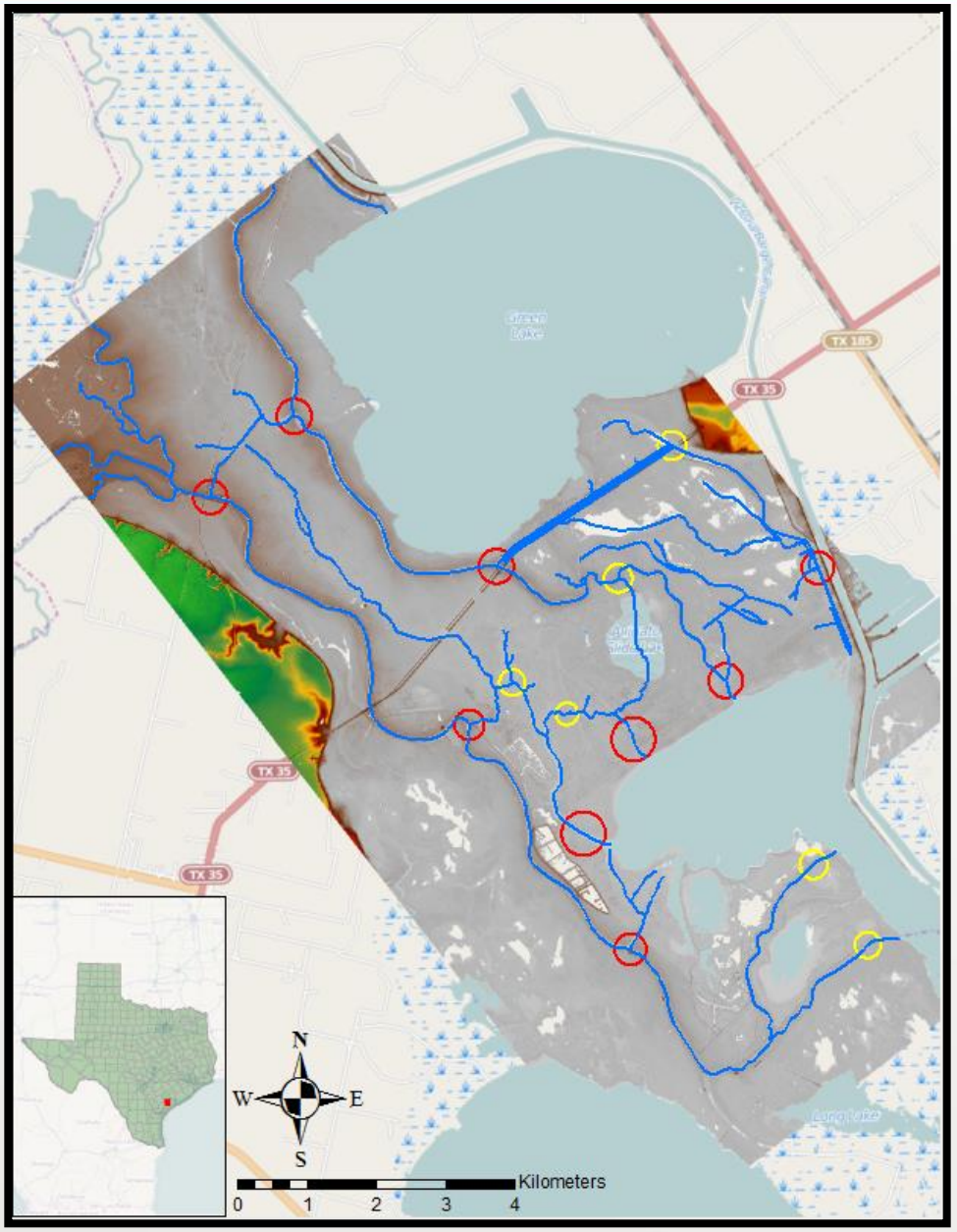
Task 2.1
Identify likely sensor locations

- Locations of primary interest circled in red
- Represent bulk system inputs/outputs and key diversions



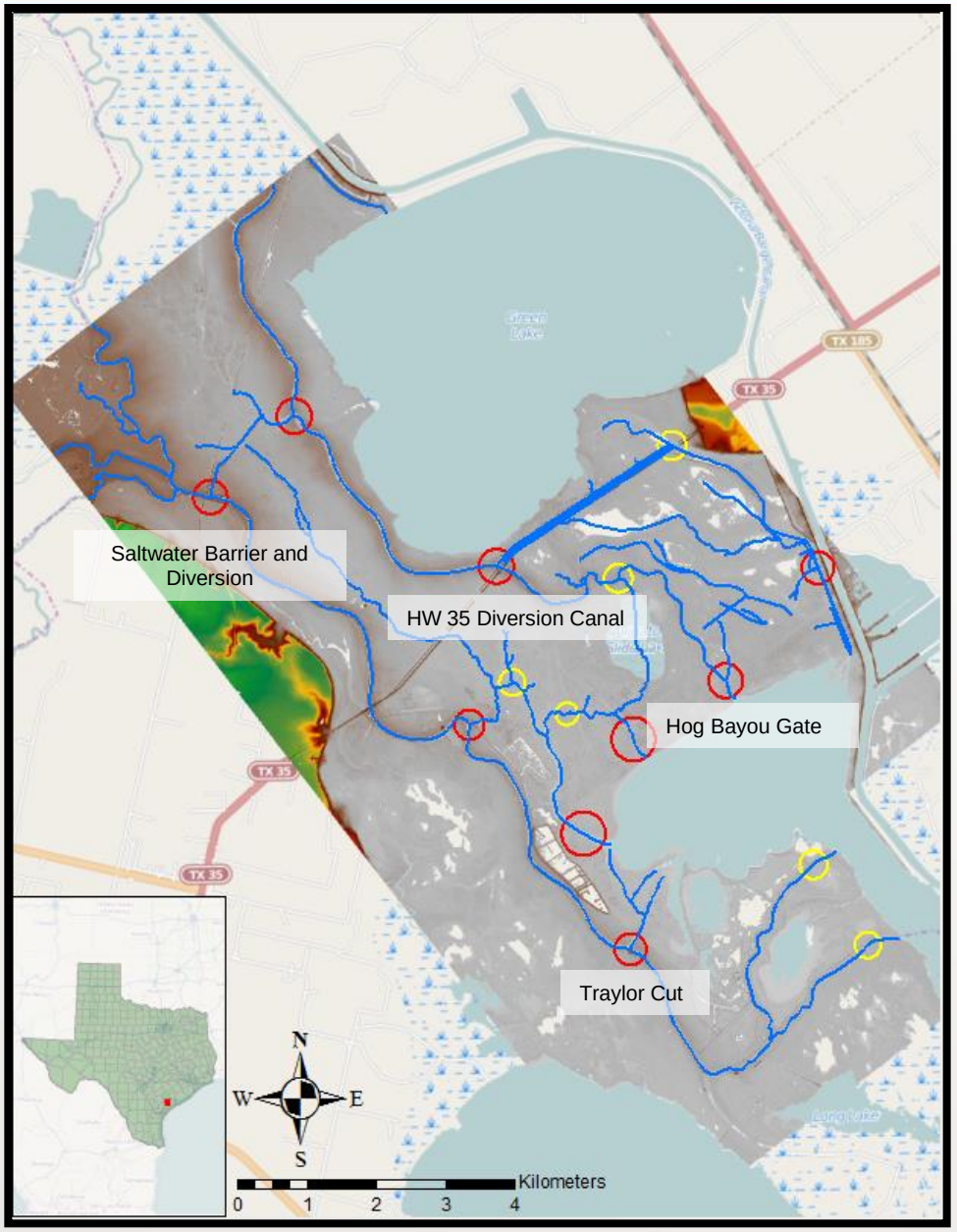
Task 2.1
Identify likely sensor locations

- Locations of secondary interest seen in yellow
- Represent more detailed views of system inputs/outputs and interior system workings



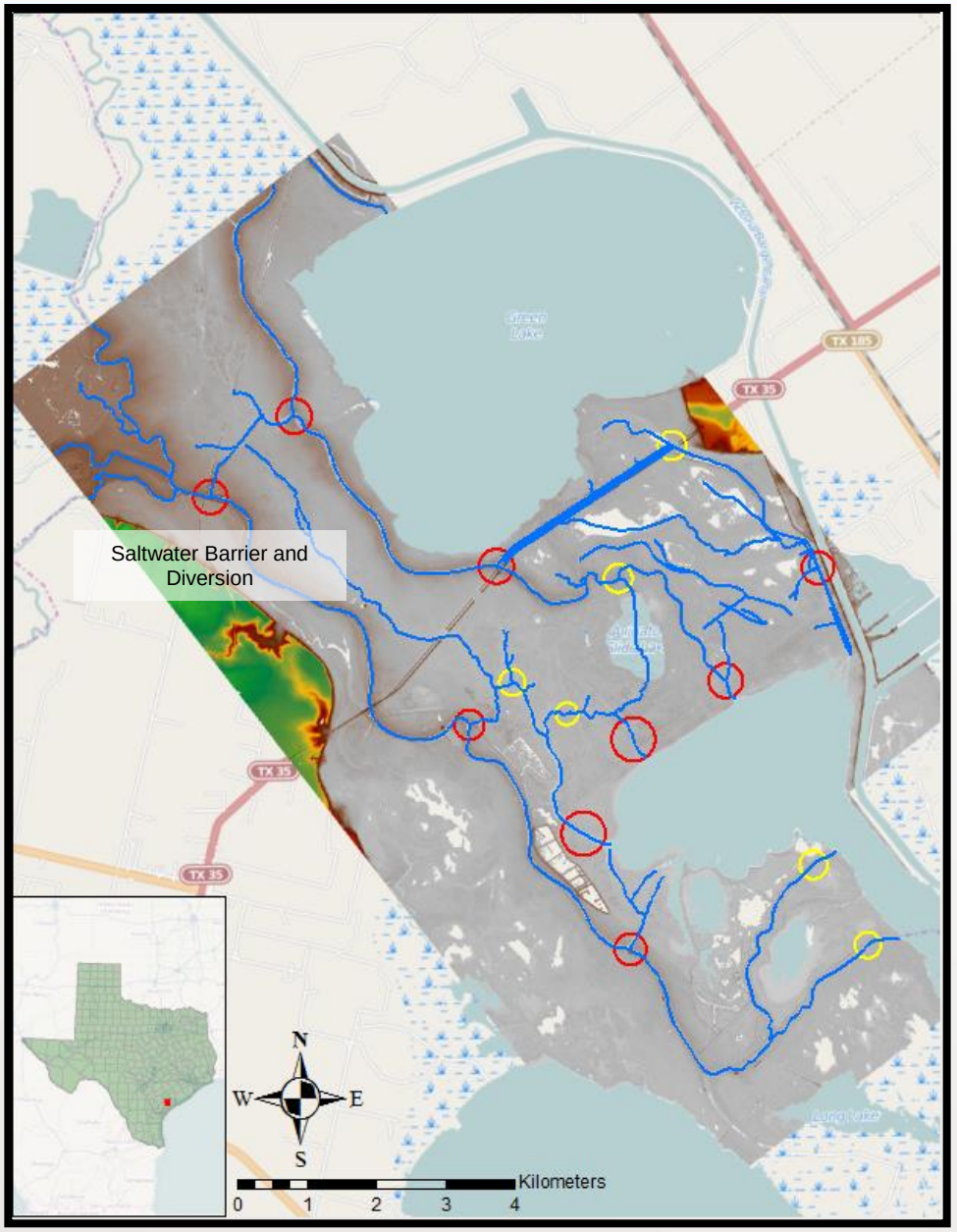
Task 2.2
Perform field reconnaissance

- Initial visit 11/21/2014 guided by Dan Alonso of SABAY
- Established on ground feel for area
- Looked at 4 specific site locations



Task 2.2
Perform field reconnaissance

- Guadalupe River saltwater barrier and diversion canal
- Barrier constructed 1965 by GBRA
- Fabridam bags inflated during low flow conditions
- Diversion redirects water from Guadalupe River into upper Hog Bayou



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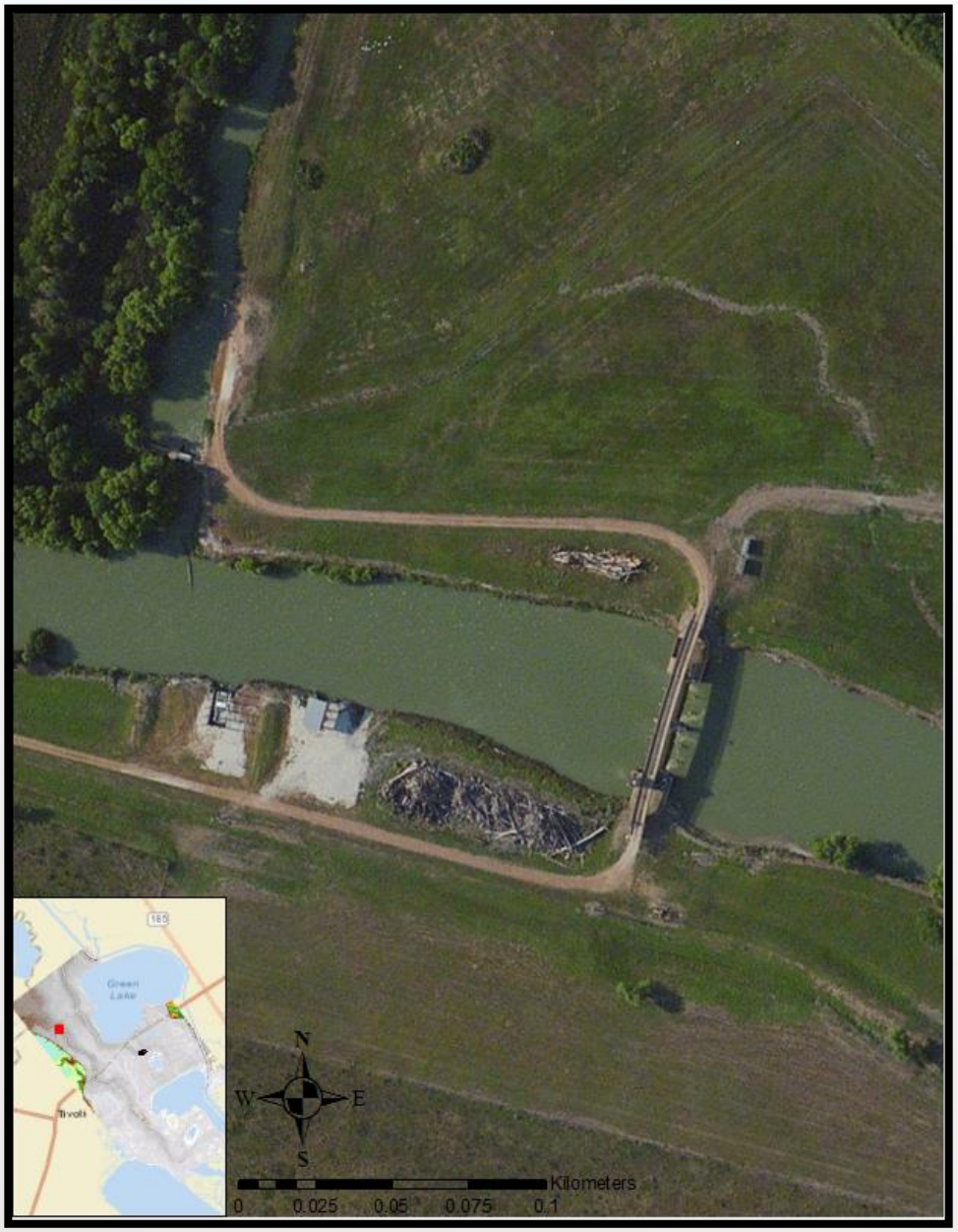

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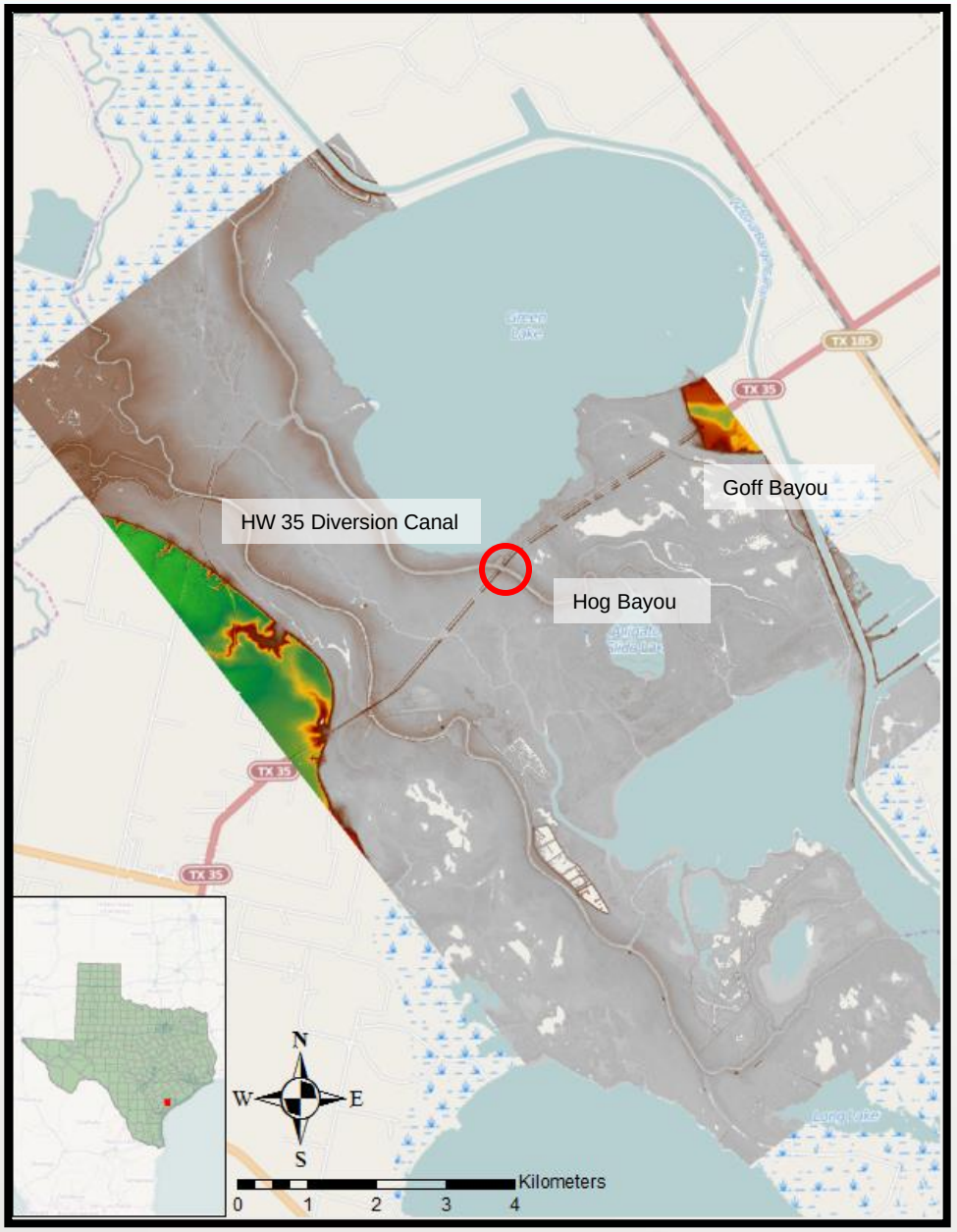
- Diverts water from Hog Bayou to Goff Bayou for industrial use across Victoria Barge Canal



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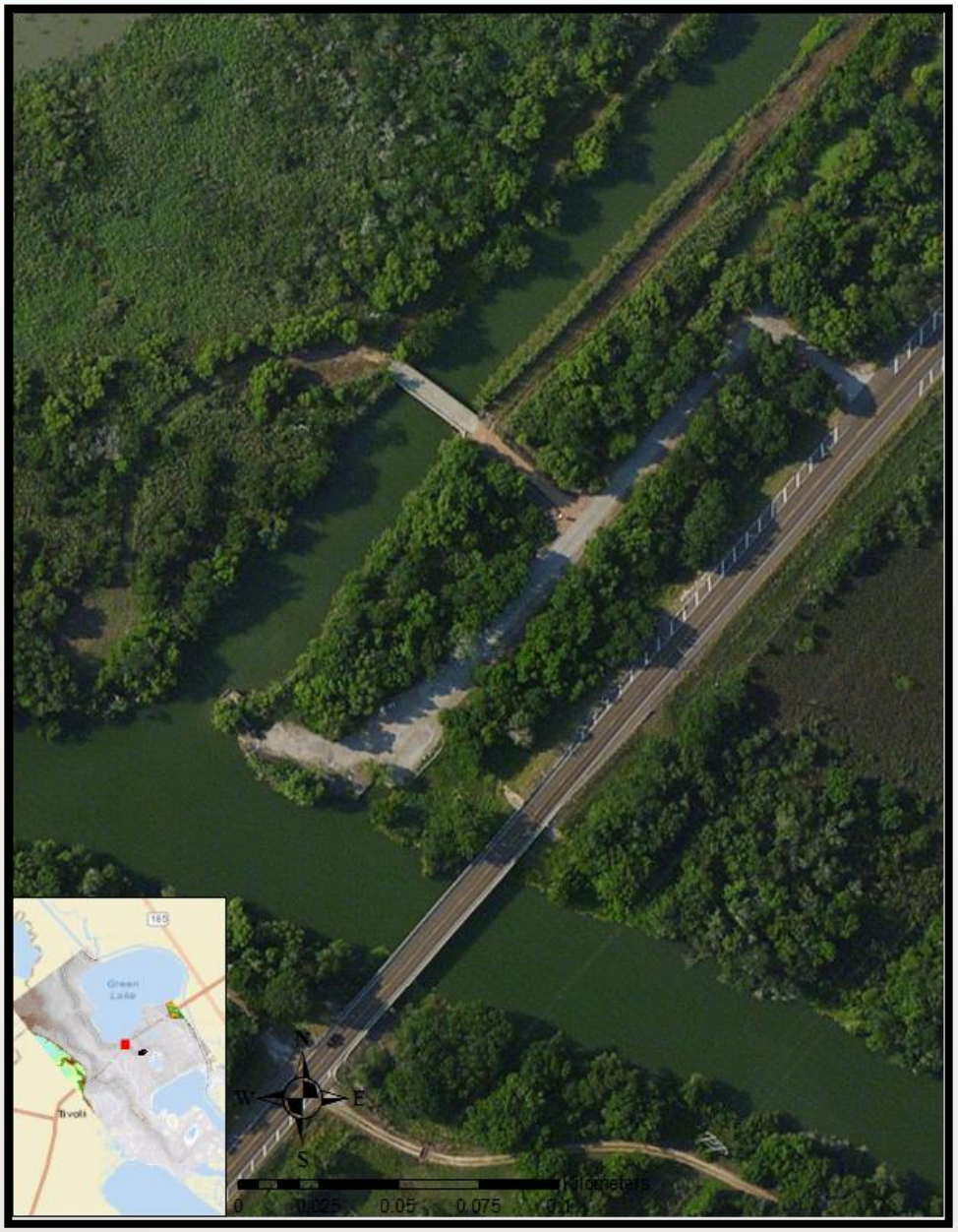

HW 35 Diversion Canal
01/2013

Upstream

Downstream

HW 35 Diversion Canal
11/2014

Upstream

Downstream

TIMELINE OF ONGOING WORK

Initial Project Timeline

Task 1

- Inundation maps: Sept 2014

Task 2

- Field Survey 1 : Sept. 2014
- Field Survey 2: Dec. 2014
- Field Survey 3: Mar. 2014

Task 3

- Model Initialization: Sept. – Dec. 2014
- Model Calibration: Jan. – Mar. 2015
- Model Analysis: Apr. – June. 2015

Updated Project Timeline

Task 1

- Inundation maps: ~~Sept 2014~~ Ongoing

Task 2

- Field Survey 1 : Sept. 2014
- Field Survey 2: ~~Dec. 2014~~ Jan. 2014
- Field Survey 3: Mar. 2014

Task 3

- Model Initialization: ~~Sept. – Dec. 2014~~ Dec.- February 2015
- Model Calibration: Jan. – Mar. 2015
- Model Analysis: Apr. – June. 2015

PROJECT OUTCOMES

Deliverables

Task 1

- Inundation maps of delta system at various depths

Task 2 and 3

- Hydrodynamic model of Guadalupe Delta system

Benefits

Task 1

- Automated, objective, reproducible method for digitizing delta channels covered with aquatic vegetation

Task 2 and 3

- Understanding of water flow through bayous

- Means of estimating effects for changing withdrawal demands

Acknowledgements

Funding

Contacts within TWDB, GBRA

Kevin Kriegel, TPWD

Dan Alonso, SABAY

QUESTIONS?

Contact Information:

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richardcarothersUT@gmail.com