Sam Rayburn Reservoir Meeting

May 15, 2003

Presentation Outline

- Project Team
- Overview of Impairments and Applicable Water Quality Standards
- Watershed Characterization
- Data Review
  - Water Quality Assessment
  - Conclusions

Project Team

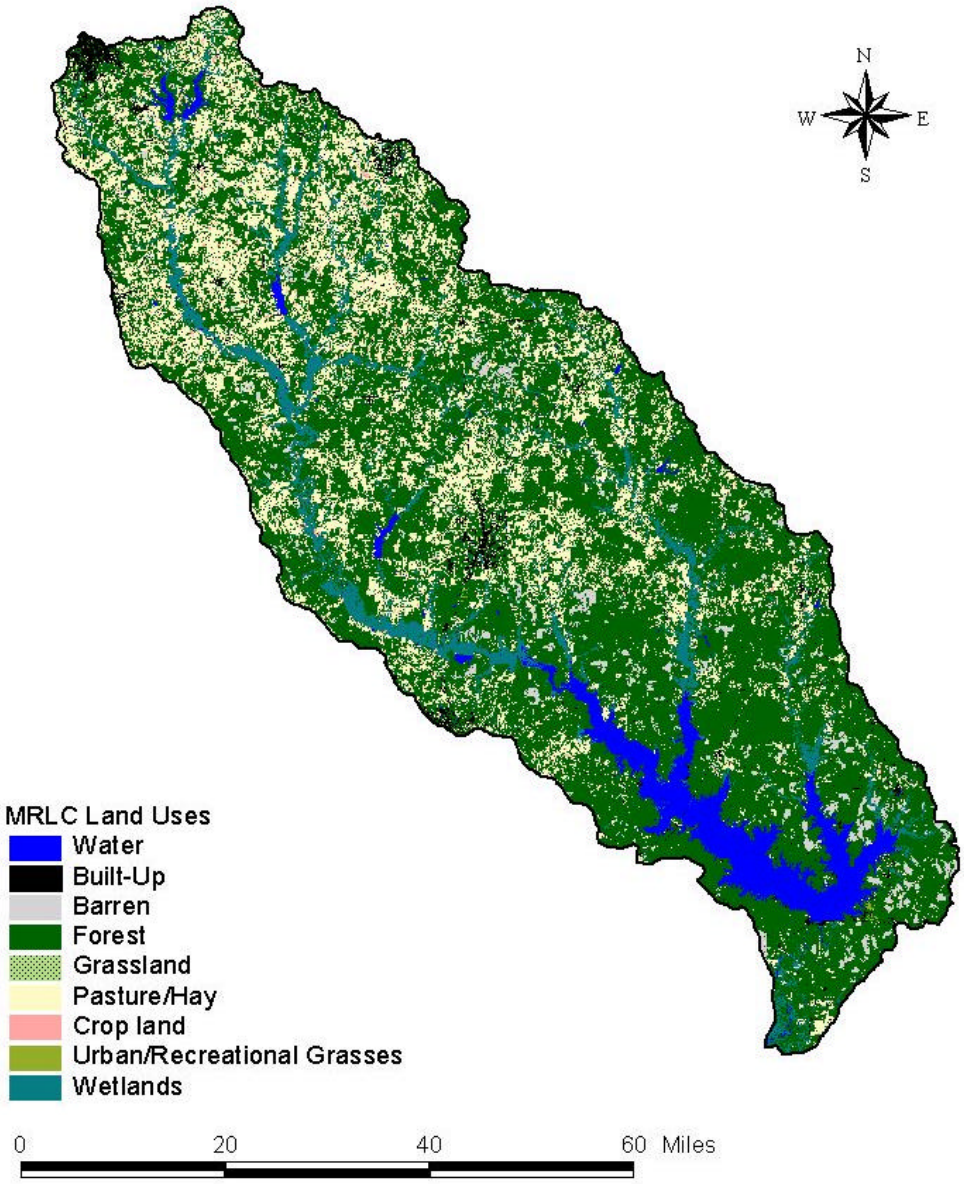
- TCEQ

  Central and regional staff
- Tetra Tech Team
  - Tetra Tech
  - Tetra Tech – MFG
  - Angelina and Neches River Authority (ANRA)
  - Lopez Garcia Group (LGG)
  - FTN Associates
  - Diane Sheridan

Source:
EPA's BASINS
TNRIS

Watershed Attributes

- Drainage Area: 1,385 mi^2
- Located in 10 counties (Smith, Rusk, Cherokee, Shelby, Nacogdoches, San Augustine, Sabine, Angelina, Newton, Jasper)
- Major towns include Lufkin, Nacogdoches, Jacksonville, Henderson, and Tyler
- Located in the Piney Woods natural region
- Soils predominantly sand, clay, and sandy clays
- Landuse predominantly forest
- Average annual rainfall: 38-48 inches



Source:
Multi-Resolution Land Characteristics (MRLC)
USEPA 1990's

Landuse Distribution:

Low-intensity Residential – 1%

Industrial – 4%

Forest – 59%

Pasture/hay – 23%

Cropland – 1%

Wetlands – 7%

Open Water – 5%

Reservoir Attributes

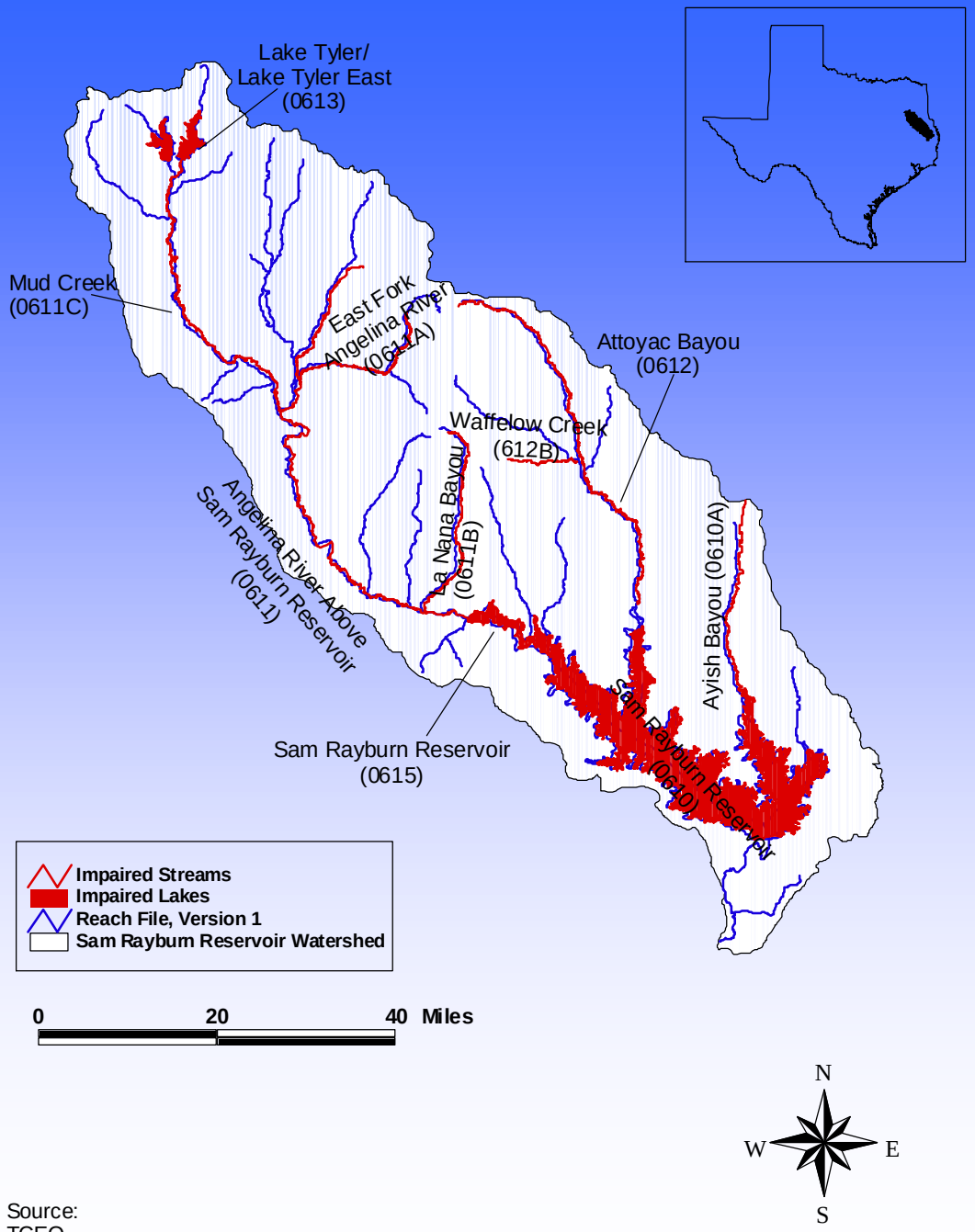
- Largest waterbody in Texas
- Conservation pool: 164.4 feet above mean sea level
- Impounds approximately 114,500 surface acres (750 miles of shoreline and 43 miles in length)
- Mean depth of 20 feet; maximum depth of 90 feet
- Annual average water fluctuation of 8 feet
- Operation Goals: flood control, hydroelectric power, maintenance of an operating pool to sustain municipal, industrial, agricultural, and recreational uses.

Section 303(d) List Information for Sam Rayburn Reservoir

Waterbody	Segment ID	Waterbody Classification	Designated Uses	2000 303(d) List Impairments	2002 303(d) List Impairments
Sam Rayburn Reservoir	0610	Classified	•Aquatic Life •Contact Recreation •General Use •Fish Consumption •Public Water Supply	•Depressed DO •Aluminum •Low and high pH	•Depressed DO •Aluminum
Angelina River/Sam Rayburn Reservoir	0615			—	•Depressed DO

Section 303(d) List Information for Tributaries to Sam Rayburn Reservoir

Waterbody	Segment ID	2000 303(d) List Impairments	2002 303(d) List Impairments
Ayish Bayou	0610A	•Bacteria	•Bacteria
Angelina River above Sam Rayburn Reservoir	0611	•Bacteria	•Bacteria
East Fork Angelina River	0611A	•Lead in water	•Bacteria
La Nana Bayou	0611B	•Bacteria	•Bacteria
Mud Creek	0611C	•Bacteria	•Bacteria
Attoyac Bayou	0612	•Cadmium •Lead	—
Waffelow Creek	0612B	•Bacteria	•Bacteria



Source:
TCEQ
EPA's BASINS

TCEQ Water Quality Standards

Parameter	Segment ID				
	0610	**0611**	**0612**	**0613**	**0615**
Cl^{-1} (mg/L)	100	125	75	50	150
$SO4^{2}$ (mg/L)	100	50	50	50	100
TDS (mg/L)	400	250	50	50	500
DO (mg/L) 24 hour average	5.0	5.0	5.0	5.0	5.0
DO (mg/L) 24 hour minimum	3.0	3.0	3.0	3.0	3.0
DO (mg/L) grab minimum	3.0	3.0	3.0	3.0	3.0
pH range	6.0—8.5	6.0—8.5	6.0—8.5	6.5—9.0	6.5—9.0
Fecal coliform bacteria #/100ml	200/400	200/400	200/400	200/400	200/400
E. coli #/100ml	126/394	126/394	126/394	126394	126/394
Temperature (°F; °C)	93; 33.9	90; 32.2	90; 32.2	93; 33.9	93; 33.9

TCEQ Water Quality Standards (continued)

	Applicable to all Segments		
Parameters	**Acute**	**Chronic**	**Human Health[1]**
Aluminum (dissolved) (mg/L)	0.991	-	-
Copper (dissolved) * (mg/L)	0.005	0.0038	-
Lead (dissolved)* (mg/L)	0.012	0.00043	0.00498
Arsenic (dissolved) (mg/L)	0.36	0.19	0.05
Zinc (dissolved) * (mg/L)	0.035	0.032	-
Selenium (total) (mg/L)	0.02	0.005	0.05
Dioxins (ug/L)	-	-	0.000000134

[1] Human Health Protection Criteria for water and fish ingestion.

* Available data indicates surface water in Sam Rayburn Reservior Watershed are soft with hardness ranging from approximatley 16-60 mg/l. Criteria based on low end value of 25 mg/l.

Nutrient Screening Levels and Reference Criteria

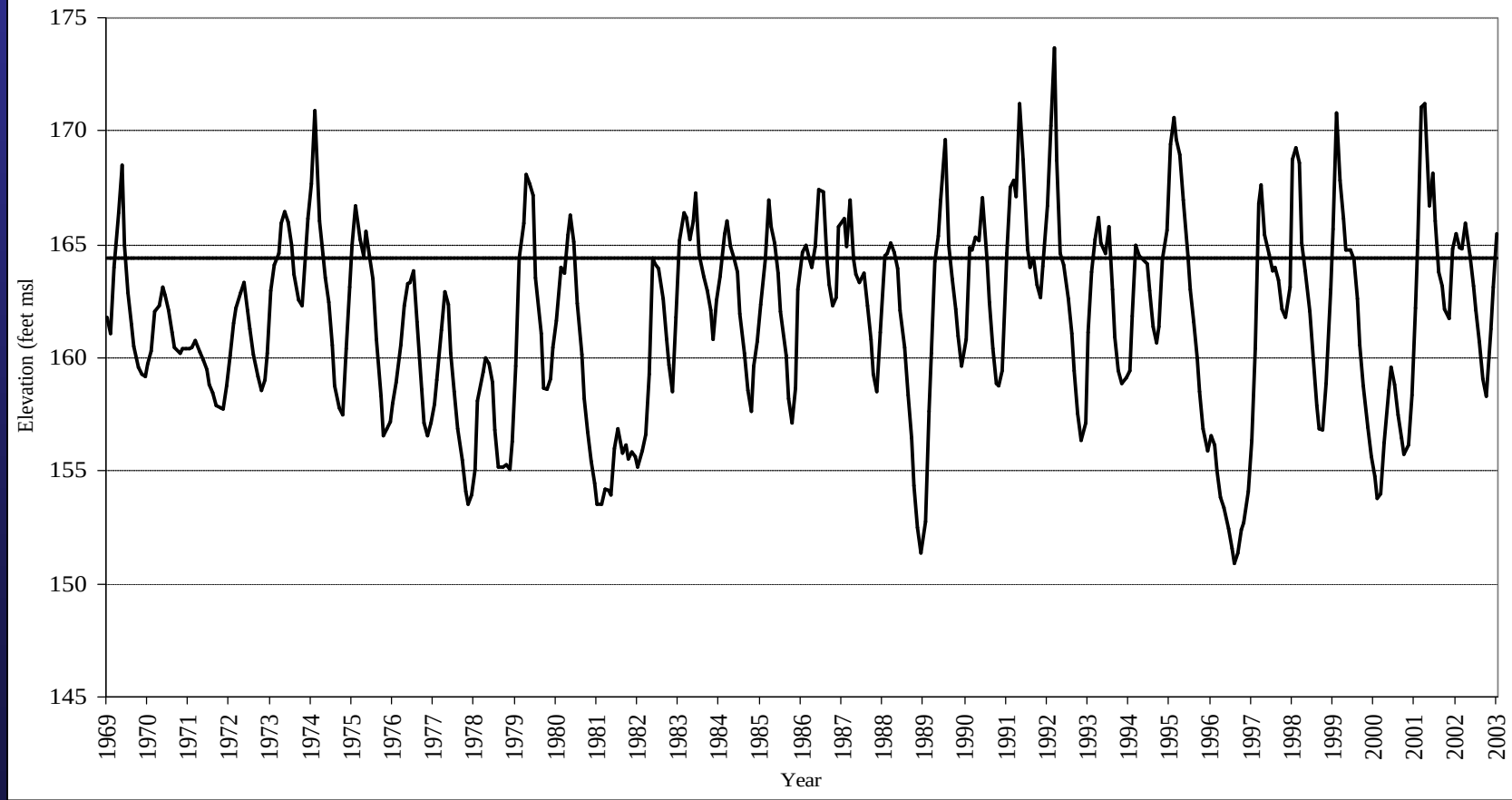
	EPA Reference Criteria		TCEQ Screening Levels	
Parameter	Lake & Reservoir	Stream	Lake & Reservoir	Stream
TKN (mg/L)	0.459	0.44	—	—
NO_2+NO_3 (mg/L)	0.033	0.067	0.32	2.76
TN calculated (mg/L)	0.492	0.507	—	—
TP (µg/L)	32.5	50	180	800
Secchi depth (meters)	1.1	—	—	—
Chlorophyll a (µg/L), spectrophotometric	2.834	0.566	21.4	11.6
Ammonia, Total (mg/L)	—	—	0.106	0.17
Ortho P (mg/L)	—	—	0.05	0.5

Historical Data Review

- Water quality and surface elevation data compiled for Sam Rayburn Reservoir
- Water quality and flow data compiled for all tributaries to the Sam Rayburn Reservoir
- Water quality data compiled from 1990 through the present:
  - Texas Review and Comment System (TRACS)
  - EPA's STORET database

Surface Elevations

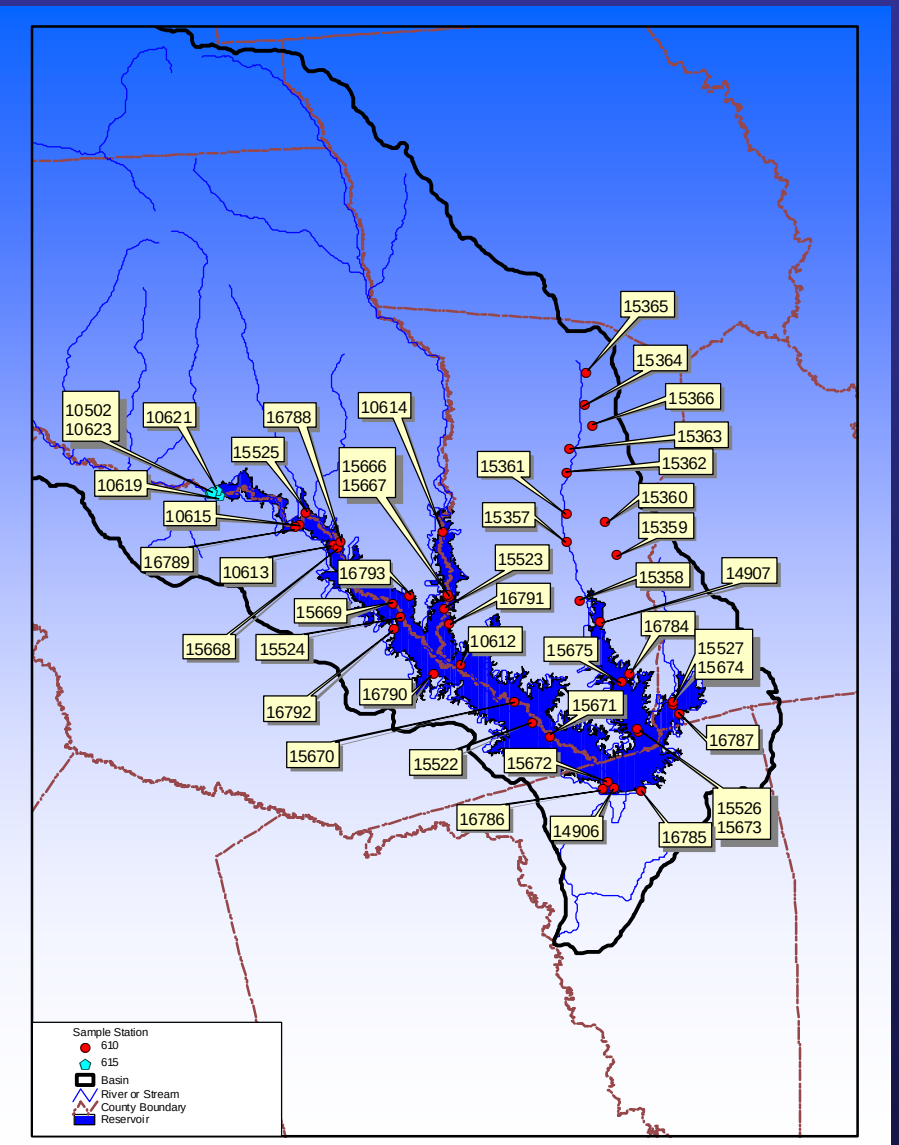
Figure 4-X.
Average Water Surface Elevation
Sam Rayburn Reservoir



Water Quality Parameters

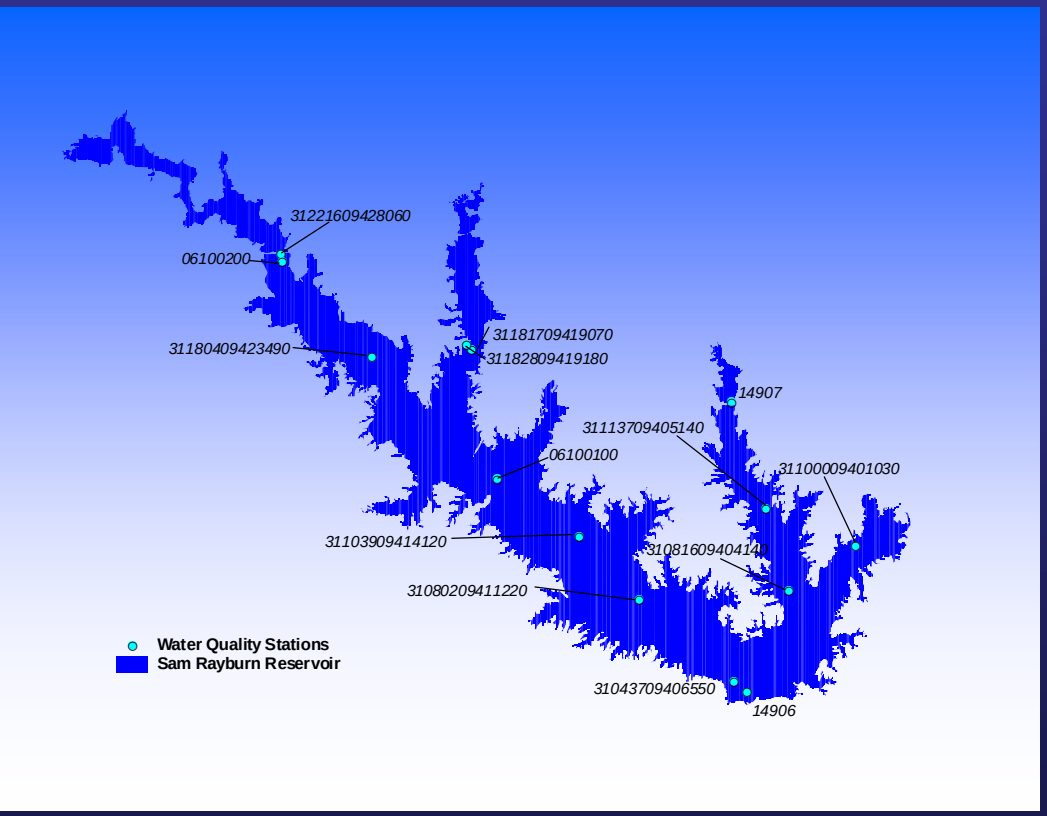
- Water temperature
- Transparency
- Conductivity
- Dissolved oxygen
- Biochemical oxygen demand
- pH
- Total alkalinity
- Total solids
- Dissolved solids
- Nitrogen
- Phosphorus
- Total organic carbon
- Chlorophyll a
- Fecal coliform bacteria
- *E. coli*
- Chloride
- Sulfate
- Dissolved arsenic
- Dissolved aluminum
- Dissolved copper
- Dissolved lead
- Total selenium
- Dissolved zinc
- Dioxin

Sam Rayburn Reservoir TRACS Monitoring Station Locations



- 45 monitoring stations on segment 0610
- 17 monitoring stations on segment 0615

Sam Rayburn Reservoir STORET Monitoring Station Locations



- 14 monitoring stations on segment 0610
- No monitoring stations on segment 0615

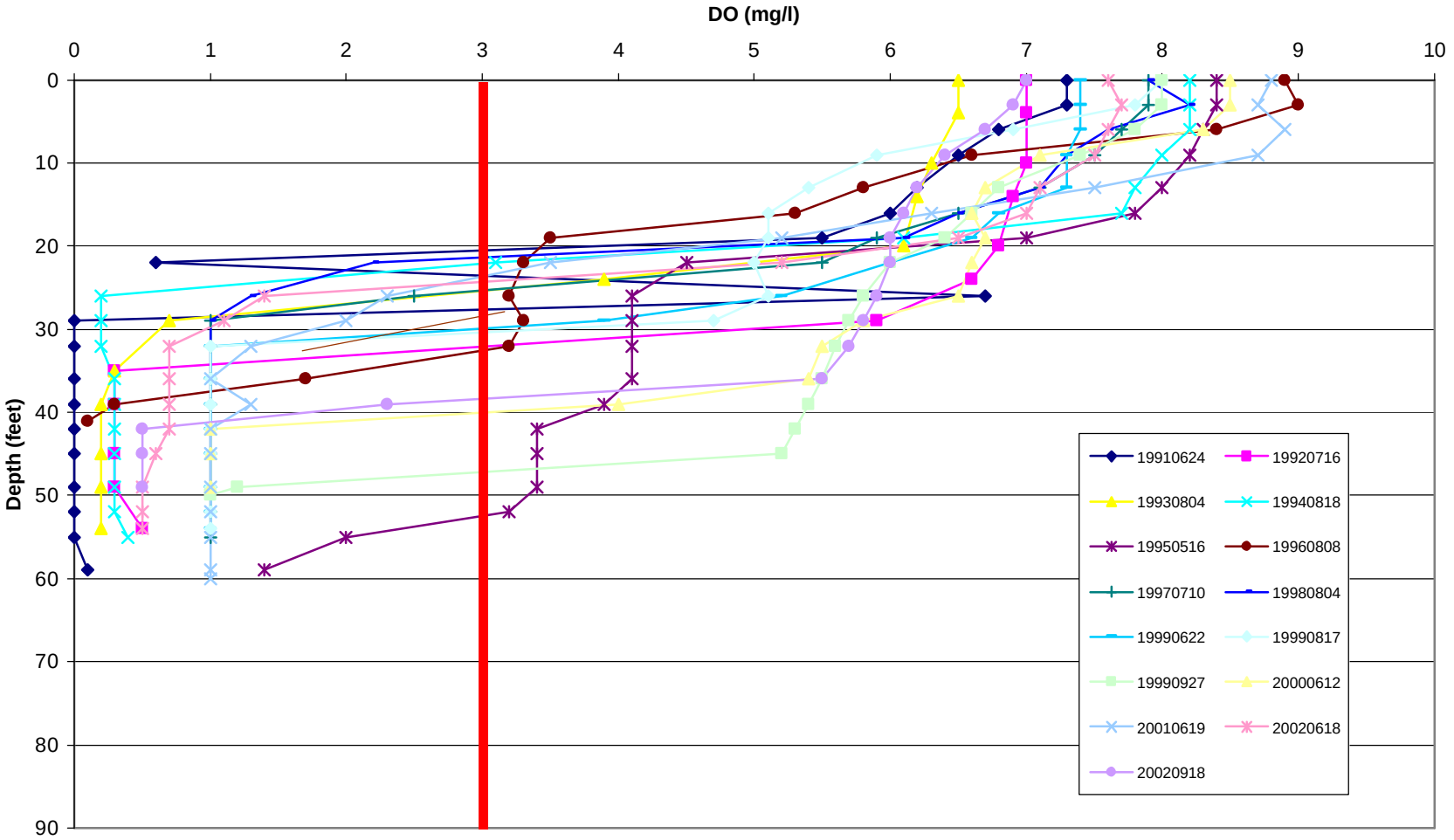
Reservoir Impairment Summary: Dissolved Oxygen

- Dissolved oxygen (DO) has historically been used to indicate the overall quality of surface water
- Adequate DO is a necessary element to all forms of life
- Decreases in DO can cause changes in the types and numbers of aquatic organisms that live in a water ecosystem
- Nutrient contributions from animal waste, fertilizer, or improperly treated wastewater can lead to aquatic plant/algae growth
- DO is depleted by bacteria as it breaks down dead aquatic plants, as well as other forms of organic matter contributed from the land
- Excessive contributions of nutrients and organic matter lead to excessive depletion of DO

Reservoir Impairment Summary: Dissolved Oxygen

- Data were compared to the 5.0 mg/L mean and 3.0 mg/L minimum criteria
  - Few exceedances of both criteria on Ayish Bayou arm of the reservoir and minimum criterion in the main pool of the reservoir (segment 0610)
  - 19 exceedances of the 3.0 mg/L minimum criterion in segment 0615
- DO stratification occurs during the summer months resulting in low hypolimnetic oxygen, although DO is usually above 3.0 mg/L in the mixed surface layer
- Very low DO observations on both Attoyac Bayou and Ayish Bayou arms of the reservoir in August of 1996

Example of a Summer DO Profile at Station 10612



Reservoir Impairment Summary: Nutrients and Transparency

- Nutrients, transparency, and chlorophyll a all compared to Texas nutrient screening levels and EPA's reference criteria
- All parameters had data that were higher than the screening levels and reference criteria (segments 0610 and 0615)
- Data suggest that conditions are present for nutrients to play a large role in oxygen dynamics of the reservoir and its tributaries

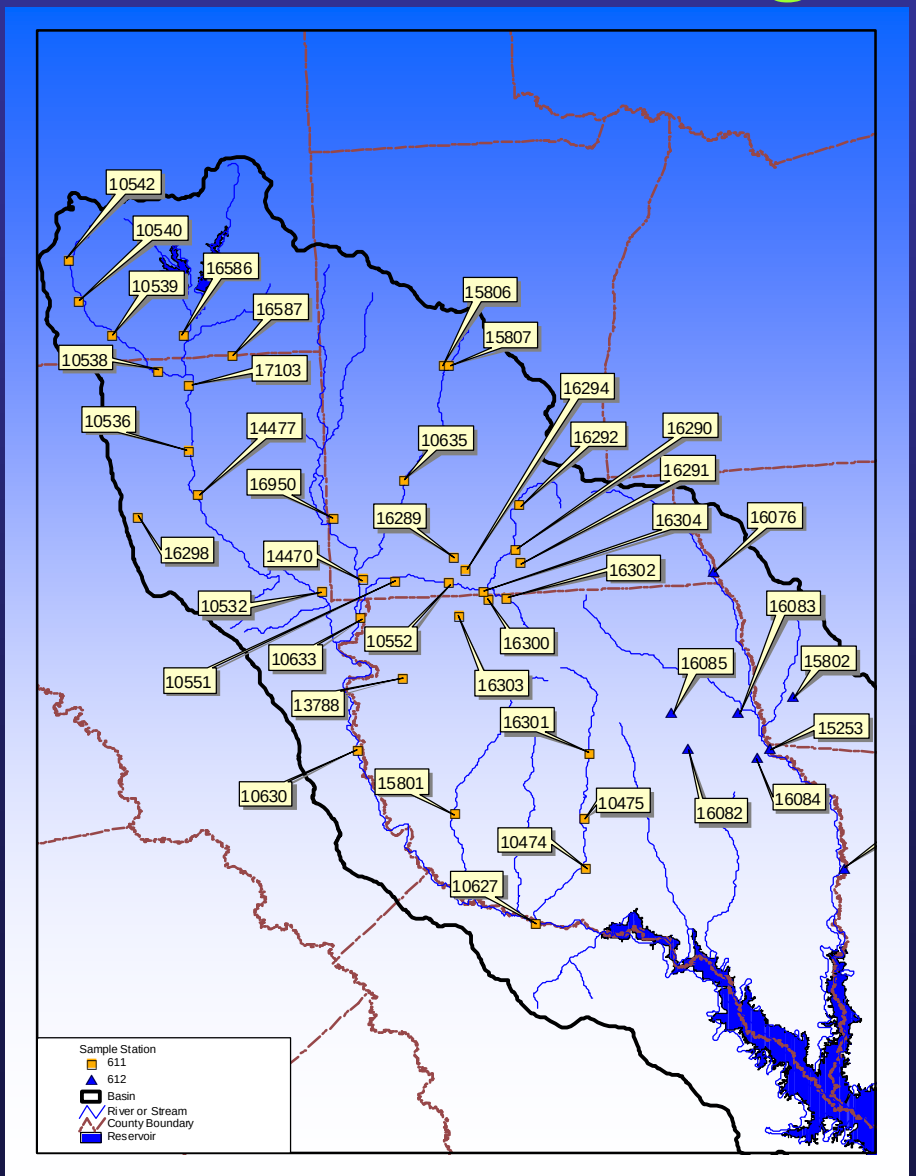
Reservoir Impairment Summary: Metals

- Dissolved aluminum, dissolved copper, dissolved lead, and dissolved zinc all showed a small number of exceedances of the appropriate criteria in segment 0610 and 0615
- High detection limits made much of the data unusable
- New clean metals program instituted by ANRA

Reservoir Impairment Summary: Additional Parameters

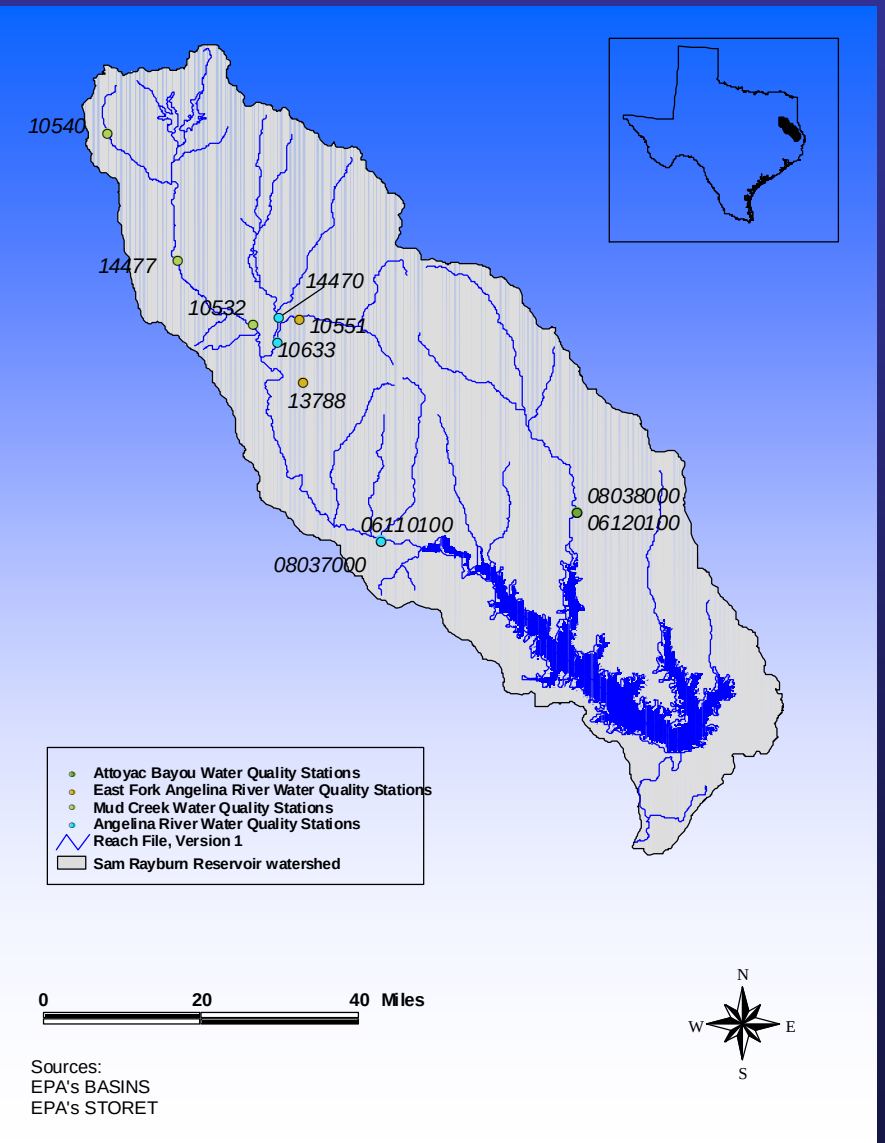
- Low and high pH observations in segment 0610 and 0615
- Bacteria exceedances in both segment 0610 and 0615, but not many. Largest number of exceedances in Ayish Bayou arm
- Chloride, sulfate, TDS: not many exceedances, but many more in 0615 than 0610

Contributing Watershed TRACS Monitoring Station Locations



- 54 monitoring stations on segment 0611
- 8 monitoring stations on segment 0612

Contributing Watershed STORET Monitoring Station Locations



- 9 monitoring stations on segment 0611
- 2 monitoring stations on segment 0612

Contributing Watershed Impairment Summary: Dissolved Oxygen

- 436 DO samples on segment 0611 with only 3 exceedances of the 3.0 mg/L minimum criterion (La Nana Bayou, Ragsdale Creek, and Caney Creek)
- No DO exceedances on segment 0612

Contributing Watershed Impairment Summary: Nutrients

- Several nitrogen and phosphorus observations higher than the Texas Screening Levels and EPA's Reference Criteria in all tributary segments with data.
- Nutrient data suggests loading of nutrients from the tributaries that may affect algal growth and subsequent DO dynamics in the tributaries as well as in Sam Rayburn Reservoir.

Contributing Watershed Impairment Summary: Metals

- Aluminum – 7 exceedances (Mud Creek, Angelina River, Attoyac Bayou)
- Some copper, lead, selenium, and zinc exceedances on segments 0611 and 0612, but difficult to get an accurate assessment of impairment because the detection limits were often higher than the criteria.

Contributing Watershed Impairment Summary: Bacteria

- Several exceedances of fecal coliform bacteria and *E. coli* criteria throughout the watershed (Angelina River, East Fork Angelina River, Mud Creek, La Nana Bayou, Attoyac Bayou)
- La Nana Bayou showed the largest percentage of bacteria exceedances in the watershed

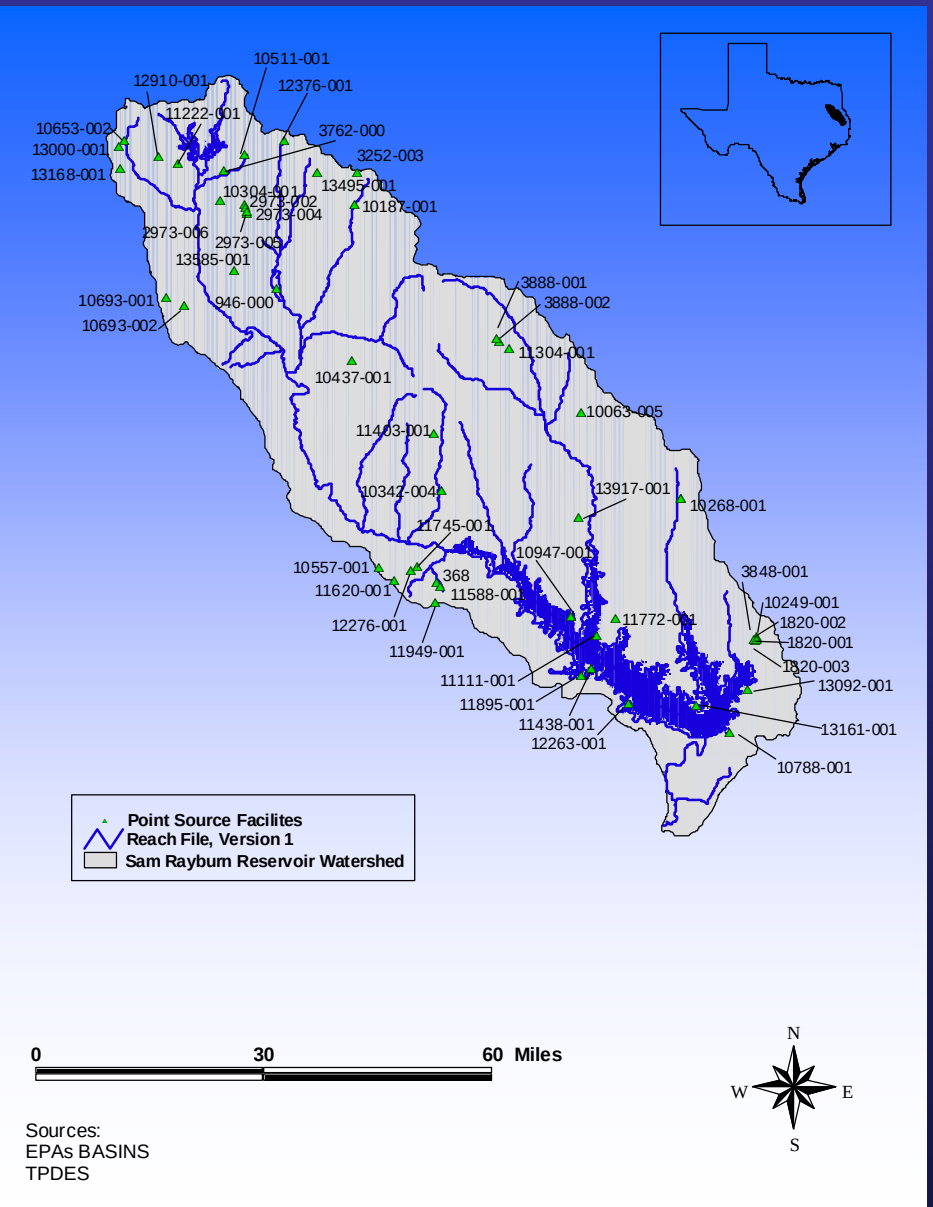
Contributing Watershed Impairment Summary: Additional Parameters

- Chloride and Sulfate – exceedances on segments 0611 and 0612, but the percentage of observations exceeding the criteria was less than 5%
- pH – exceedances on segments 0611 and 0612, usually below the lower threshold of 6.0
- TDS – several exceedances on segments 0611 and 0612, with more exceedances on 0612

Nonpoint Source Assessment

- Agriculture
  - Cropland
  - Livestock
- Silviculture
- Urban Areas
  - Population Centers
  - Land Fills
  - Septic Systems

Point Source Assessment



Sources:
EPAs BASINS
TPDES

- 44 point source facilities in the watershed (TPDES)
- 35 facilities have available Discharge Monitoring Report (DMR) data
- 7 major facilities (design flow > 1.0 mgd)

Conclusions

- Reservoir stratifies in summer
- Mixed layer (based on temperature) often does not include entire epilimnion, resulting in DO concentrations in the mixed surface layer of the reservoir that meet criteria, but several meters below the surface DO decreases substantially
- The worst case conditions appear to be during stratification after an extended dry period

Conclusions (continued)

- Nutrients, chlorophyll a, and transparency were regularly higher than the Texas screening levels and EPA's reference criteria in the reservoir as well as its tributaries
- Especially high nutrient observations in the arms of the reservoir in August 1996 after a period of rain after a long drought
- There is potential for DO to become a problem with the high nutrient concentrations observed in the reservoir and the contributing watershed
- Potential nutrient sources include urbanization, agriculture, point sources, failing septic systems, and erosion

Conclusions (continued)

- Metals (aluminum, copper, lead, zinc, and selenium) showed exceedances of the applicable criteria in the reservoir and its tributaries
- Detection limits for metals need to be reduced for future sampling efforts
- Metals may exist in naturally high levels in the local soils. Further research into background levels of metals in soils in the watershed needs to be conducted.

Conclusions (continued)

- There were bacteria exceedances in the reservoir as well as several of the tributaries, with the largest number of exceedances on La Nana Bayou and Attoyac Bayou
- Possible bacteria sources include urban areas, municipal point sources, and agriculture
- Continued monitoring for all pollutants should continue in the reservoir as well as the major tributaries on a year-round basis and during wet and dry weather to obtain a better understanding of the pollutant sources to the reservoir