# DOUBLE BAYOU WATERSHED:
## OVERVIEW OF THE COMPLETED WATERSHED CHARACTERIZATION PROJECT AND BEGINNING THE WATERSHED PROTECTION PLAN

Photo courtesy of Linda Shead

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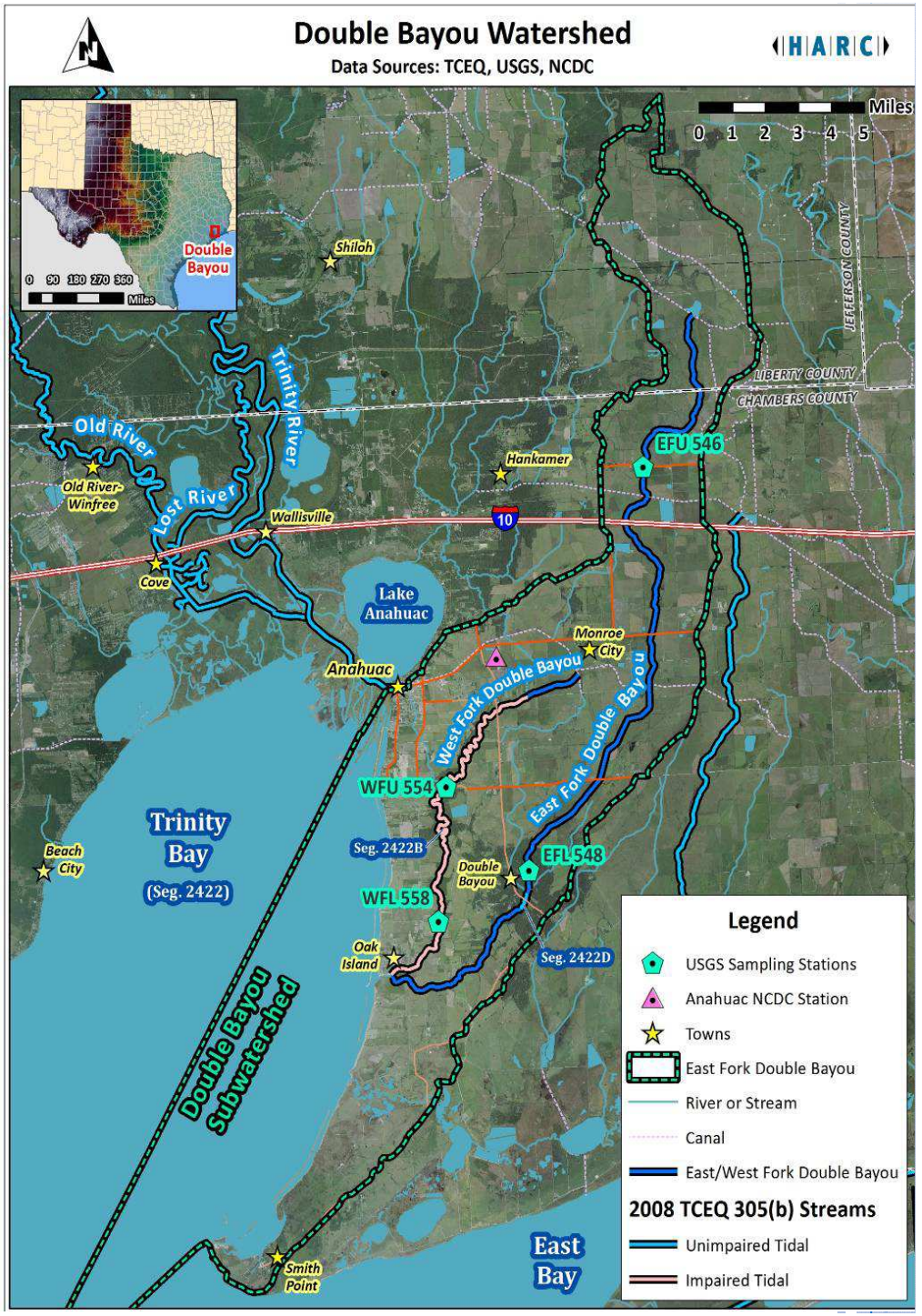
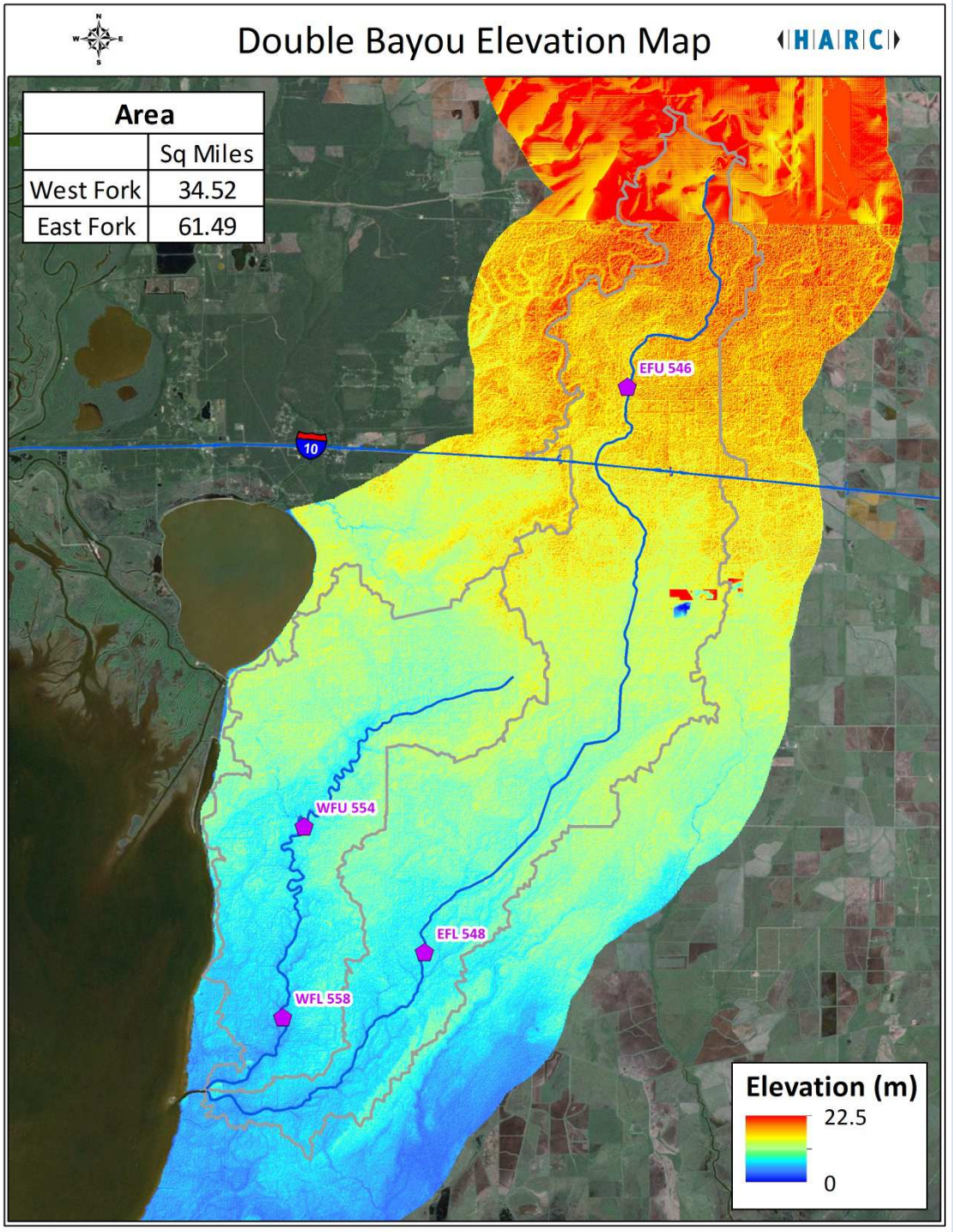
# DOUBLE BAYOU WATERSHED

- In the Lower Galveston Bay watershed of the Upper Texas Gulf Coast
- 138 square miles
- West Fork – listed as impaired for dissolved oxygen and bacteria since 2004
- East Fork – lower scenic section used for recreation
- Land use – mostly rice and cattle



# LAND ELEVATIONS

- Topography is generally very flat.
- Rice irrigation canals and channelized waterways have altered the natural drainage pattern.
- Oil and gas wells are scattered through the area.



# CHARACTERIZATION STUDY

- August 2009 – October 2011
- Funded through GBEP and TCEQ (ARRA funding).
- Researched baseline data from various agencies and universities.
- Identified gaps and implemented water quality monitoring.
- Analyzed water quality data, spatially and temporally.
- Introduced results and watershed planning to key stakeholders in the watershed.

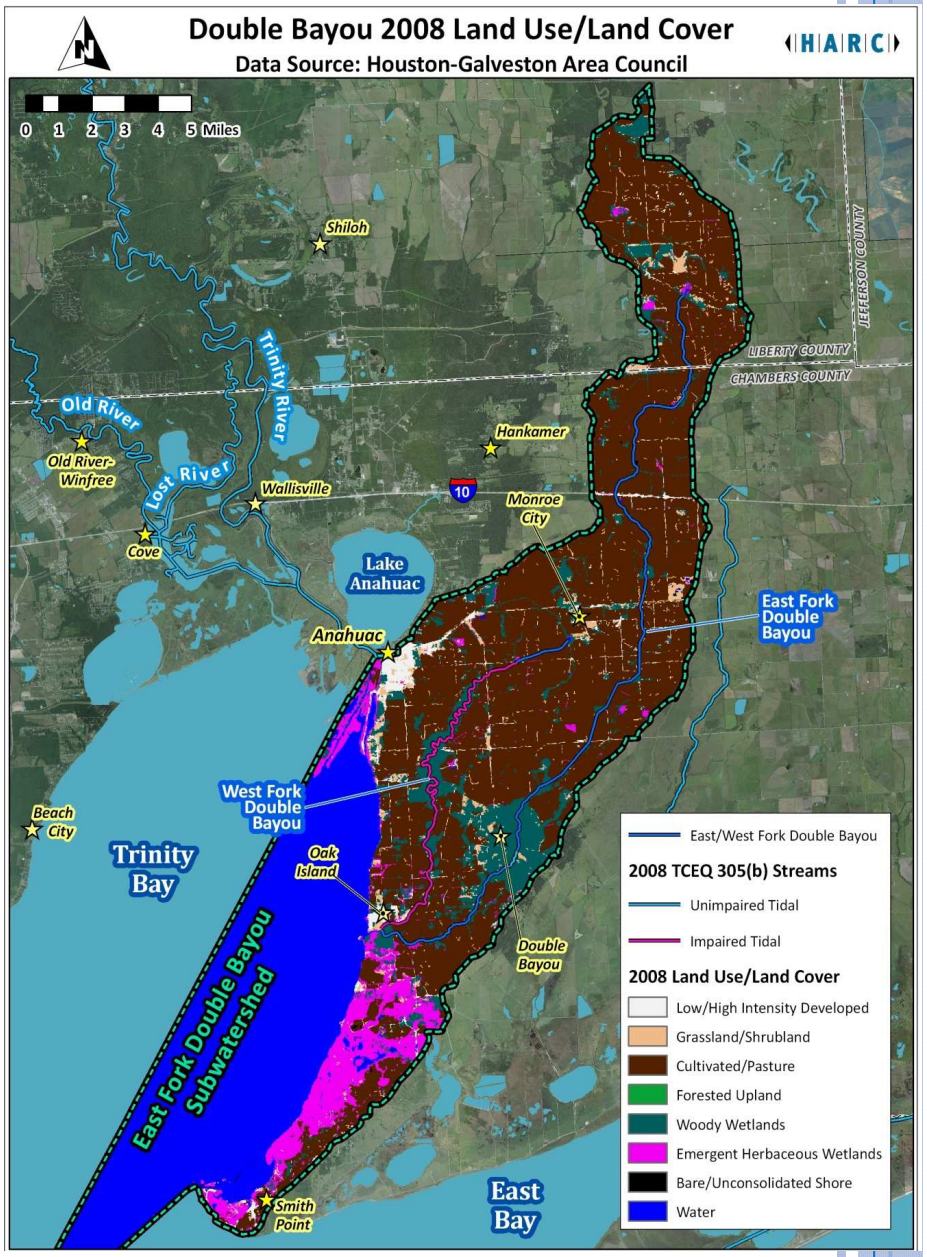
East Fork Double Bayou, Upper Site.

East Fork Double Bayou, Lower Site

photos courtesy of HARC

# REPORTED LAND USE CONCERNS

- Lack of drainage
- Effluent discharge by sprinklers upstream of 1663
- Possibly increased animal loading with more divided interests and smaller tracts
- Bacteria applied to ponds to reduce algae growth by using up nutrients
- Double Bayou water carried to Smith Point oyster reefs by Trinity Bay currents
- Types of control measures that might be “required” for agricultural inputs



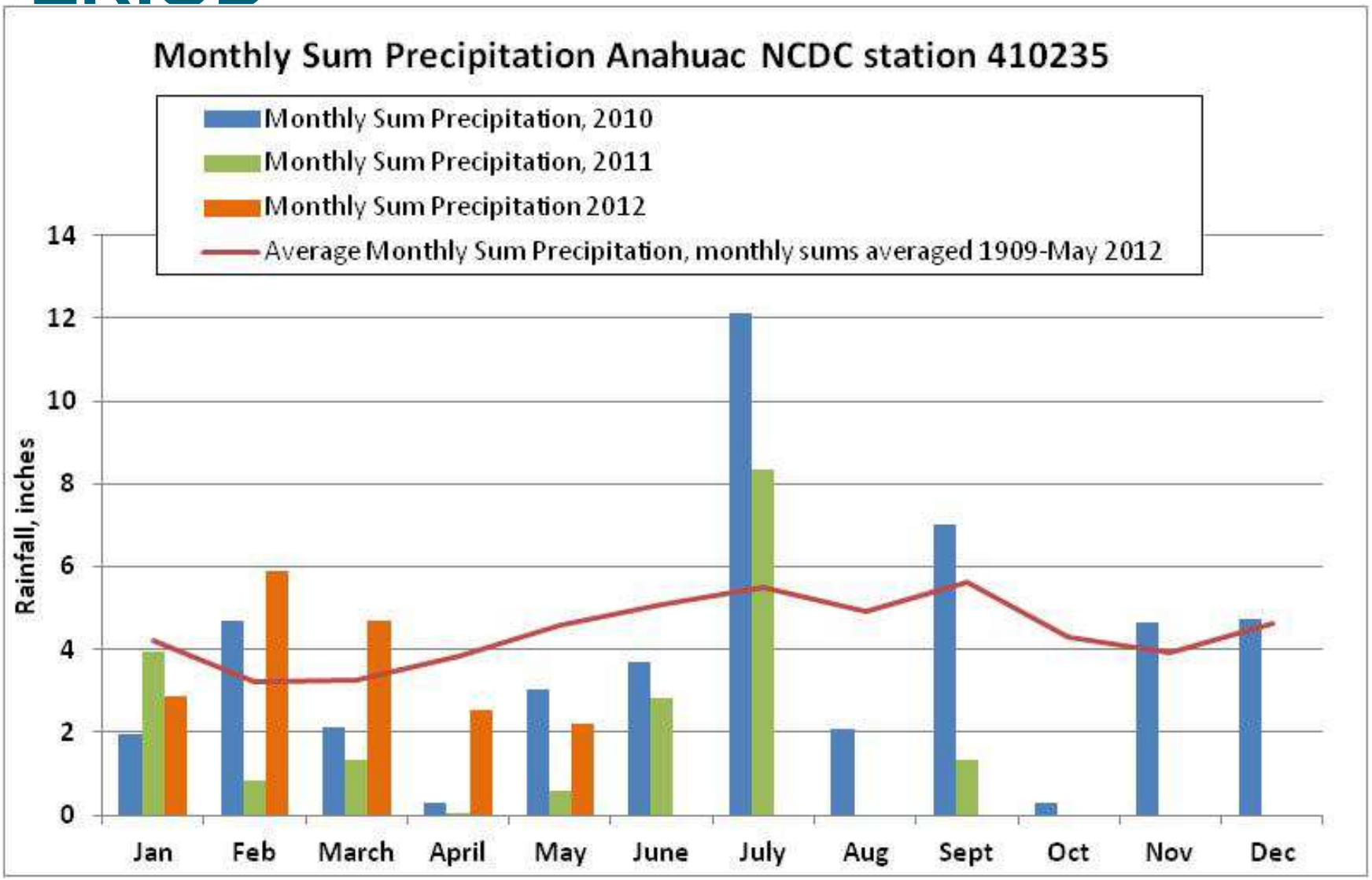
# WATERSHED CHALLENGES

- Small baseline data set
- No quantitative flow data
- Tidal influences
- Unusual climate conditions during characterization study
- Presentation of technical data to diverse group of stakeholders
- Lack of awareness of riparian benefits



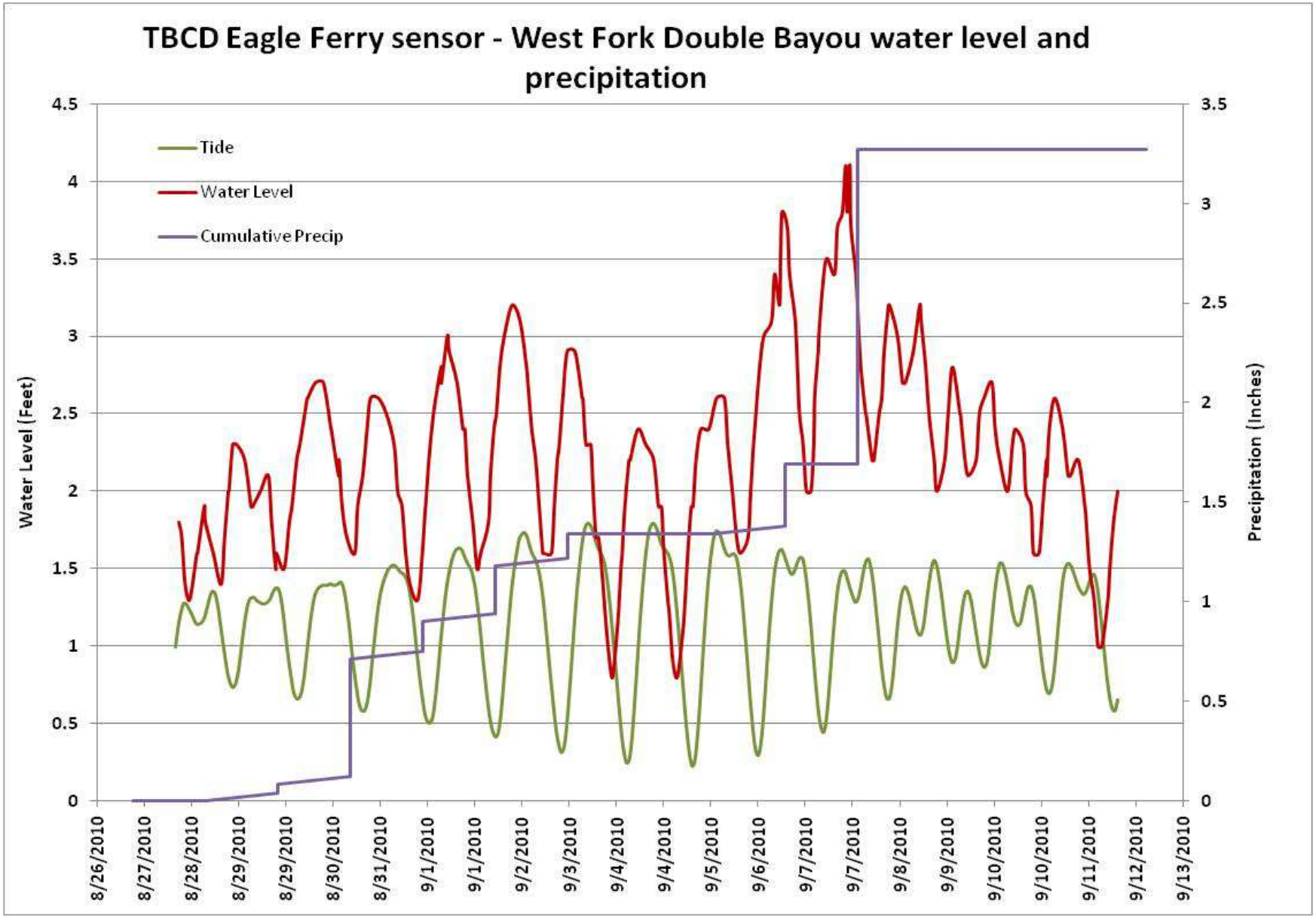
photos courtesy of Linda Shead

# RAINFALL DURING SAMPLING PERIOD

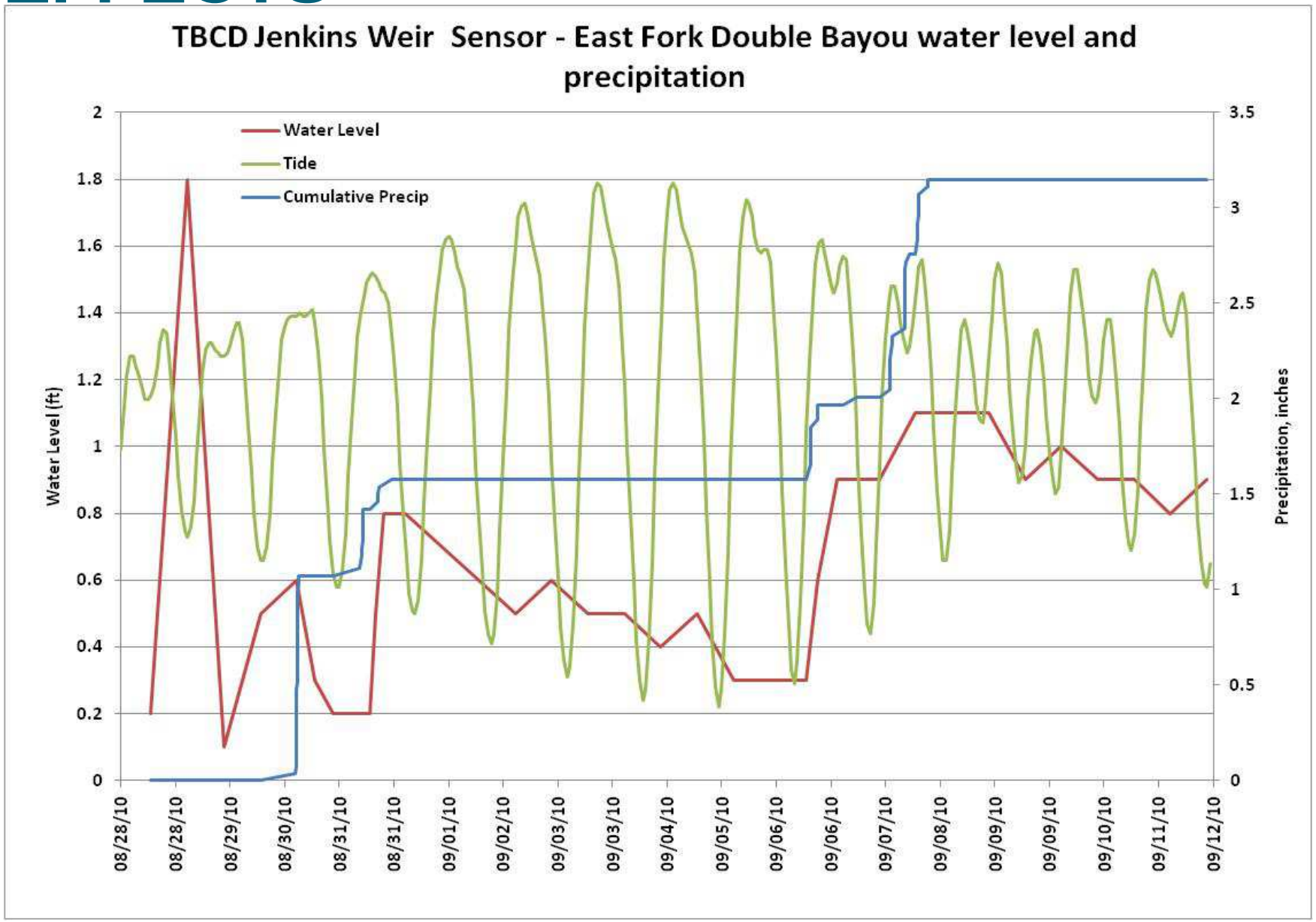


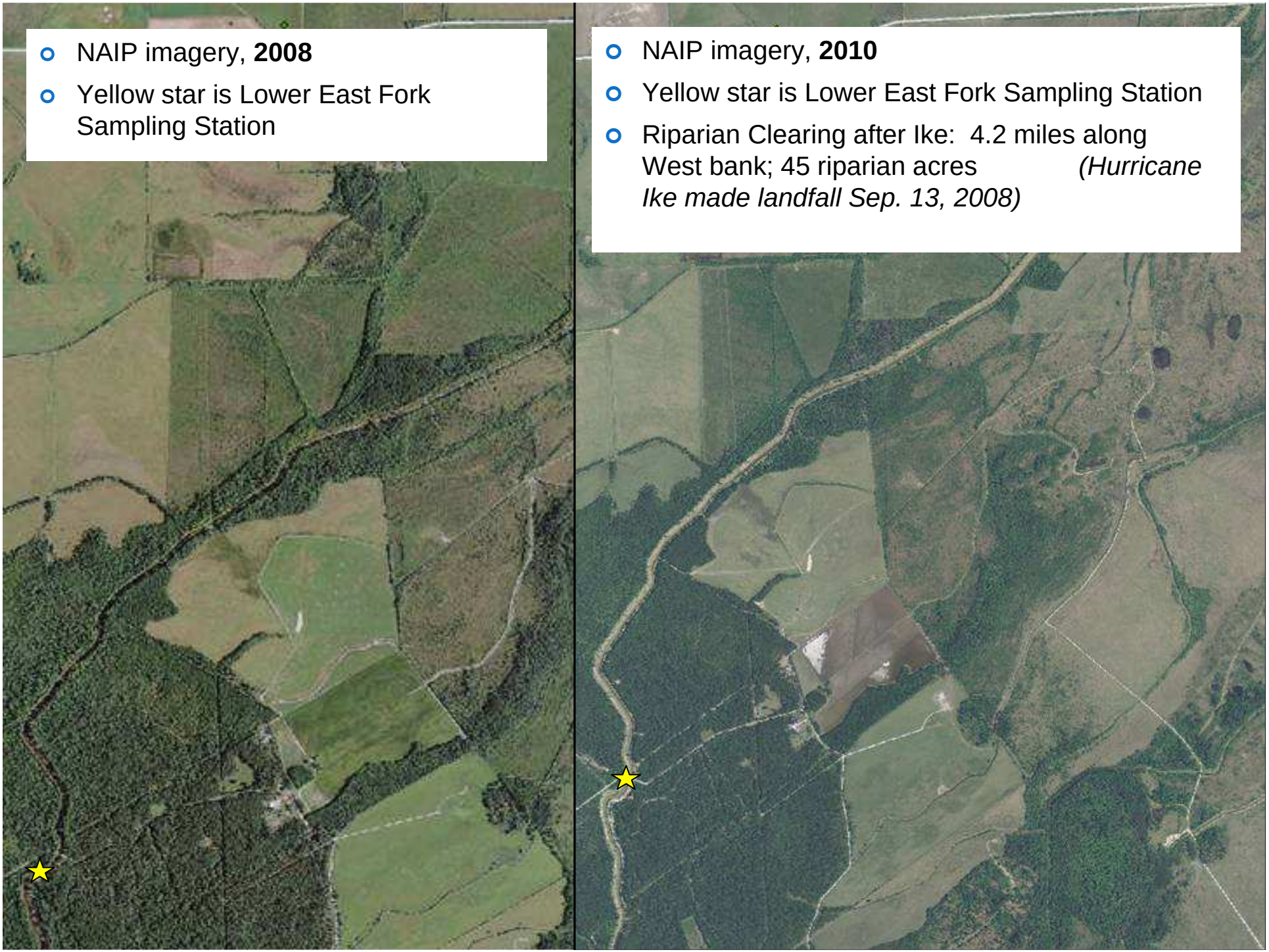

**Historic drought during sampling period**

# LOWER WEST FORK – TIDAL EFFECTS



# UPPER EAST FORK – TIDAL EFFECTS




NAIP imagery, **2008**
Yellow star is Lower East Fork Sampling Station
NAIP imagery, **2010**
Yellow star is Lower East Fork Sampling Station
Riparian Clearing after Ike: 4.2 miles along West bank; 45 riparian acres *(Hurricane Ike made landfall Sep. 13, 2008)*

# SAMPLING PARAMETERS – FALL OF 2010 AND SPRING 2011

- **On-site parameters for 24-hour monitoring events:**
  - Turbidity
  - pH
  - Dissolved oxygen
  - Water temperature
  - Specific conductivity

- **Lab parameters on same days as 24-hour monitors:**
  - Residue on evaporation
  - Chloride
  - Sulfate
  - Ammonia
  - Nitrite plus nitrate
  - Nitrite
  - Orthophosphate
  - Phosphorus
  - Nitrogen
  - Atrazine
  - *Escherichia coli*
  - Fecal coliform
  - Total coliform
  - *Enterococci*
  - Chlorophyll-a, phytoplankton
  - Pheophytin-a, phytoplankton
  - Biochemical oxygen demand
  - Carbonaceous bio-chemical oxygen demand

# SCREENING LEVEL EXCEEDANCES – FALL OF 2010 AND SPRING 2011

| Station | Station Type | Parameters with Screening Level Exceedances during sampling periods |
|---|---|---|
| West Fork, Upper WFU 554 | Tidal | Bacteria, Dissolved Oxygen, Chlorophyll-a, Ammonia |
| West Fork, Lower WFL 558 | Tidal | Bacteria, Chlorophyll-a |
| East Fork, Upper EFU 546 | Non-Tidal | Bacteria, Dissolved Oxygen, Chlorophyll-a, Ammonia |
| East Fork, Lower EFL 548 | Tidal | Bacteria, Dissolved Oxygen, Chlorophyll-a, Ammonia |

# DISSOLVED OXYGEN

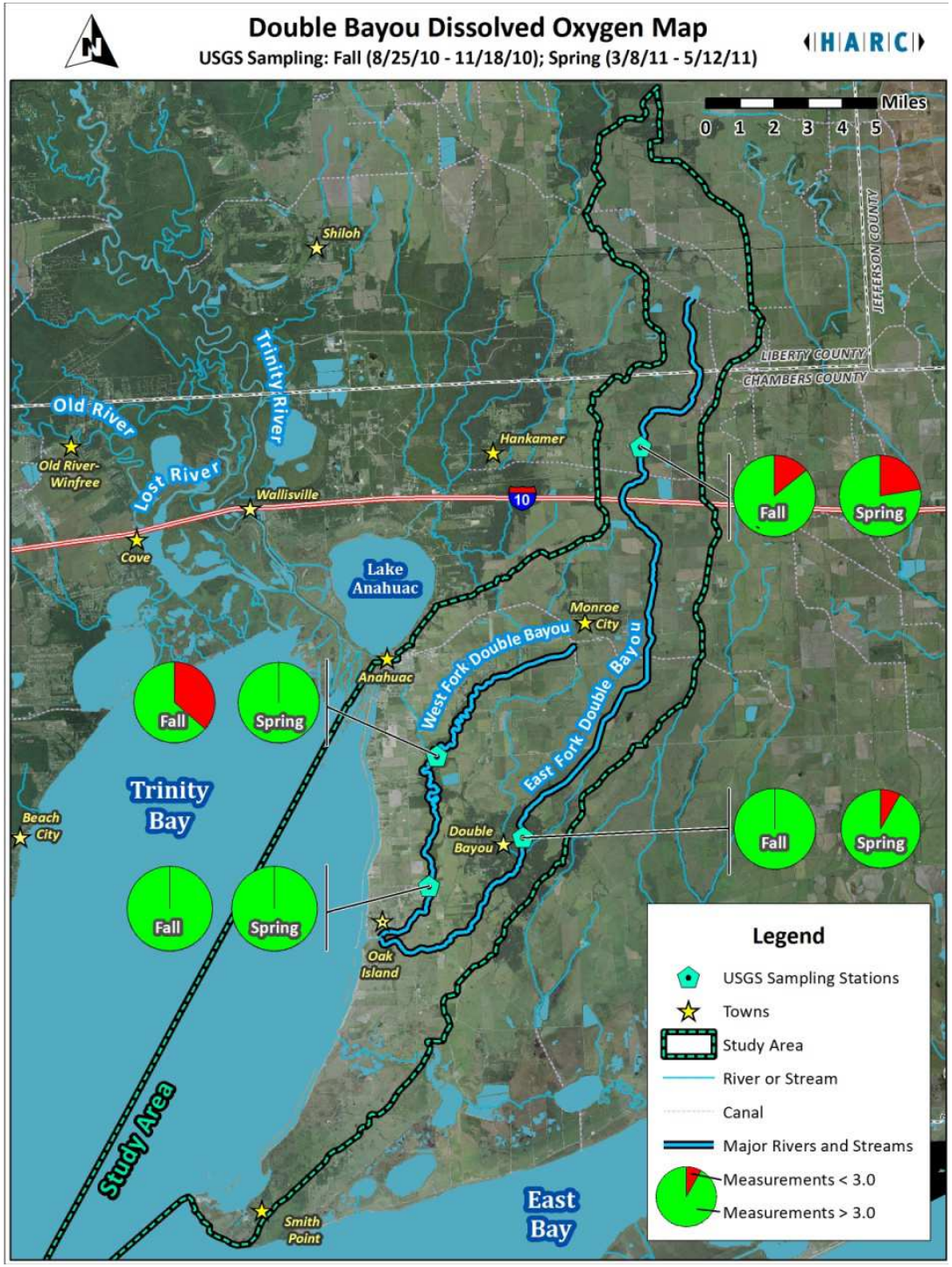
- **Designated Use:  Aquatic Life**
- **Dissolved oxygen levels below 3 ppm are stressful to most aquatic organisms.**
- **Low DO levels can indicate an excessive demand on the oxygen in the system.**

  **Some pollutants, such as sewage or agricultural runoff, result in the build up of organic matter and the consumption of DO by microbial decomposers as they break down the organic matter.**

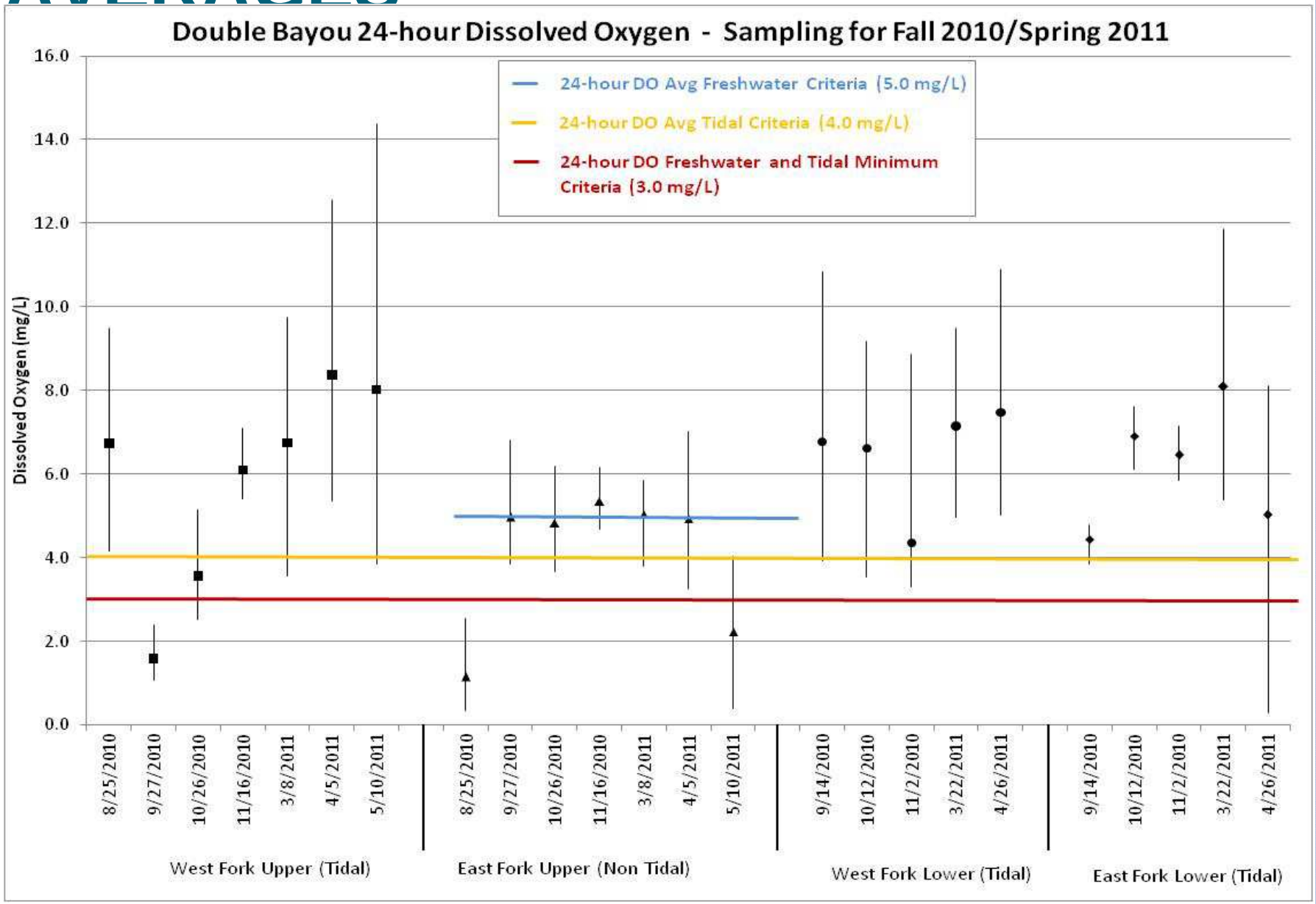
photos courtesy of Linda Shead

# DISSOLVED OXYGEN – SUMMARY OF RESULTS

**Dissolved oxygen levels could be too low to support healthy aquatic life in the upper reaches.**



# DISSOLVED OXYGEN - 24-HR AVERAGES

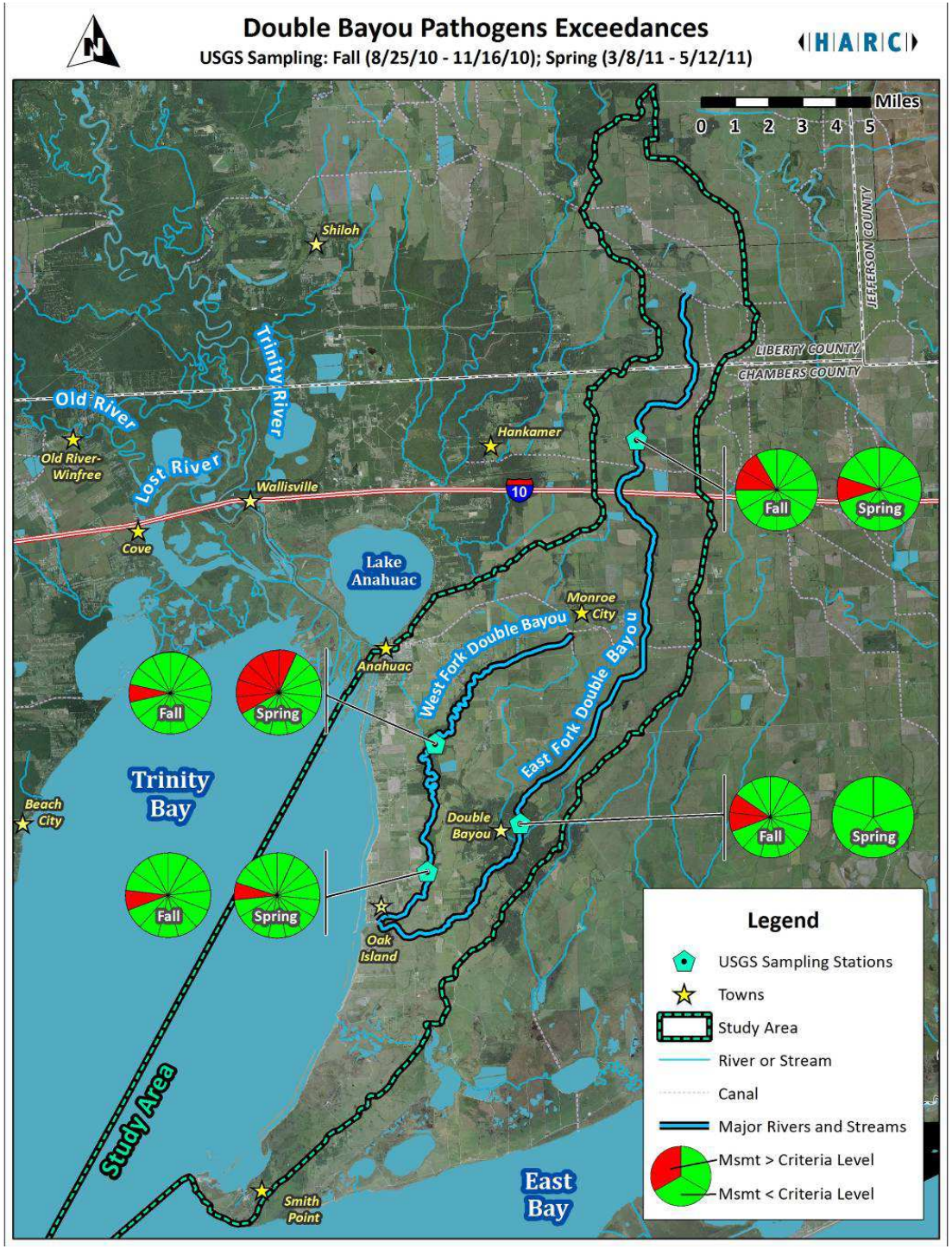


# BACTERIA

- **Designated Use:  Contact Recreation**
- **Testing for *E. coli*, enterococci, and fecal coliform bacteria in water are used as indicators for presence of other pathogenic bacteria that pose health hazards.**
- **Elevated bacteria levels cannot support primary recreation in the bayous, and could be a problem for oysters in the bay.**
- **Aerobic decomposition of excess fecal matter can also reduce dissolved oxygen levels.**
- **Sources include:  direct discharge of waste from mammals and birds, agricultural and storm runoff, or human sewage.**

# BACTERIA – SUMMARY OF RESULTS

- **West Fork Upper: 20% of samples exceeded the criteria limit during both sampling periods**
- **West Fork Lower: 13% exceedance**
- **East Fork Upper: 17% exceedance**
- **East Fork Lower: 13% exceedance**

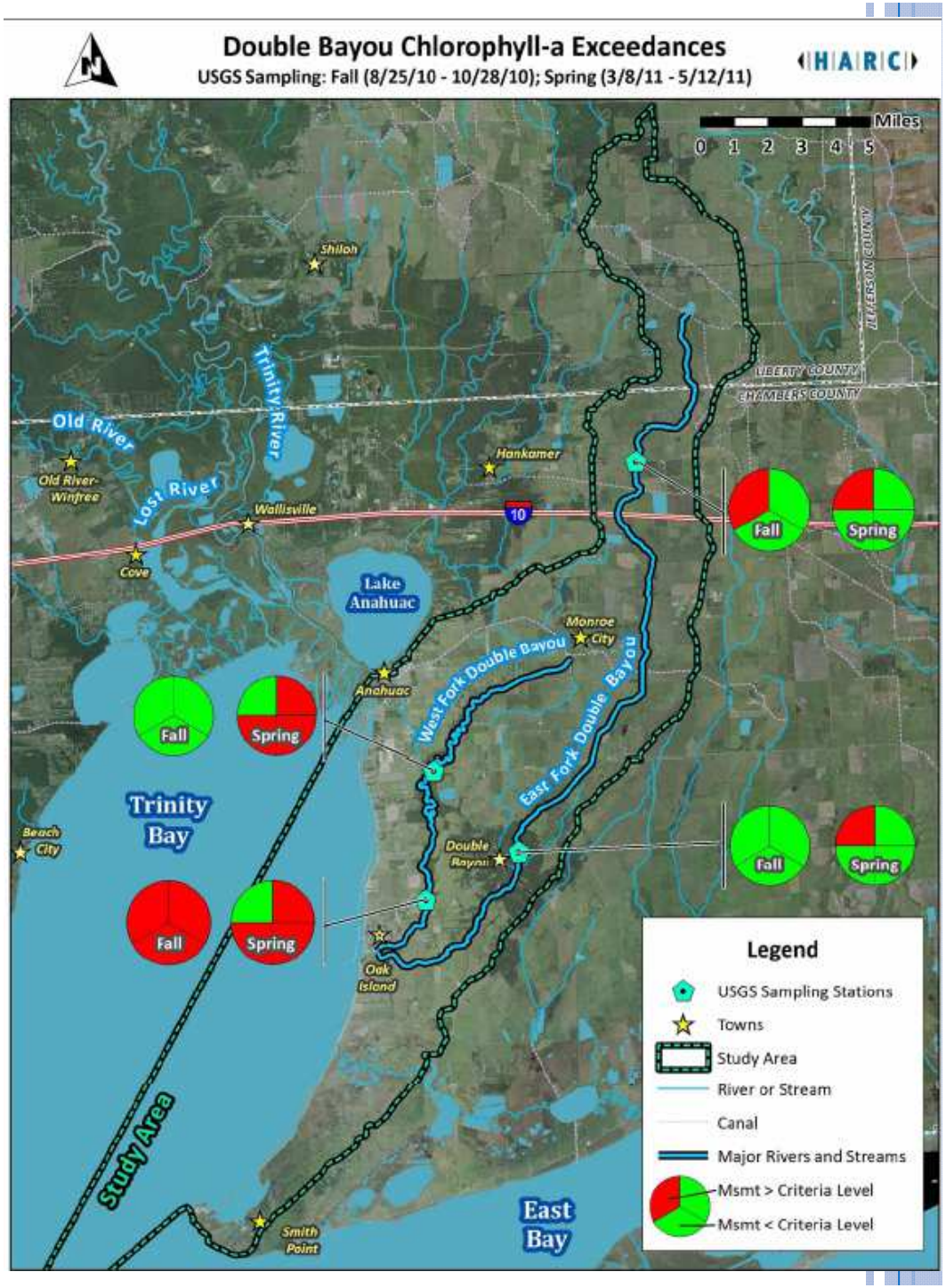


# CHLOROPHYLL-A & NUTRIENTS

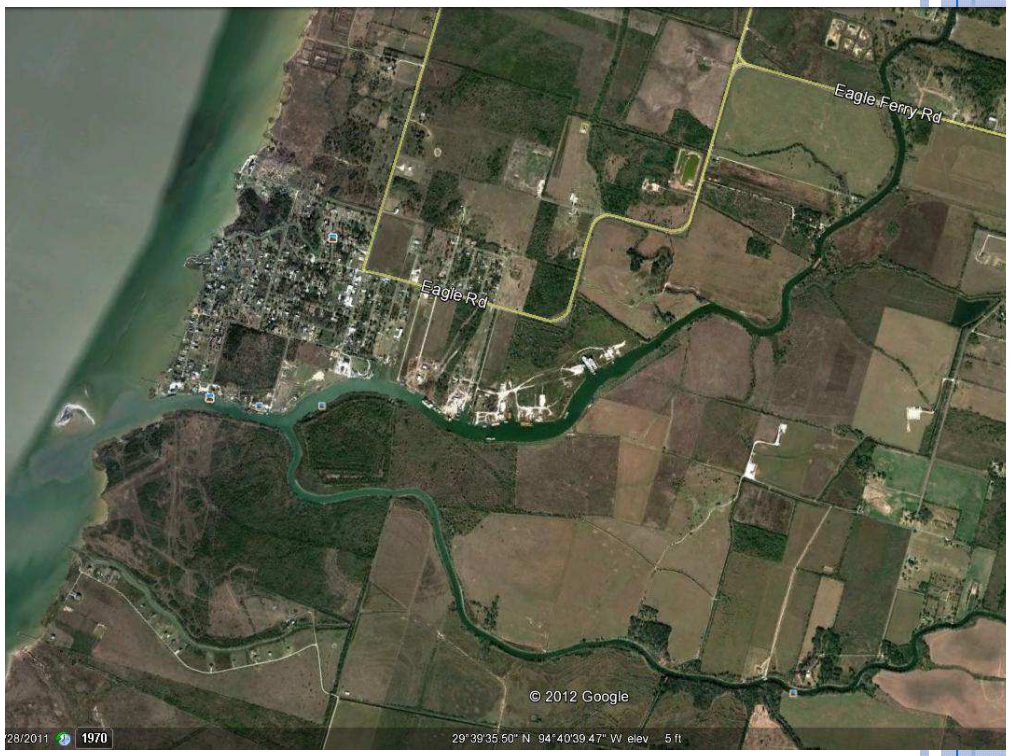
- **Chlorophyll-a – an indicator of phytoplankton abundance and biomass in coastal and estuarine waters.**
- **Chlorophyll-a – a green pigment found in plants that absorbs sunlight and converts it to sugar during photosynthesis, using nutrients such as phosphorus and nitrogen.**
- **High levels often indicate poor water quality and low levels often suggest good conditions, BUT it is the overall cycle that is important - phytoplankton populations can exhibit significant spatial and temporal variation; it is the long-term persistence of elevated levels that can be problematic.**
- **Sources include: agriculture, sewage treatment plant effluent, forest harvesting, urban development, recreation.**

# CHLOROPHYLL-A SUMMARY OF RESULTS

**Samples of Chlorophyll-a were limited in number, but the levels indicate the possibility of too many nutrients and/or too much light in both forks, though more often in the West Fork.**



# TIDAL RIPARIAN ZONES AND CONTAMINANTS




## The Tidal Mixing Factor

- **Low tide samples typically provide "worst-case" scenarios.**

  **(Mallin, et. al., MacPherson, et.al)**

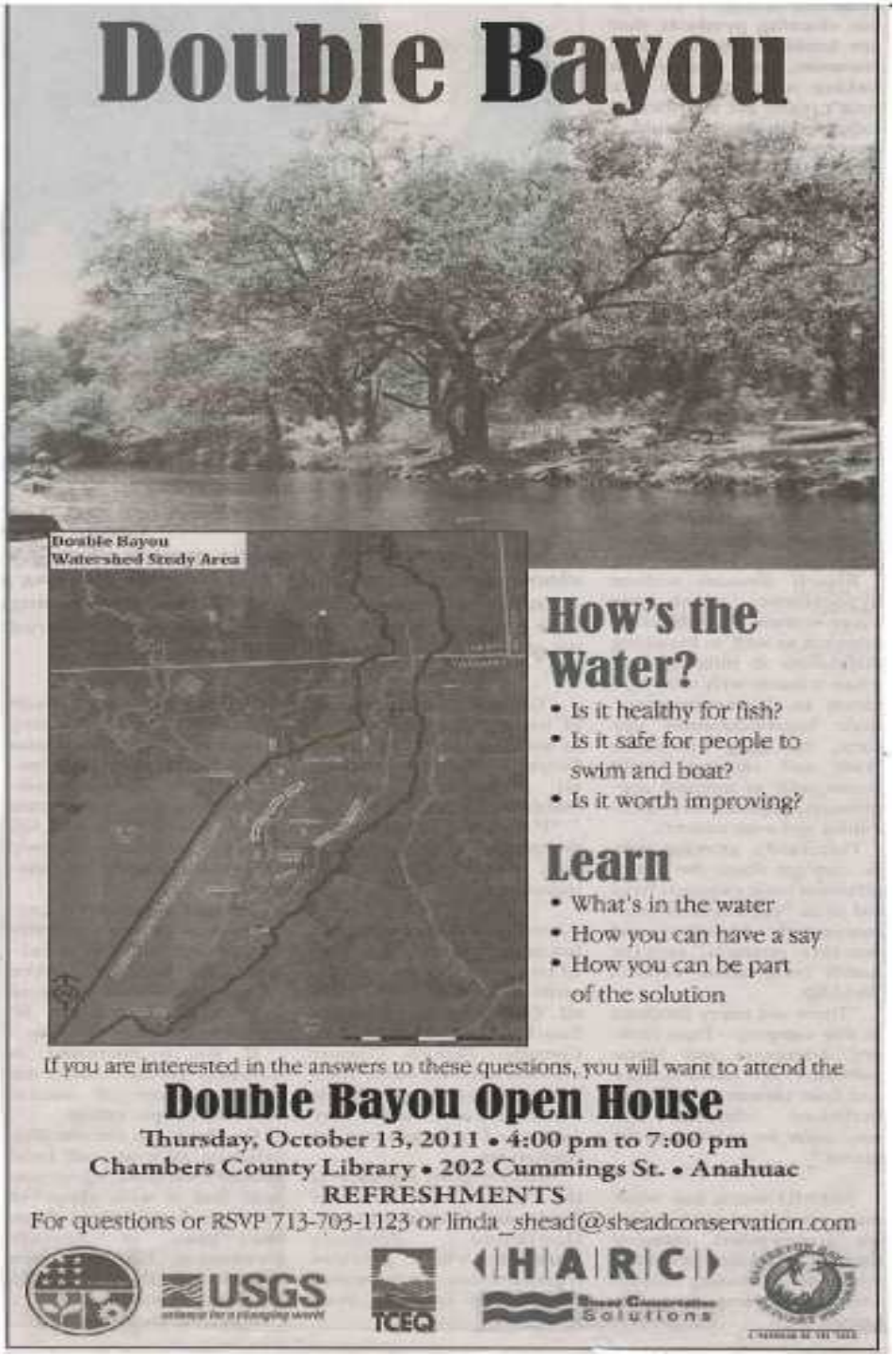
- **Lower DO might be "normal" for bayous and tidal creeks; dual patterns (increasing after daytime productivity/decreasing at night) are common.**

  **(Hubertz and Cahoon, MacPherson, et. al)**

- **However, the Upper East Fork (only non-tidal station in sampling system) had parameter exceedances for Bacteria, Dissolved Oxygen, Chlorophyll-a, Ammonia, and some of the worst DO exceedances.**

# STAKEHOLDER OUTREACH

- Stakeholders represented: Chambers County, City of Anahuac, local agencies (TBCD & CLCND), federal & state agencies, landowners, paddlers, nongovernmental organizations, Anahuac, Oak Island, and Double Bayou communities
- Two rounds of individual / small group interviews with stakeholders
- Successful Open House in Anahuac



# NEXT STEPS – EPA / TSSWSCB §319 GRANT

- **Funding for full Watershed Protection Plan received. Project began in April 2012.**
- **Overall Goal is to develop a nine element Watershed Protection Plan (WPP) for the Double Bayou watershed by:**
  - **Establishing and providing direction for a stakeholder group that will serve as a decision-making body;**
  - **Conducting targeted water quality sampling and analysis;**
  - **Identifying and analyzing spatial and temporal patterns in watershed data; and**
  - **Increasing understanding among targeted audience.**

# NEXT STEPS – PUBLIC PARTICIPATION AND STAKEHOLDER COORDINATION

- Establish Double Bayou Watershed Partnership
- Work with stakeholders to determine priorities for BMPs
- Watershed Steward training for stakeholders
- Riparian Workshop for stakeholders



photos courtesy of Linda Shead

# NEXT STEPS – SURFACE WATER QUALITY MONITORING AND DATA ANALYSIS

- **More monitoring**
  - 4 original sites sampled monthly for 24 months
  - 24-hour Dissolved Oxygen monitoring
  - Flow meter
- **Data Analysis**
  - Conduct statistical trend analysis for spatial or temporal patterns
  - Develop Load Duration Curves and utilize models, such as SELECT, to estimate loadings and identify sources



photos courtesy of HARC

# FINAL STEP – DOUBLE BAYOU WATERSHED PROTECTION PLAN

- **Founded on decisions made by stakeholders through the watershed planning process**
- **Incorporating findings from water quality monitoring and data analysis**



photos courtesy of Linda Shead

# QUESTIONS?

**With Thanks to team members:**

- **Stephanie Glenn, Lisa Gonzalez, and Zach Vernon– Houston Advanced Research Center**
- **Linda Shead – Shead Conservation Solutions**
- **Mike Lee and Lee Bodkin – USGS Texas Water Science Center**
- **Ashley Alexander and Brian Koch – TSSWCB**

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