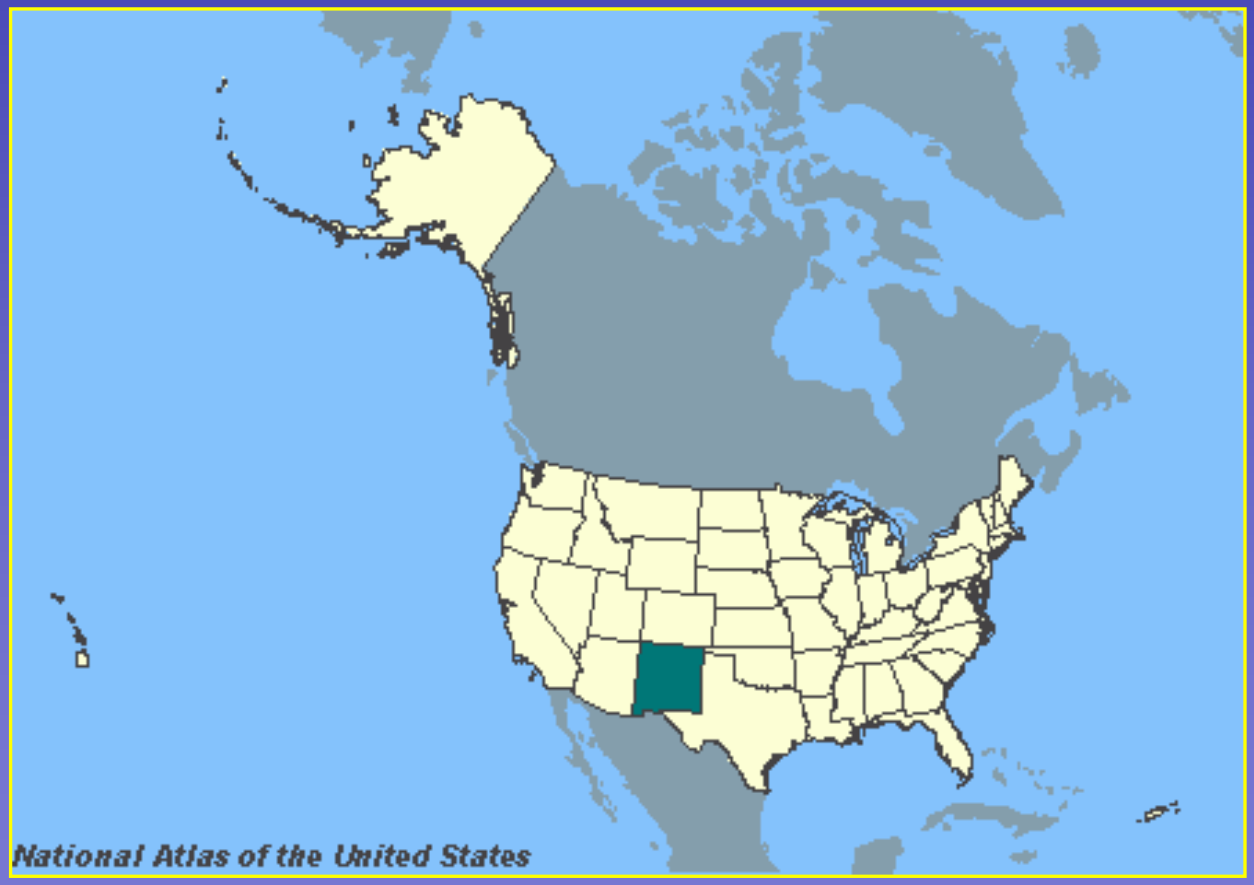
Hydrologic and Hydraulic Happenings in the Southern US

By

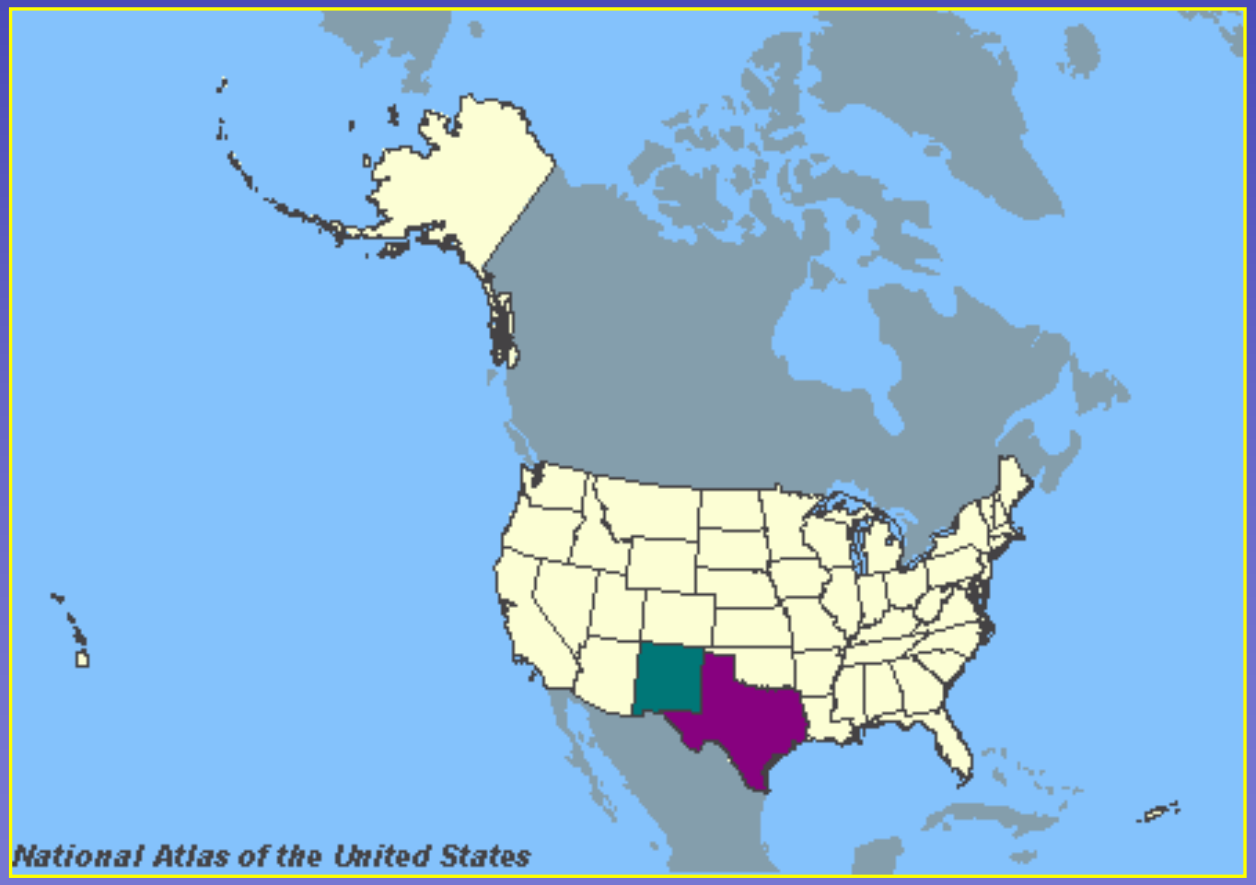
Cynthia Nurmi

Southern States

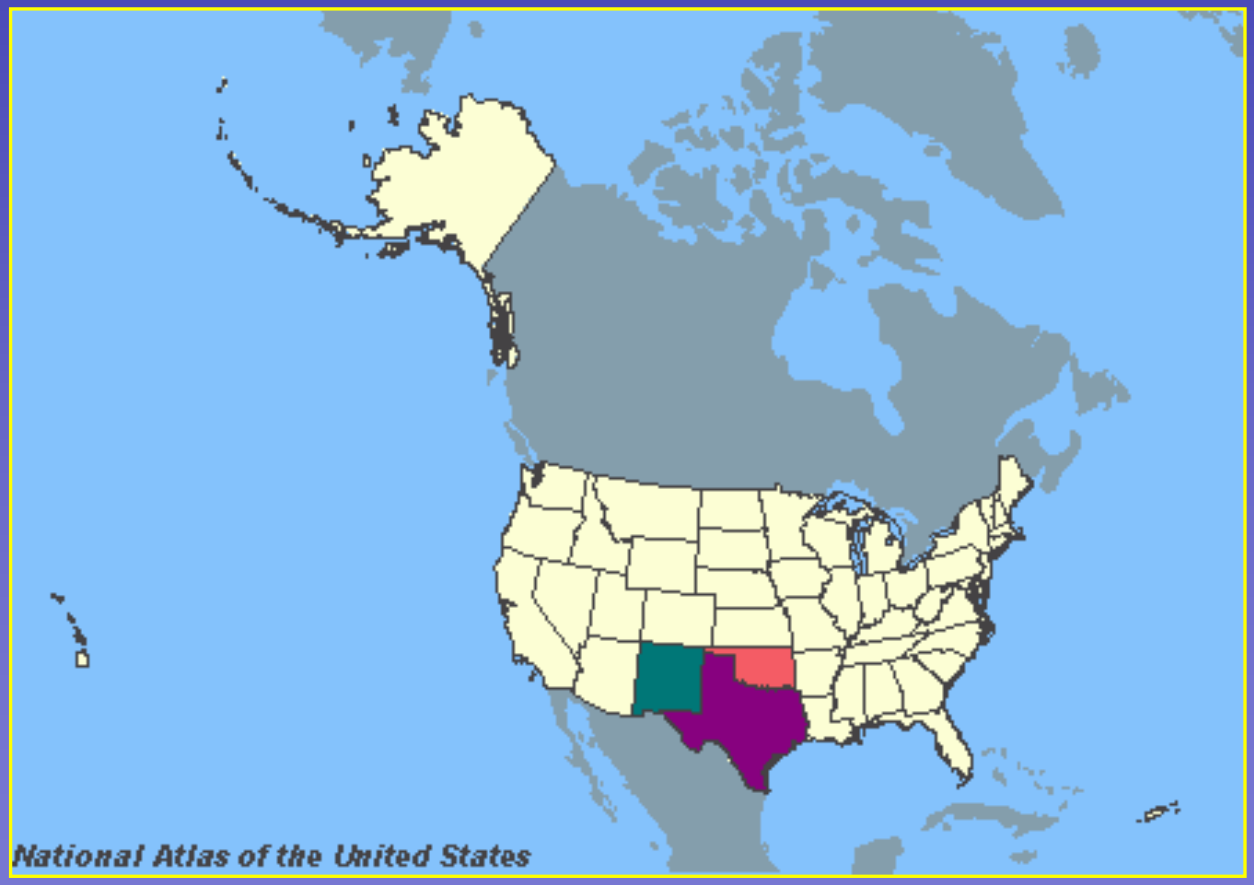
Southern States: New Mexico



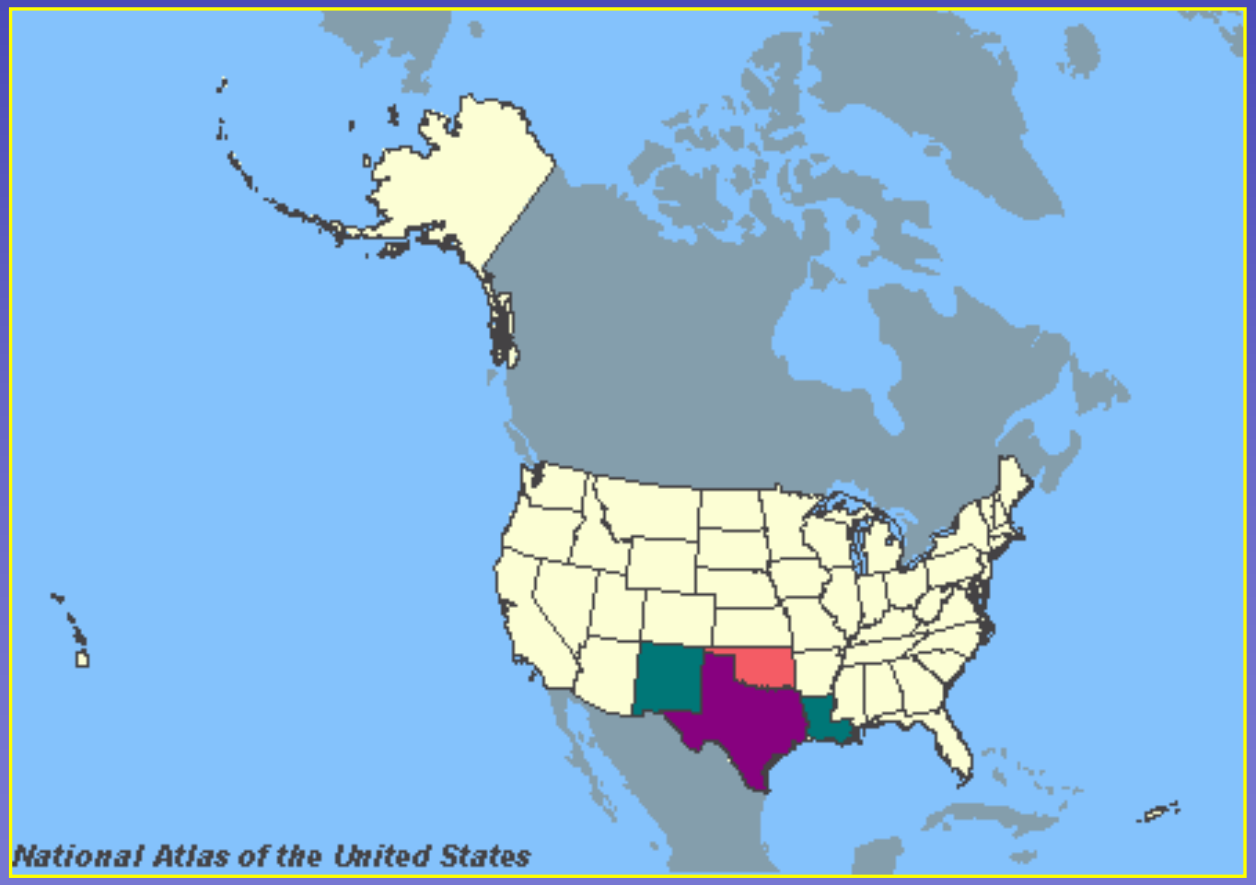
Southern States: Texas



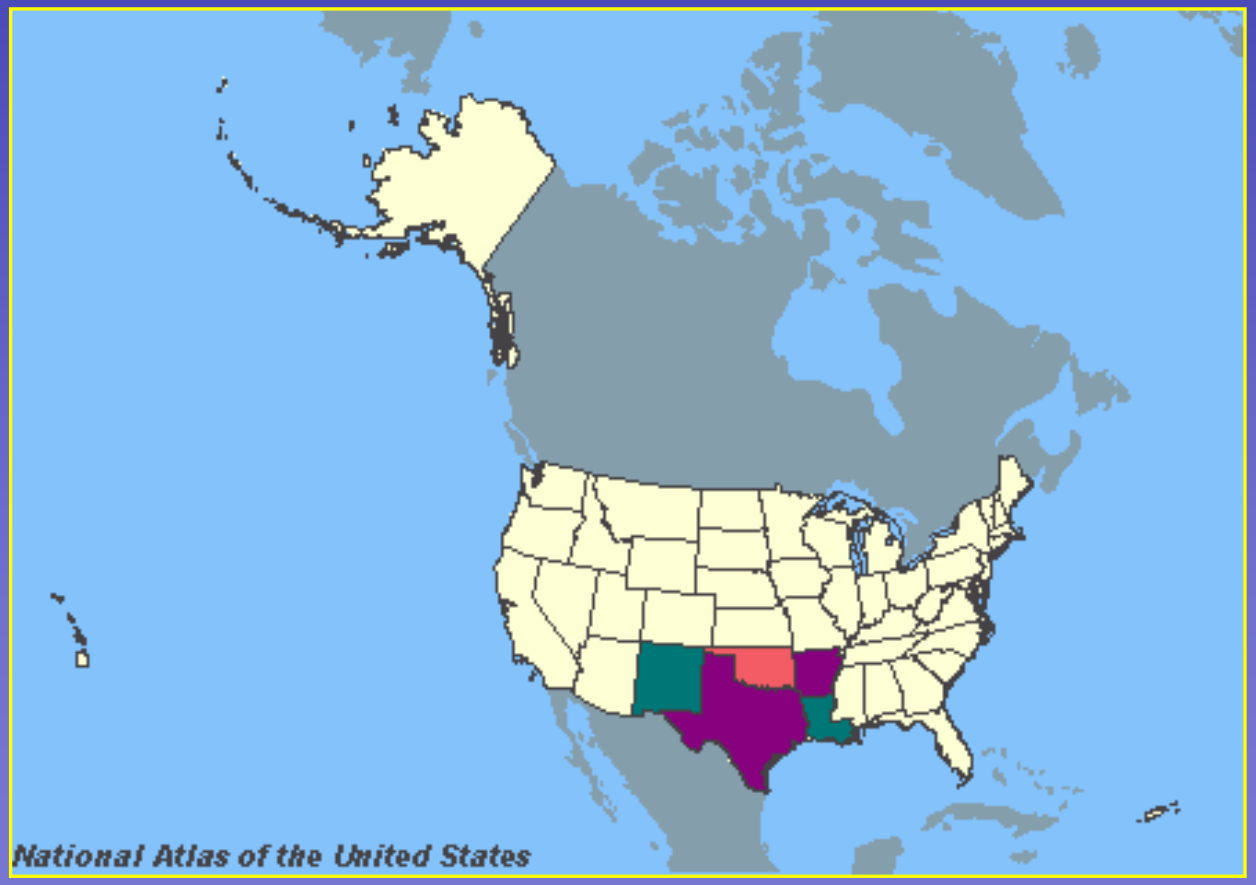
Southern States: Oklahoma



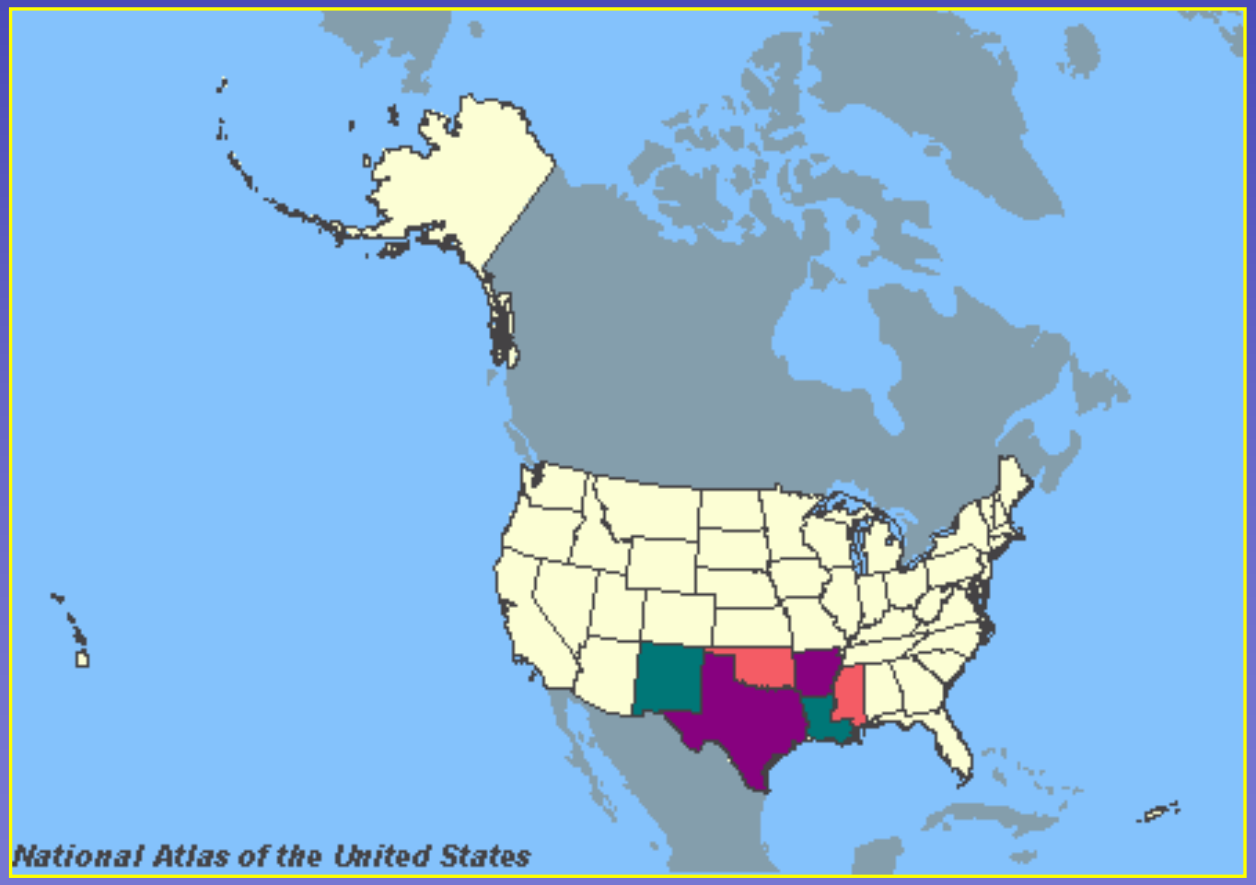
Southern States: Louisiana



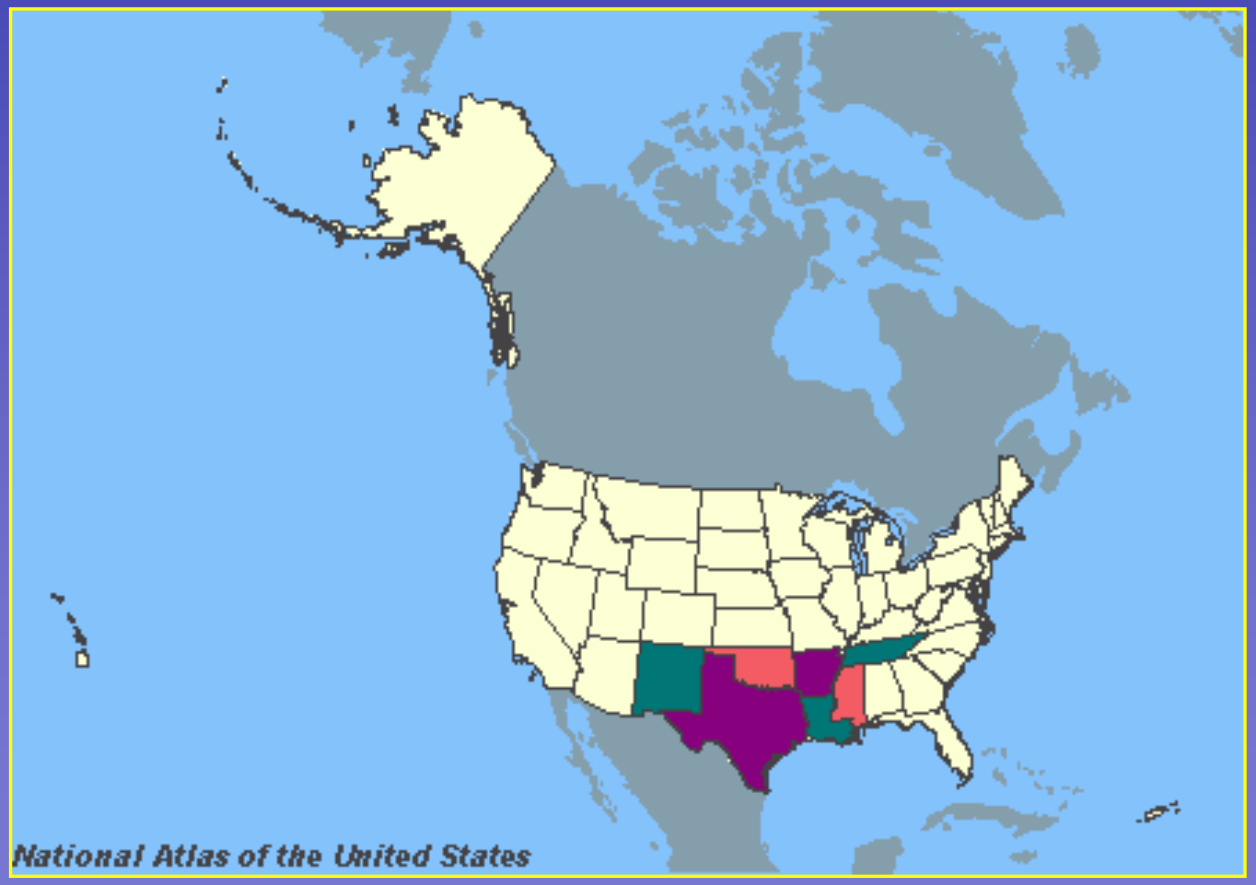
Southern States: Arkansas



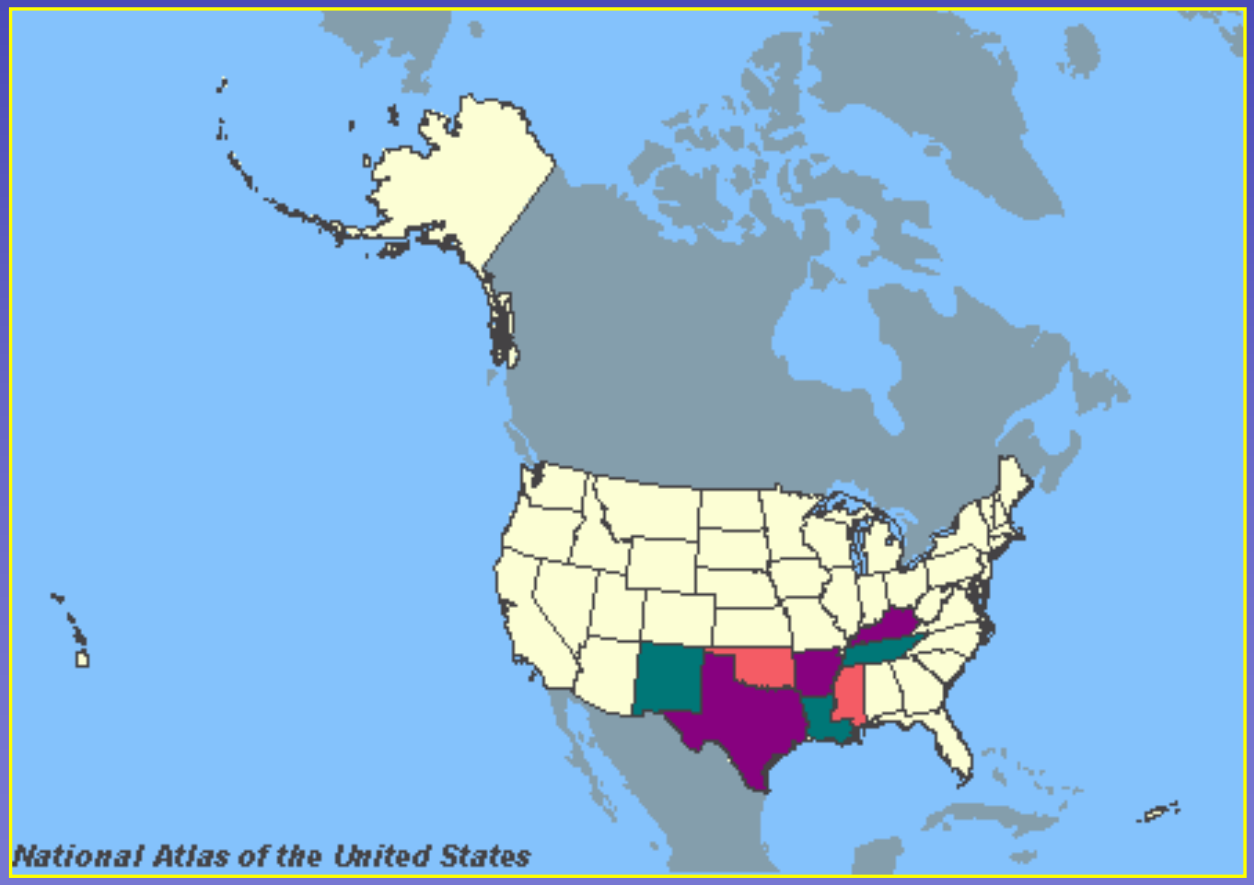
Southern States: Mississippi



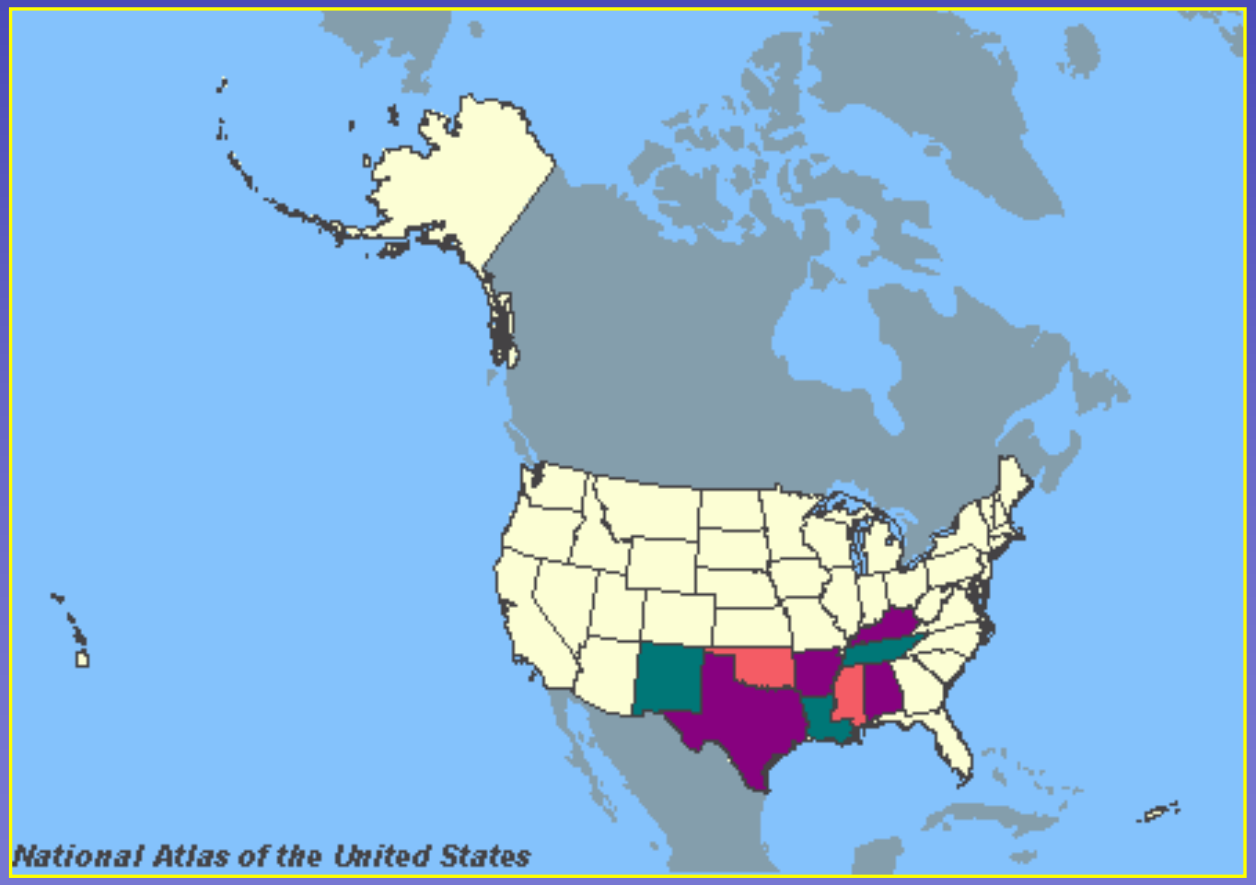
Southern States: Tennessee



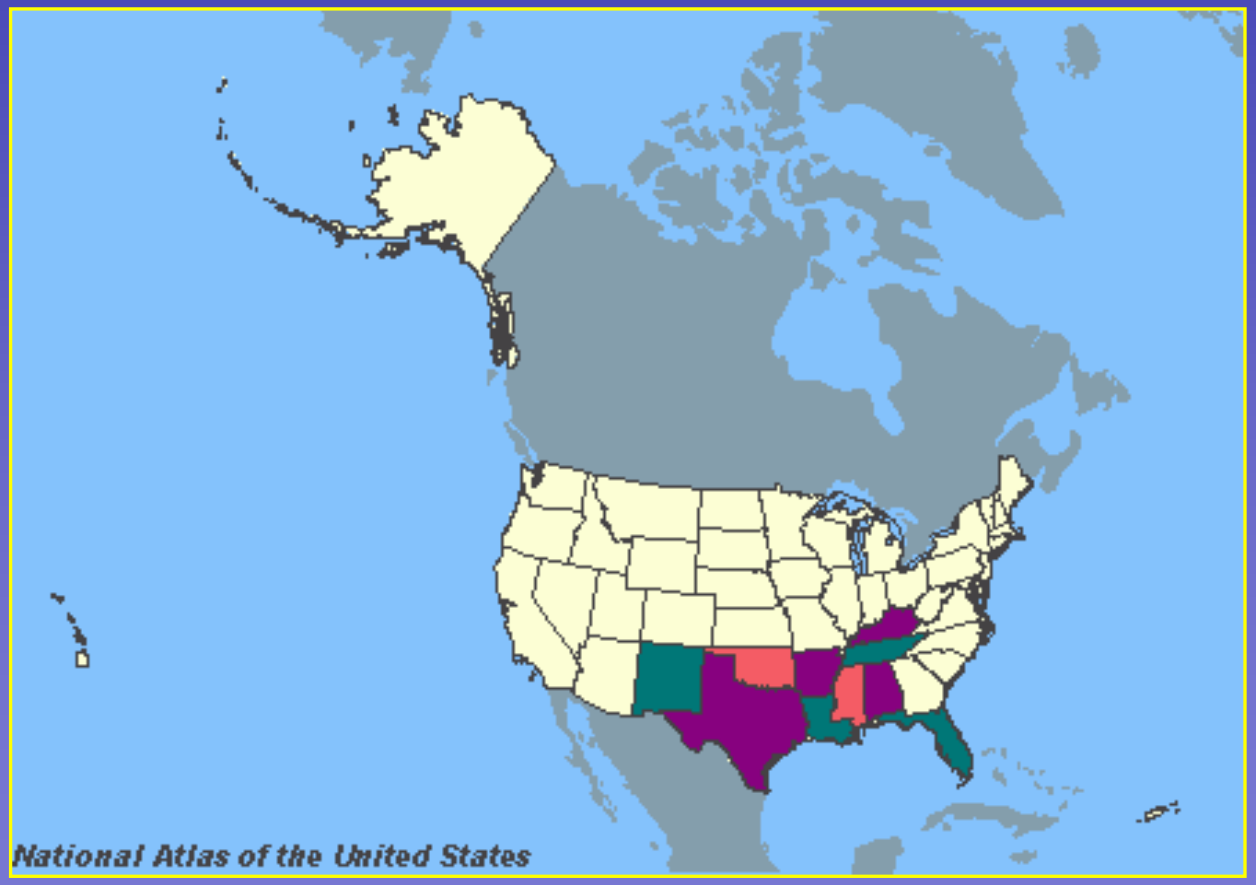
Southern States: Kentucky



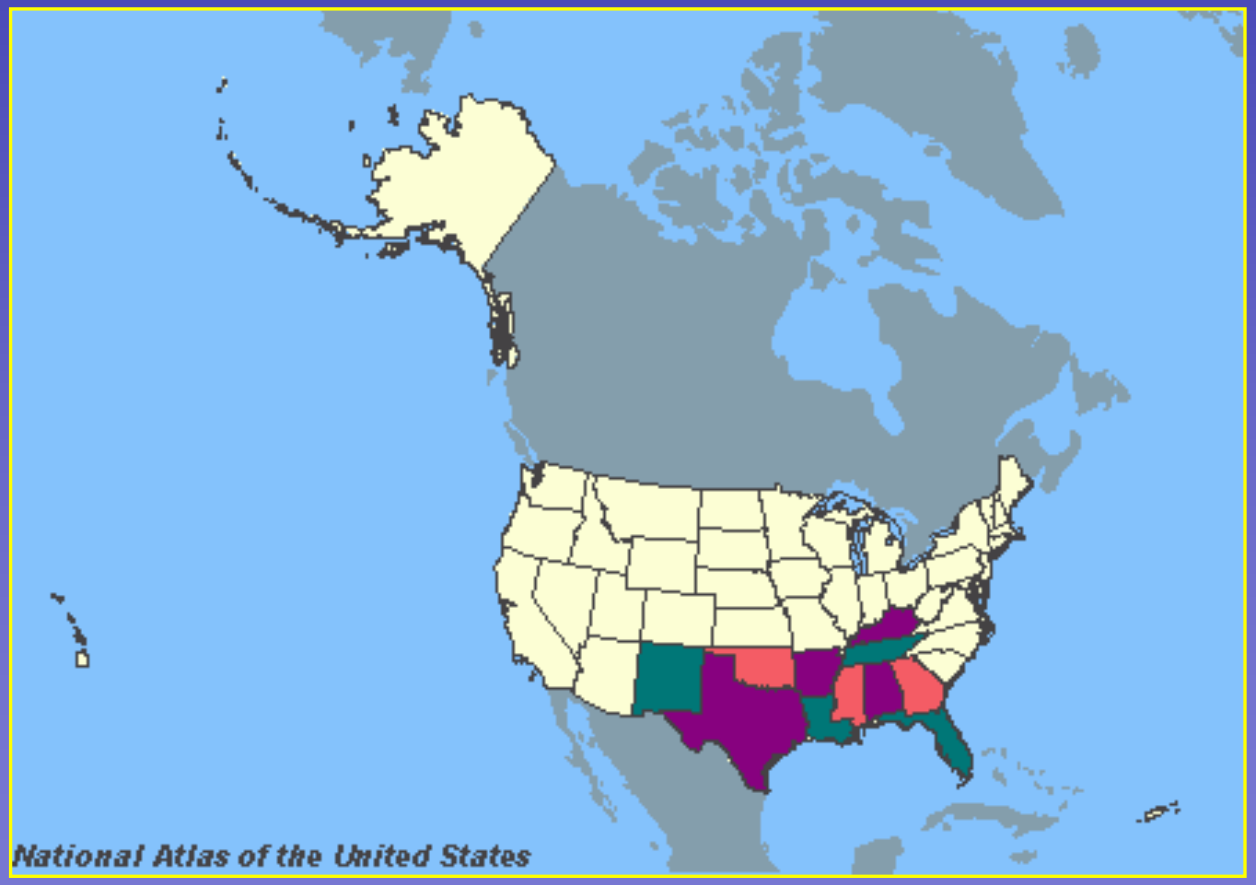
Southern States: Alabama



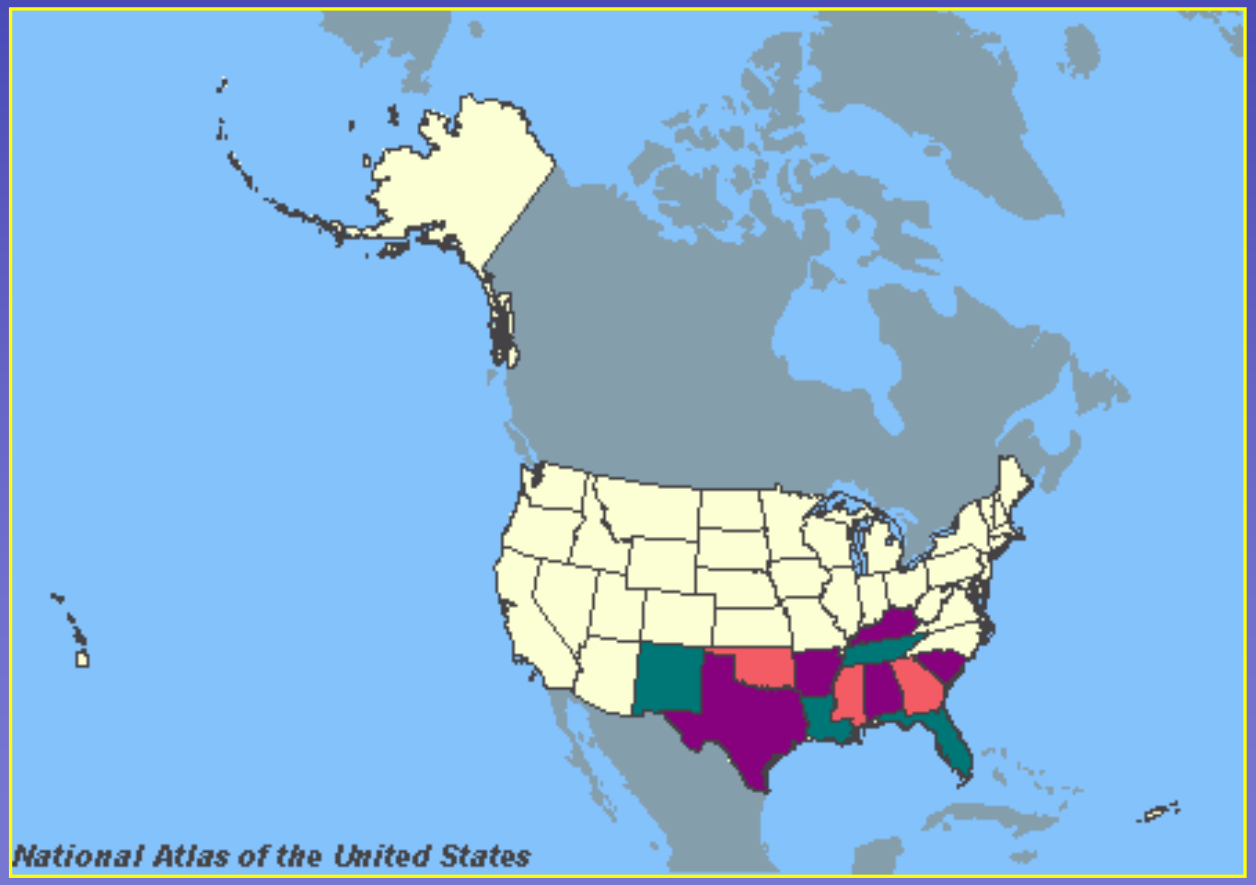
Southern States: Florida



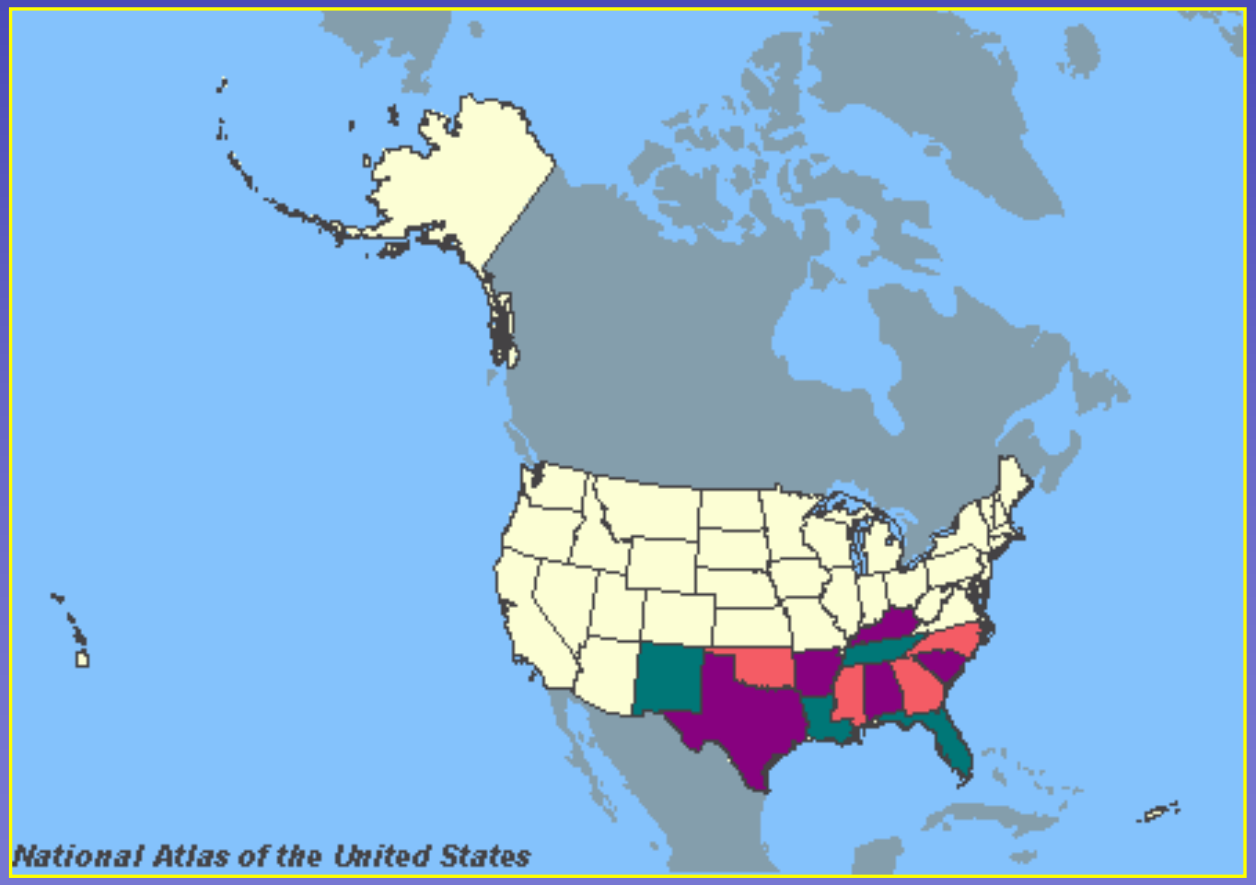
Southern States: Georgia



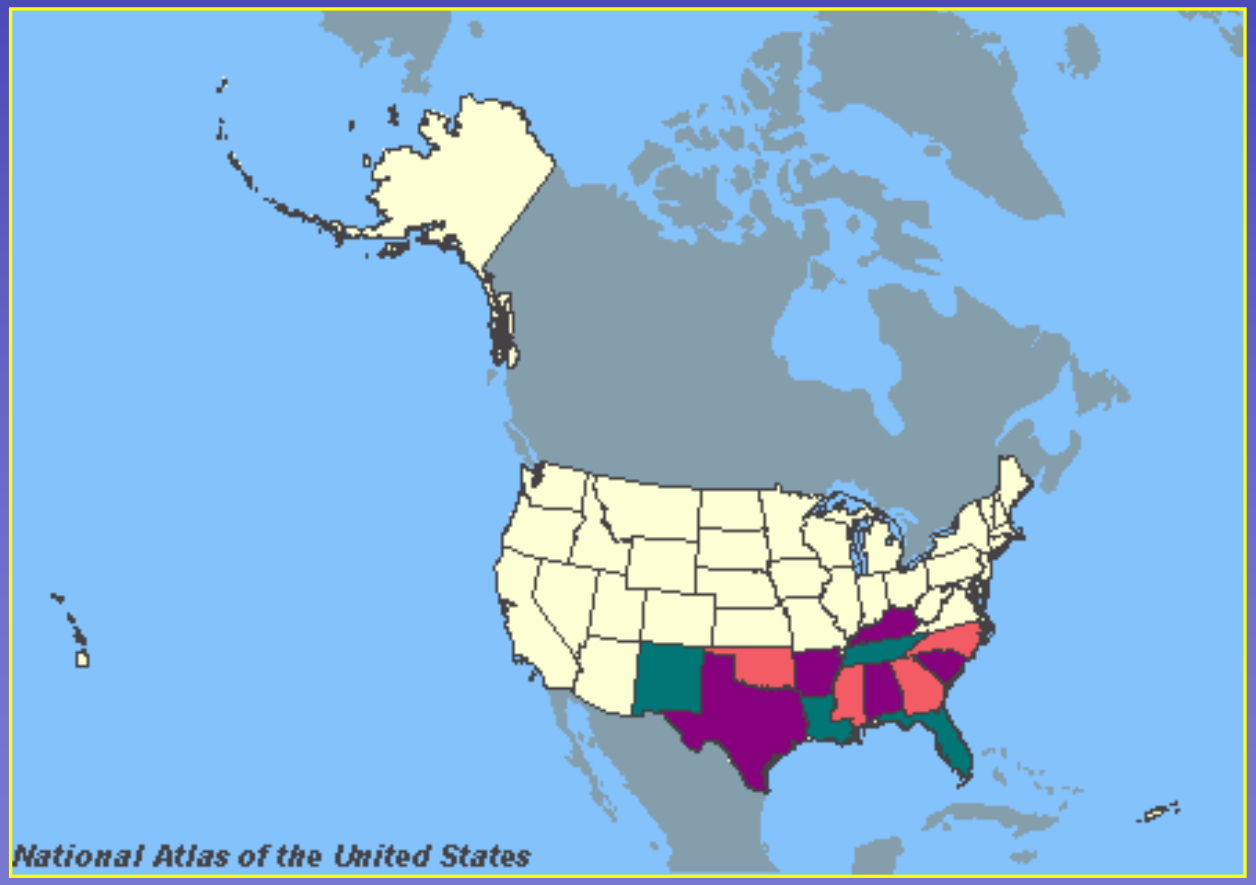
Southern States: South Carolina



Southern States: North Carolina

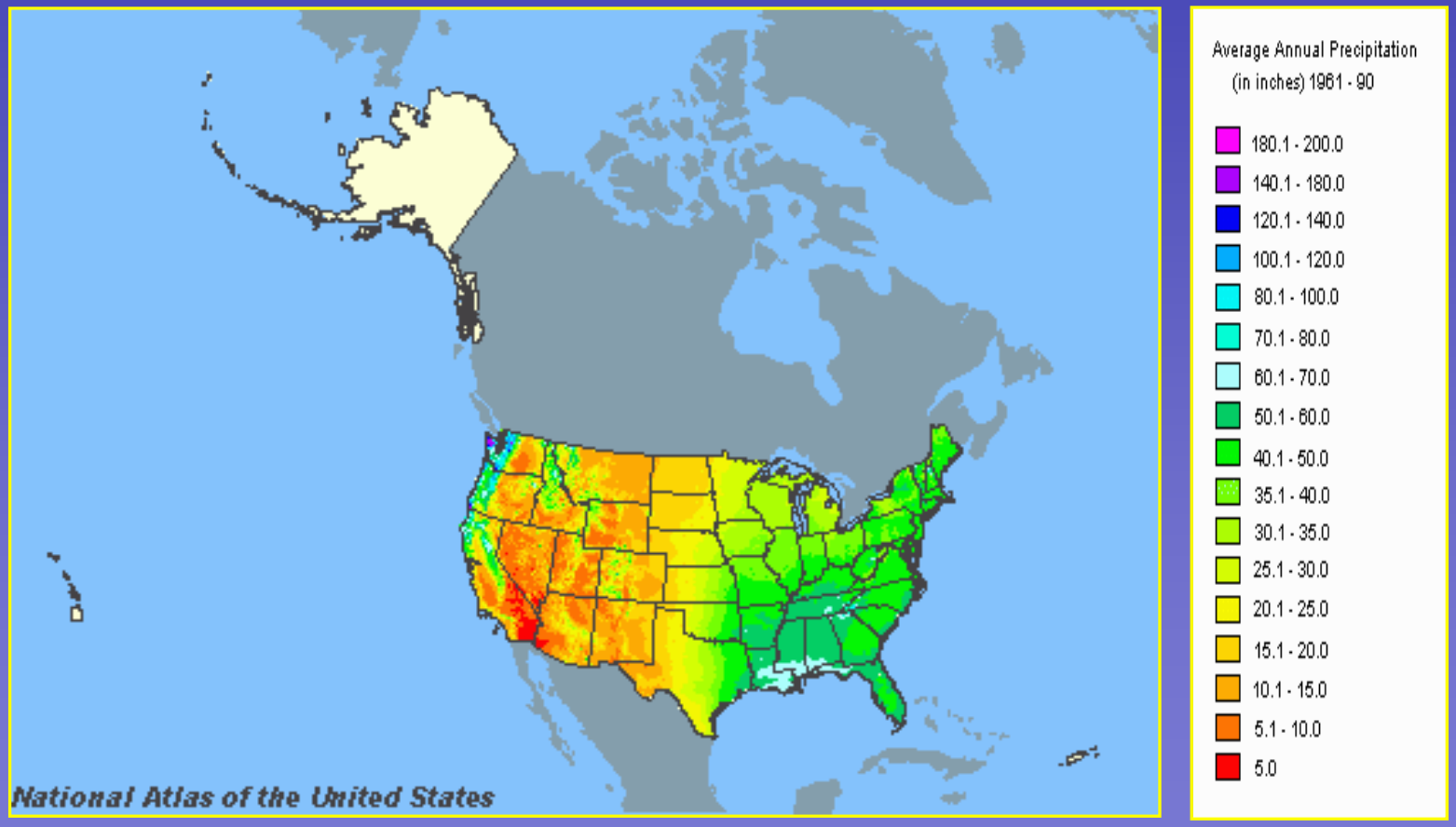


Southern States: Puerto Rico



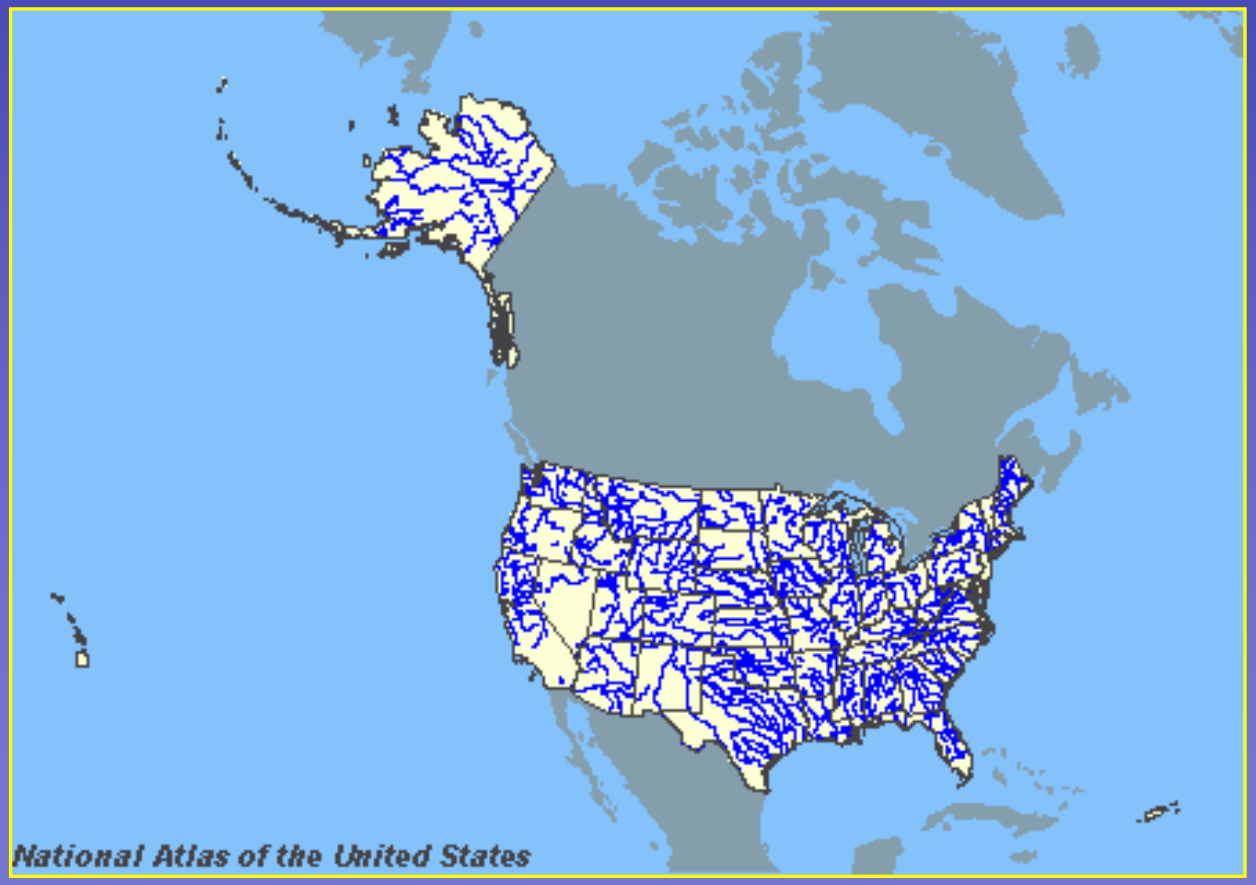
Southern States: Characteristics

Characteristic: Precipitation

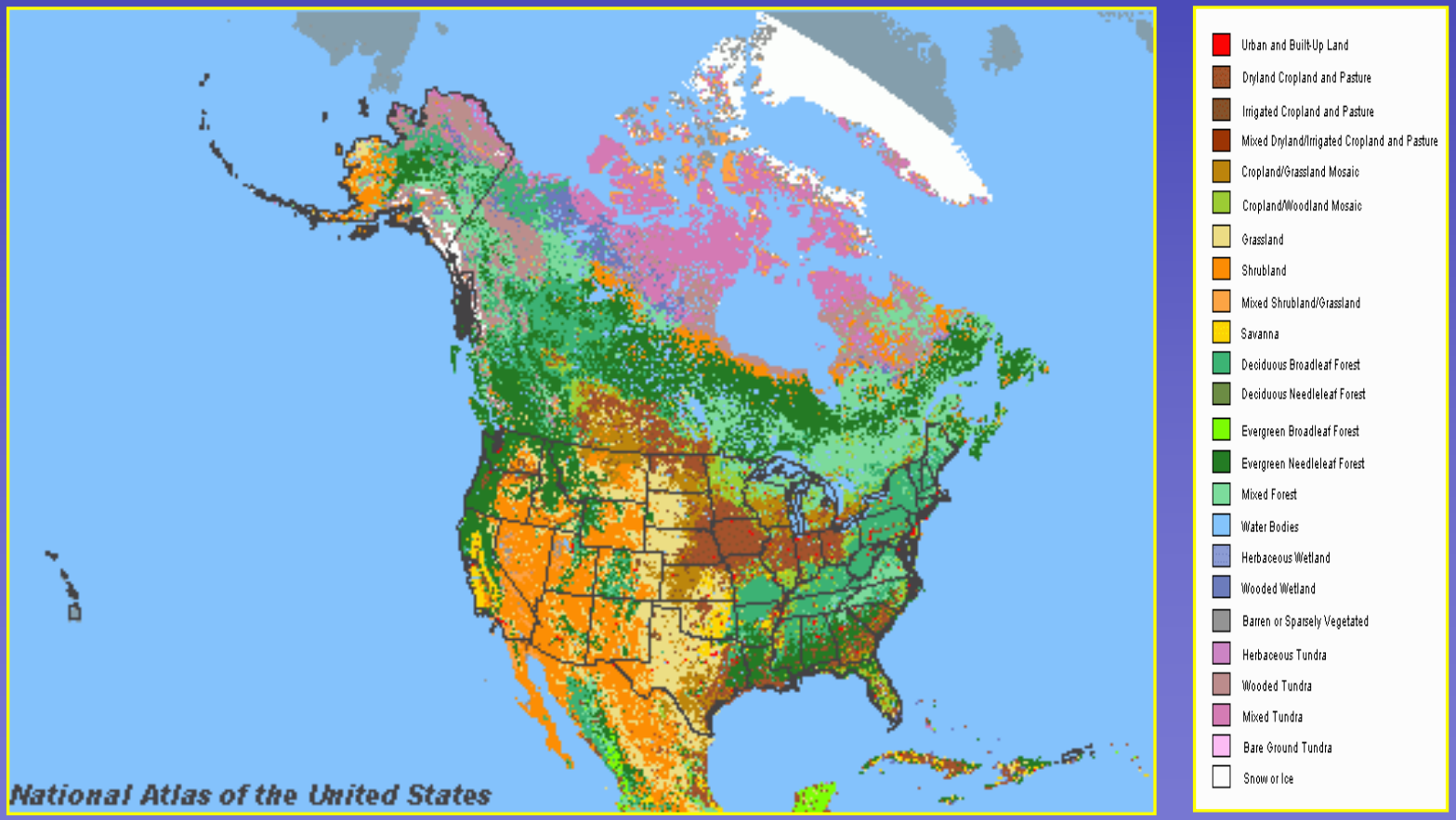


Characteristic: Hurricanes

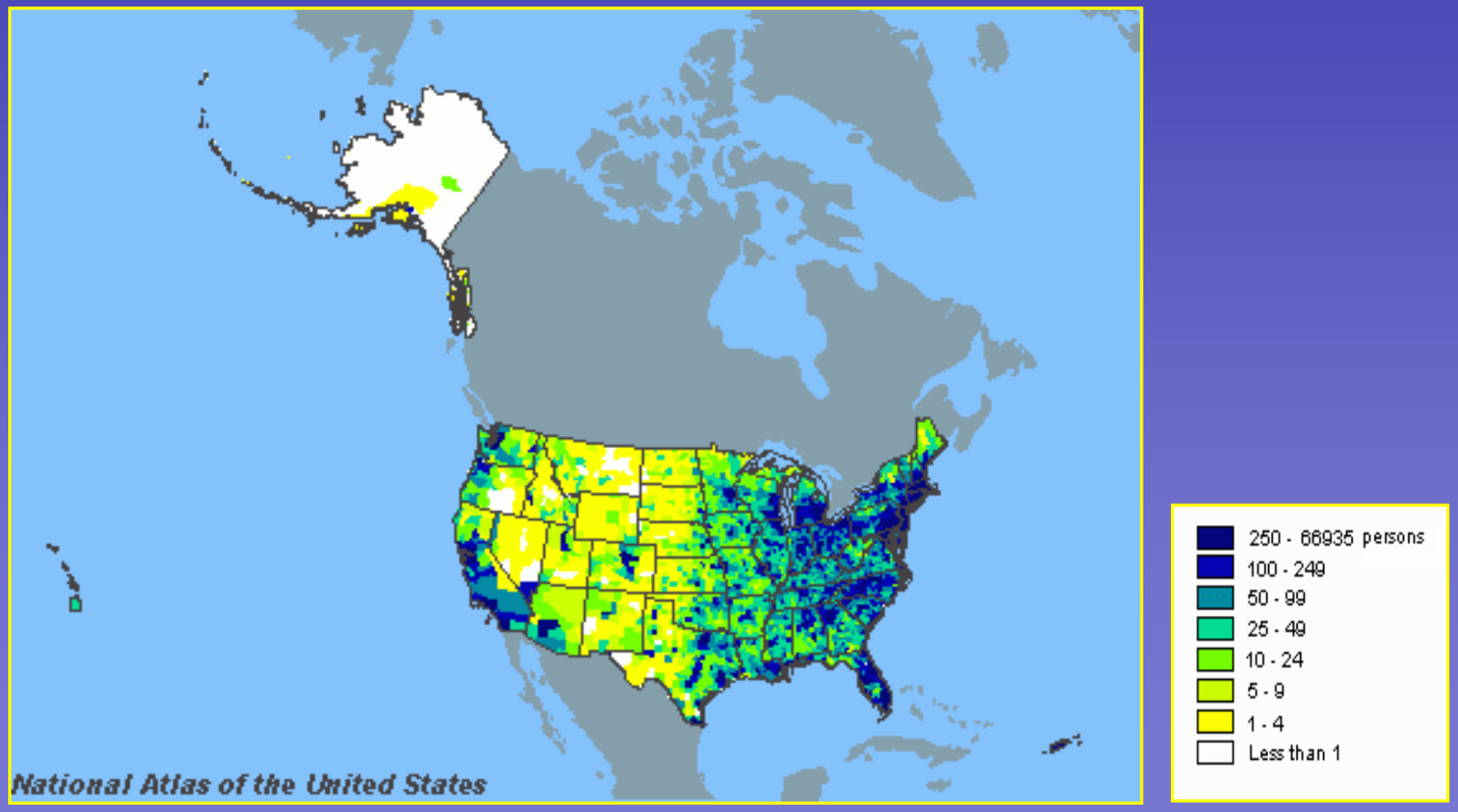
Characteristic: Waterways



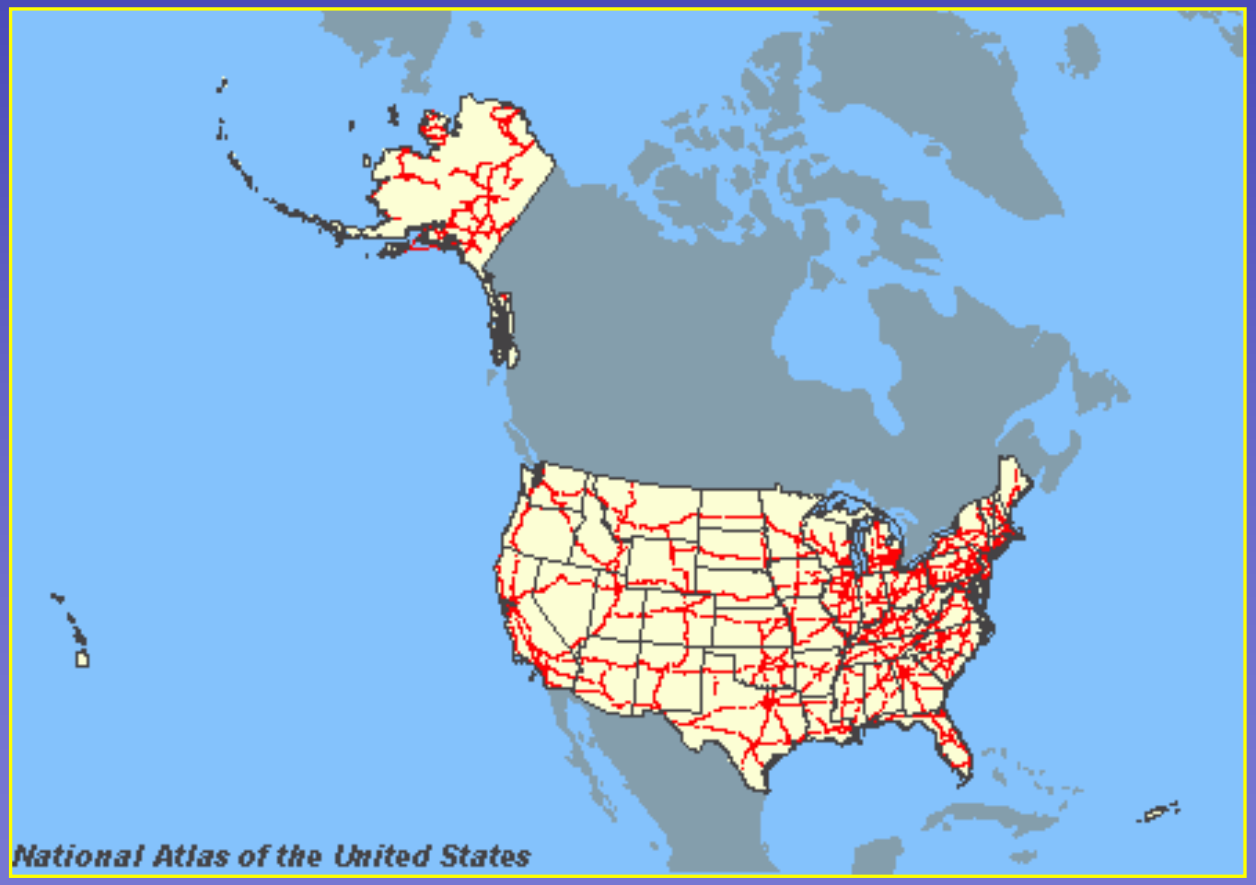
Characteristic: Land Cover



Characteristic: Population



Characteristic: Roadways



Characteristic: Roadways

- Interstate Roadways
  - 13,800 miles
  - 31% of US
- Non-Interstate Roadways
  - 321,500 miles
  - 44% of US
- Bridges over Waterways
  - 186,500 Bridges
  - 39% of US

Southern States: Issues

Southern States: Issues

- Hydrology
- Scour
- Stream Stability
- Drainage
- Environment

Issue: Hydrology

- Texas DOT Research
  - Texas Tech University - TECHMRT

Hydrology: Texas DOT Research

- Regional Characteristics of Unit Hydrographs (Project 0-4193)
  - Using Actual Rainfall and Runoff Data
    - Currently L-gamma distribution relationships
  - Publish Guidance for Development and Application of Synthetic Unit Hydrographs

Hydrology: Texas DOT Research

- Regional Characteristics of Storm Hyetographs (Project 0-4194)
  - Using Actual Rainfall and Runoff Data
    - Storm Peaks more Front-end than Centrally loaded
    - Variation in Intensity throughout storm – less severe
  - Will Test Distributions against the NRCS 24-hr Type II and III storms
  - Publish Guidance for Development and Application of Rainfall Hyetographs

Hydrology: Texas DOT Research

- Estimating Time Parameters of Direct Runoff and Unit Hydrographs for Texas Watersheds (Project 0-4696)
  - Literature Review – Methods estimating time parameters for hydrographs
  - Verify Methods for Small Watersheds with Actual Data
  - Publish Guidance

Issue: Scour

- Calculating Scour
  - Pier Scour
  - Abutment Scour
  - Cohesive Material Scour
  - Rock Scour
  - Tidal Scour
  - Unknown Foundations
- Inspecting and Monitoring
- Countermeasures

Scour: Pier

- Florida DOT Research – Dr. Sheppard
  - Equation:
    - Based on data from many laboratories
    - Predicts equilibrium scour depths
    - Function of three dimensionless groups
      - Water Depth/Structure Diameter
      - Velocity/Sediment Critical Velocity
      - Structure Diameter/Sediment Diameter

Scour: Pier – Florida DOT Research

- Compared to HEC-18
  - Regular Piers:
    - Florida Equation less than HEC-18
  - Wide Piers:
    - Florida Equation comparable to HEC-18 WP for small D_{50}
    - Florida Equation more than HEC-18 WP for large D_{50}

Scour: Pier – Florida DOT Research

- Verify Equation
  - Clearwater Scour Flume – Massachusetts
    - Fine Sediment lowered equilibrium scour depths
  - Live Bed Scour Flume – Auckland, New Zealand

Scour: Pier – Florida DOT Research

- Massachusetts Clearwater Flume

Scour: Pier – Florida DOT Research

- Auckland, New Zealand Live Bed Flume

Scour: Pier – Florida DOT Research

- Auckland, New Zealand Live Bed Flume

Scour: Abutment

- Georgia DOT Research – Dr. Sturm
  - Compound Channel
    - Equations: Clearwater and Livebed
    - HEC 18 - Appendix E
    - Additional Lab Data to Confirm

Scour: Cohesive Materials

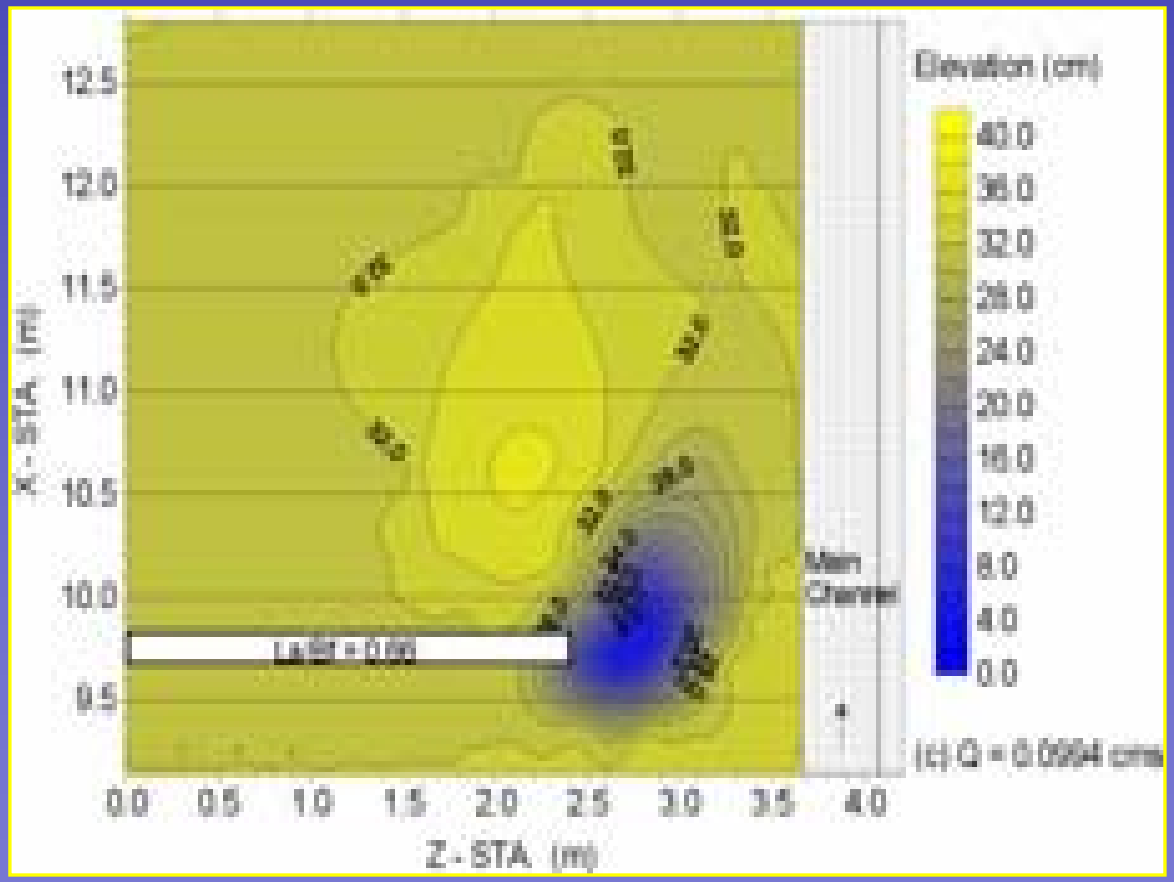
- Georgia DOT Research – Dr. Sturm
  - Laboratory and 3D Numerical Modeling with Field Monitoring of Regional Bridge Scour in Georgia
    - 4 Bridges Monitored
    - 2 Bridges Modeled in Lab
    - Compare Field, Lab, and 3-D Modeling Results
    - Regional Bridge Scour Prediction Methodology

Scour: Cohesive Materials – Georgia DOT Research

- Laboratory Modeling

Scour: Cohesive Materials – Georgia DOT Research

- 3-D Numeric Modeling



Scour: Cohesive Materials

- Texas DOT Research – Dr. Briaud
  - Erosion Function Apparatus (EFA)
    - Determine time rate of scour
  - SRICOS Method
  - HEC 18 Appendix L

Scour: Cohesive Materials – Texas DOT Research

- Erosion Function Apparatus

Scour: Rock

- North Carolina DOT
  - Tidal Bridges with Large Seals
  - 75 year life
  - EFA Machine
  - Limestone

Scour: Rock

- Florida DOT Research – Dr. Sheppard
  - Procedure for Determining Scour in Rock
    - Determine “Rate of Erosion” properties
      - Rotating Erosion Test Apparatus (RETA)
      - Flume Erosion Test Apparatus (FETA)
    - Determine Flows over Life of Bridge
    - Construct Time History Bed Shear Stress
    - Estimate Contraction Scour
    - Estimate Local Scour

Scour: Tidal

- Tidal Pool Fund
  - Led by South Carolina DOT
  - Phase 3 completed
    - http://www.fhwa.dot.gov/bridge/hydpub.htm - SC-02-03
  - Phase 4 being evaluated
    - Wind
    - Waves
    - Time-dependent Scour
  - HEC 25

Scour: Unknown Foundations

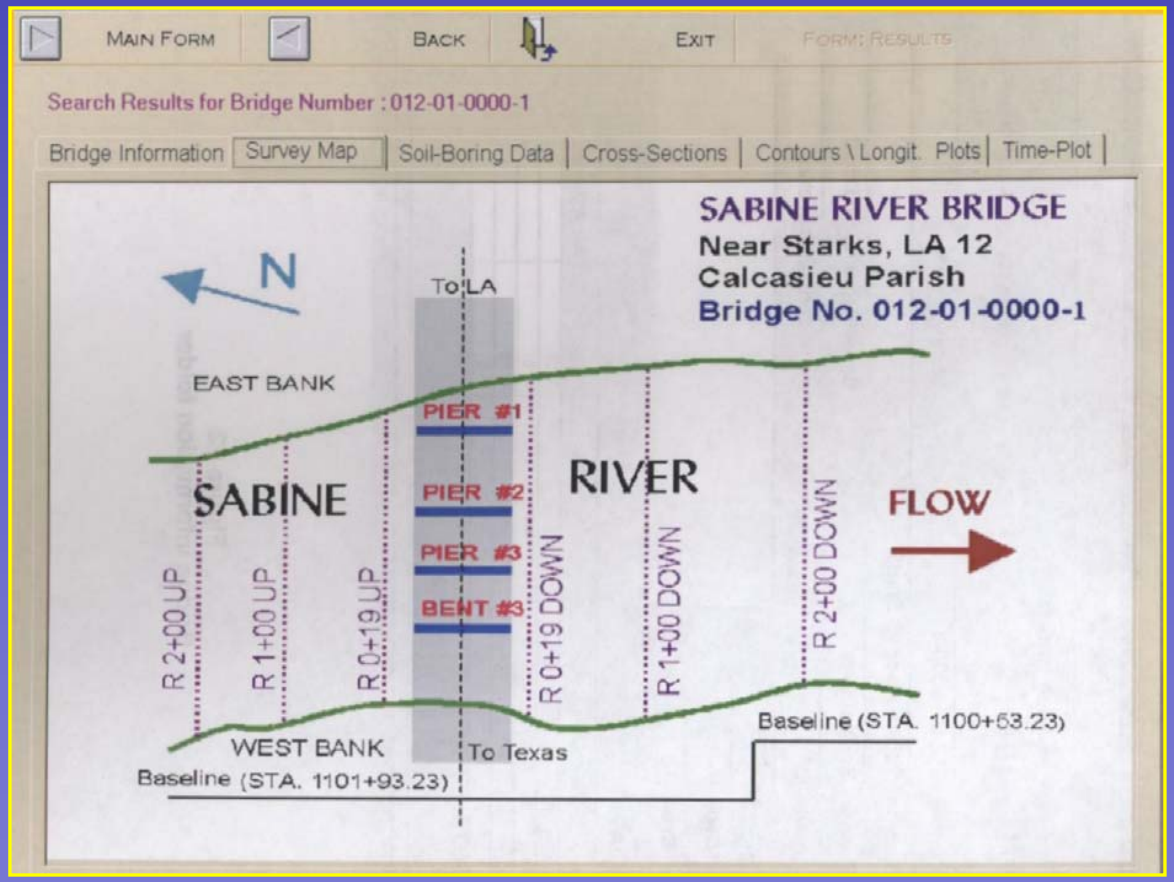
- 53,500 Bridges with Unknown Foundations
  - 60% of All Bridges with Unknown Fdns in US
  - 29% of Total Bridges over Water in South
- Determine Tip Elevation
  - Most Waiting for Technology
  - Mississippi DOT
    - Dispersive Bending Wave Technology

Scour: Inspecting and Monitoring

- Louisiana DOTD Scour Monitoring System
  - Developed by LSU
  - Used Research Money
    - Program Development
    - Historical Data Input
  - New Data Input by Survey Section
  - Analyzed by Full-time Hydraulic Engineer

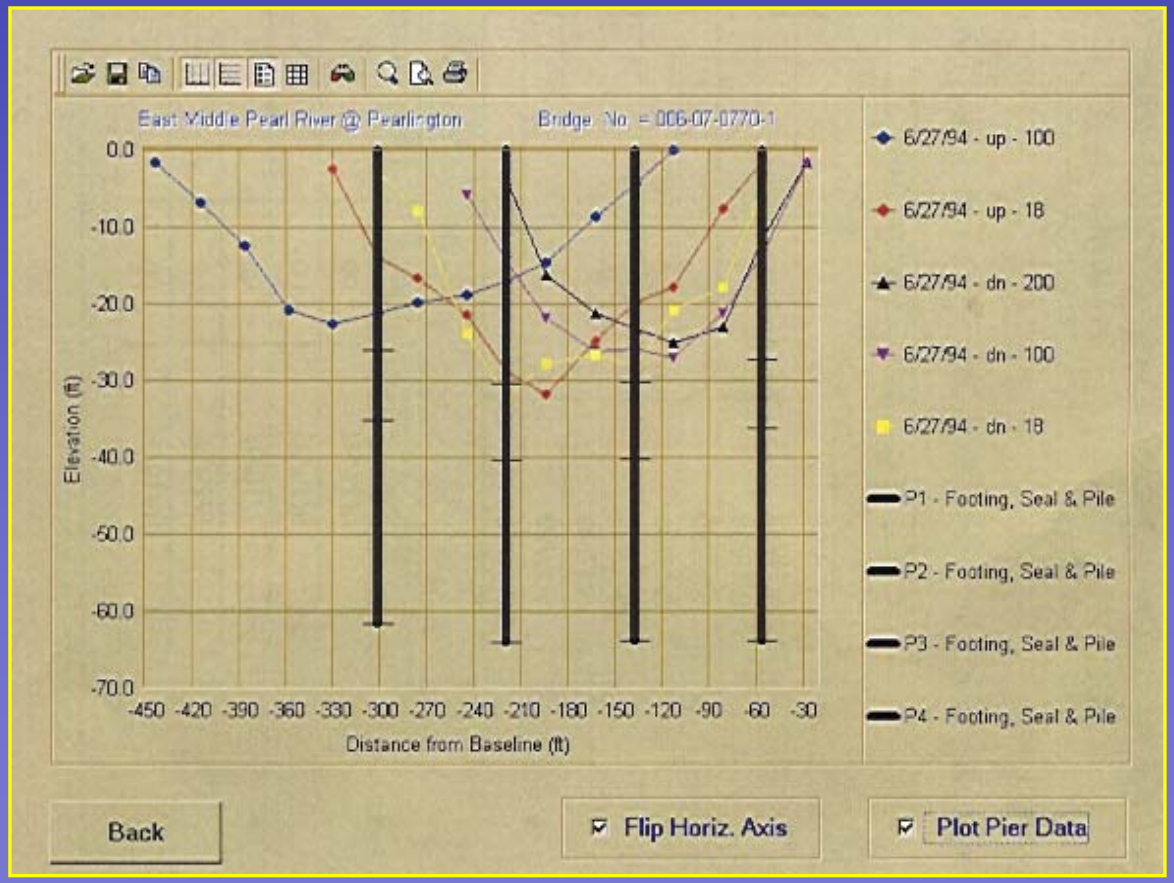
Scour: Inspecting and Monitoring – LADOTD Scour Monitoring System

- Survey Map



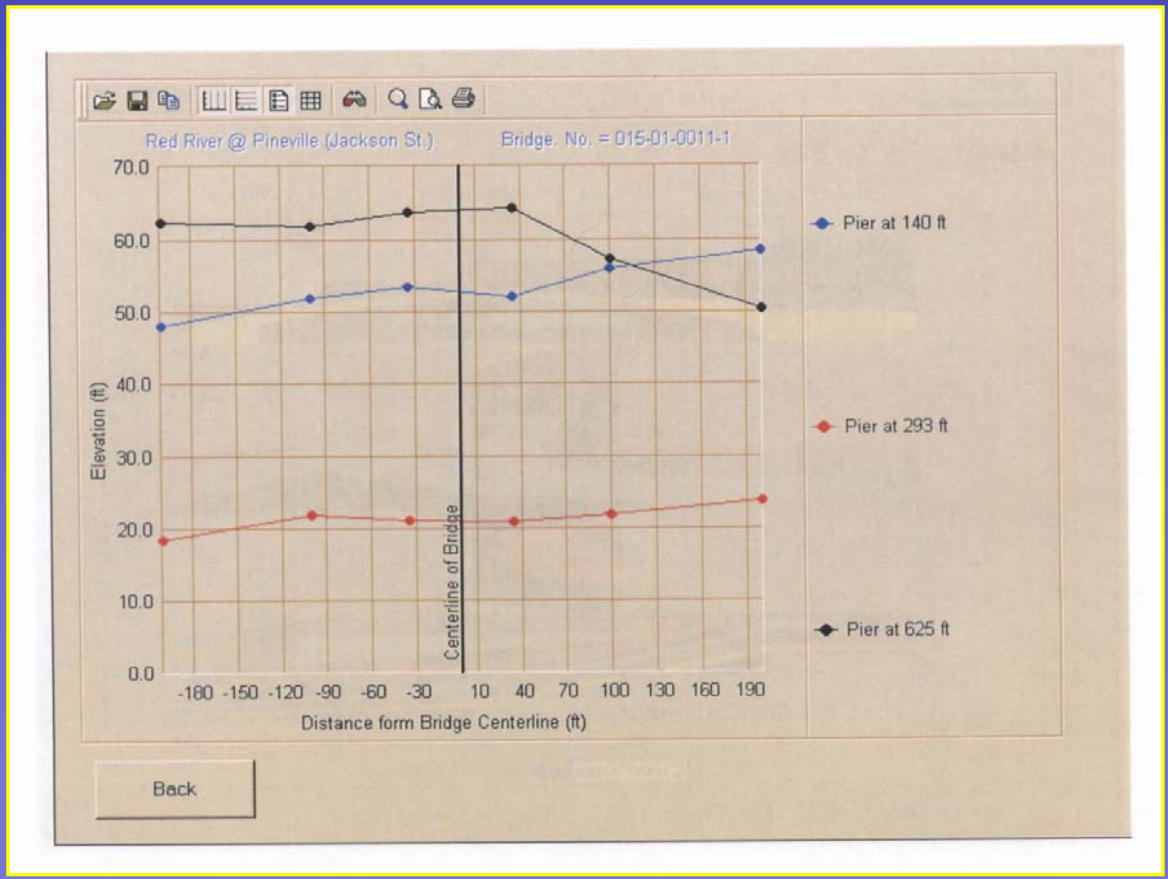
Scour: Inspecting and Monitoring – LADOTD Scour Monitoring System

- Cross-sections for Different Locations Upstream and Downstream



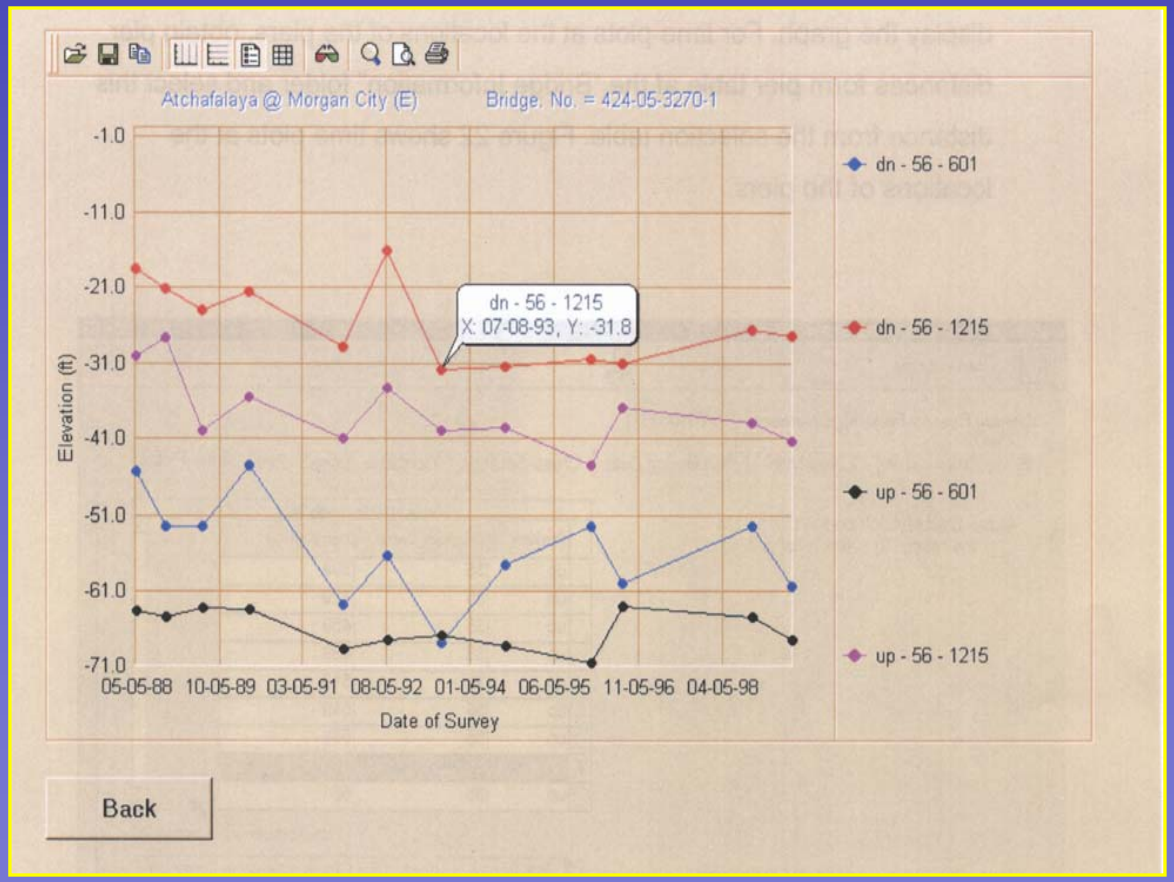
Scour: Inspecting and Monitoring – LADOTD Scour Monitoring System

- Longitudinal Plot



Scour: Inspecting and Monitoring – LADOTD Scour Monitoring System

- Survey Points Plotted Over Time



Scour: Countermeasures

- Riprap Preferred
- Ajacks - Kentucky KYTC
  - Experimented
  - Requirements for Success
    - Tie together
    - Bury

Scour: Countermeasures – KYTC Ajacks

- Ajacks around pier

Issue: Stream Stability

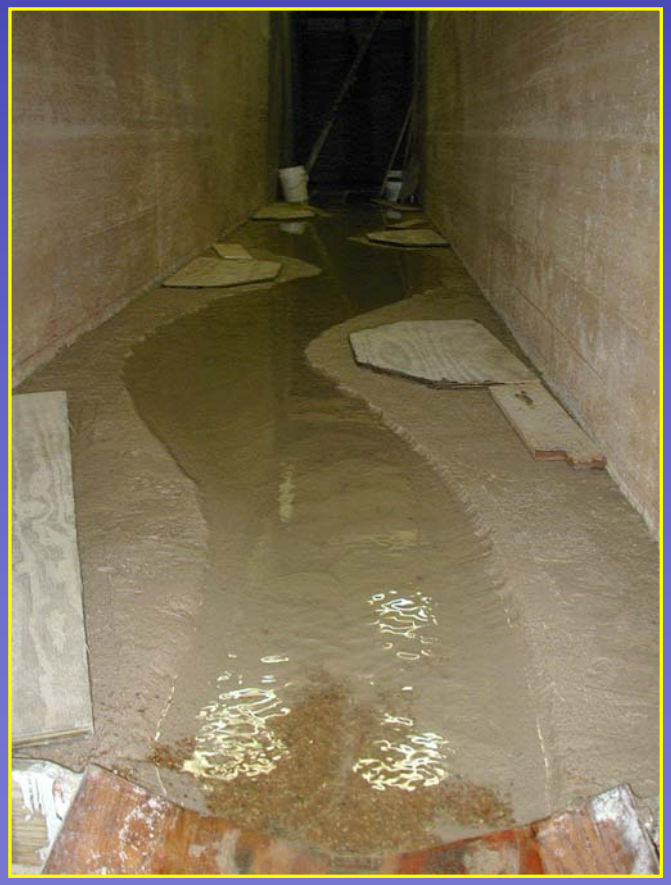
- Research
  - Texas DOT
- Countermeasures
  - Oklahoma DOT
  - Tennessee DOT
  - New Mexico SHTD
  - Mississippi DOT
  - Kentucky TC

Stream Stability: Texas DOT Research

- Establish Guidance for Soil Properties Based Prediction of Meander Migration Rate (Project 0-4378)
  - Flume Tests
  - Numerical Simulations
  - Develop Prediction Method
  - Verification

Stream Stability: Texas DOT Research

- Flume

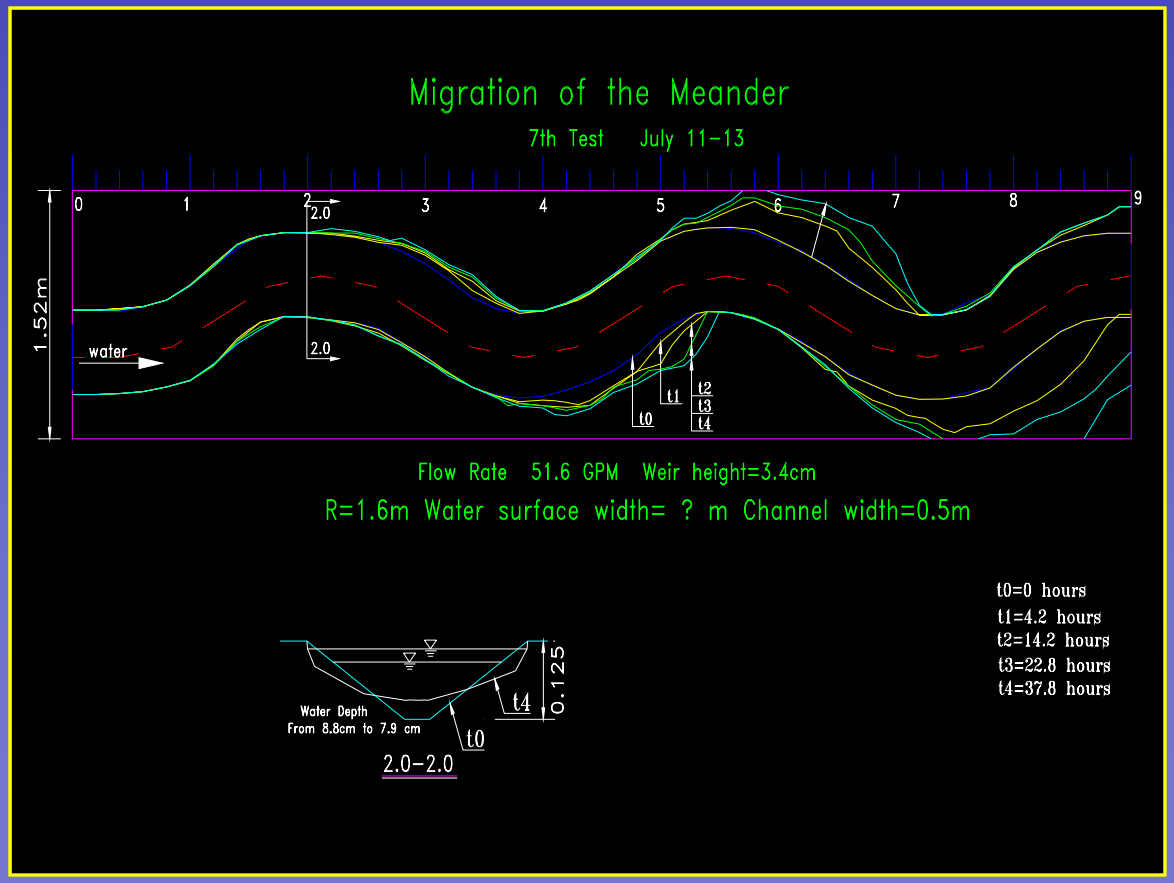


Stream Stability: Texas DOT Research

- Coastal Engineering Lab Flume

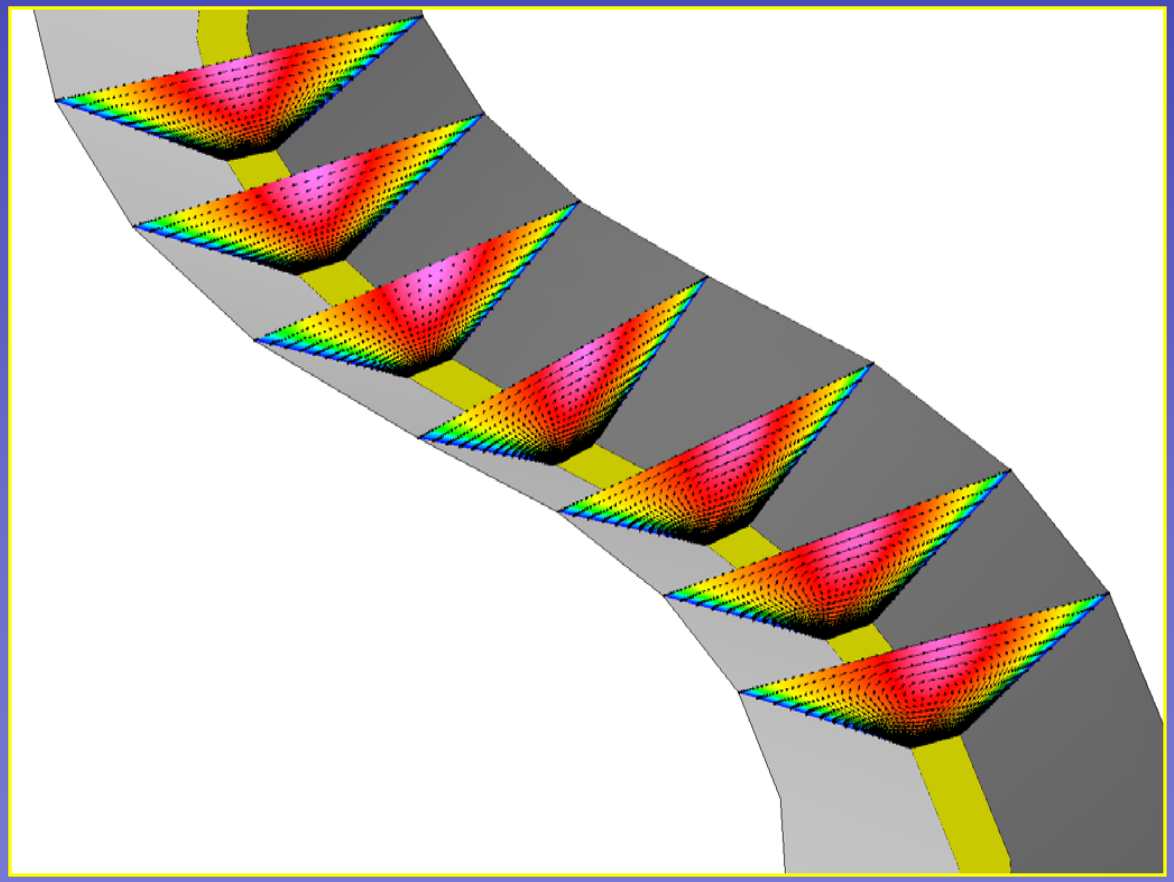
Stream Stability: Texas DOT Research

- Plot of Flume Test



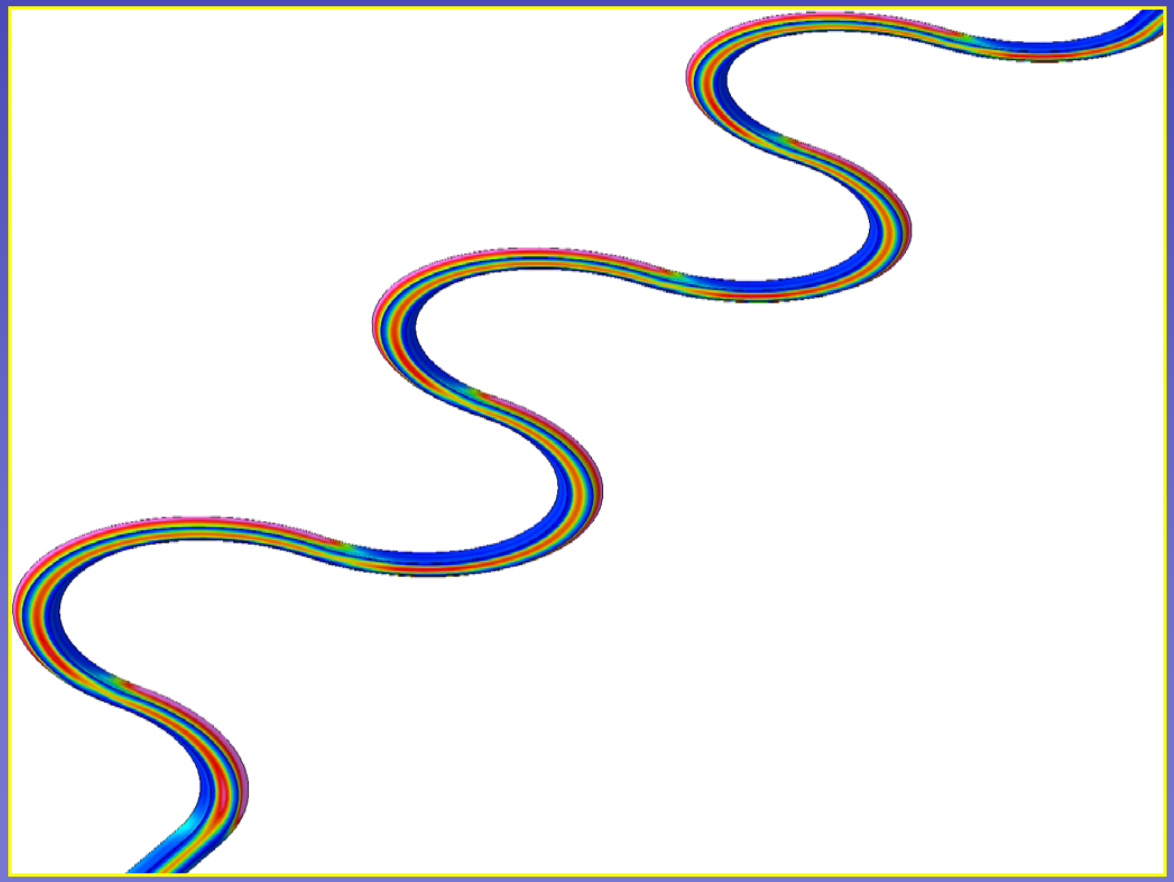
Stream Stability: Texas DOT Research

- Velocity and Secondary Flow Vectors



Stream Stability: Texas DOT Research

- Bed and Bank Shear Stress Distributions



Stream Stability: Countermeasures

- Cohesionless, Highly Erodible Material
- Channelization
- Examples

Stream Stability: Countermeasures

- Spurs

Stream Stability: Countermeasures

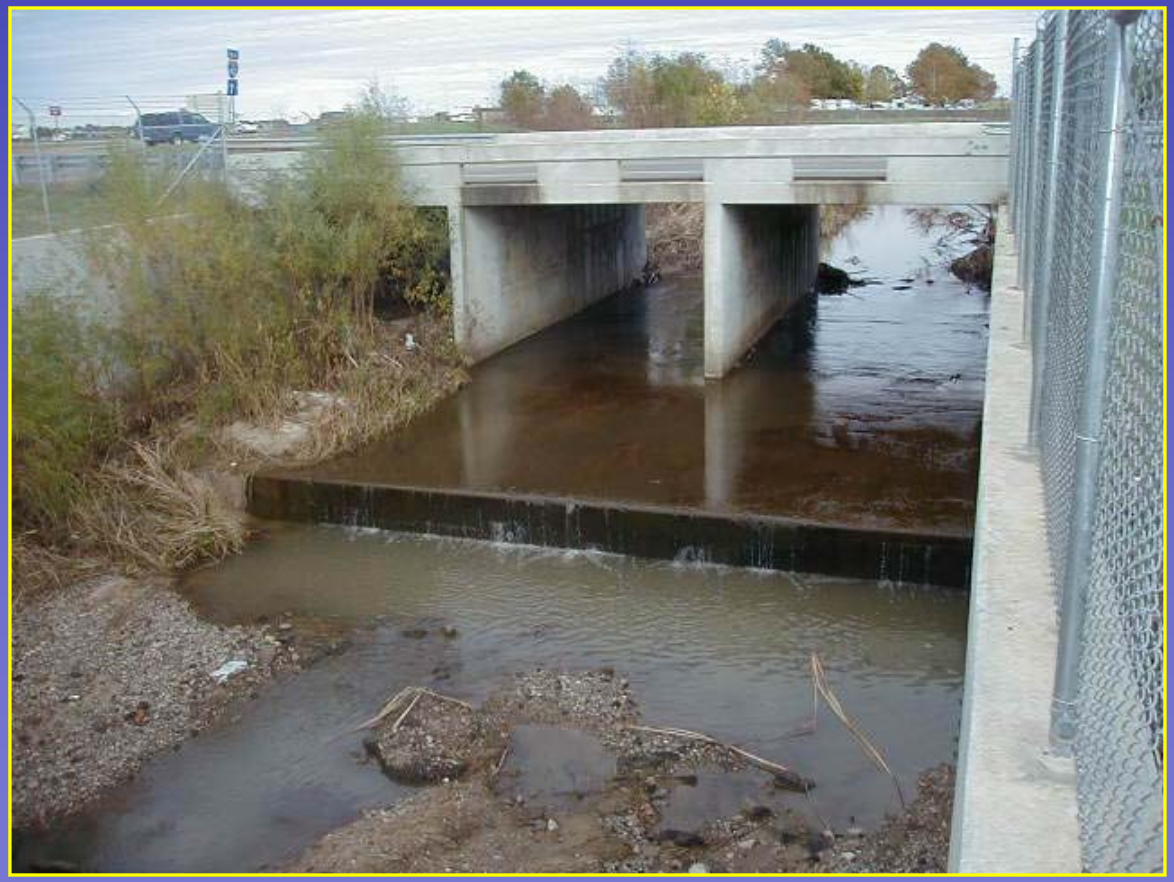
- Bendway Weirs

Stream Stability: Countermeasures

- Jack Field

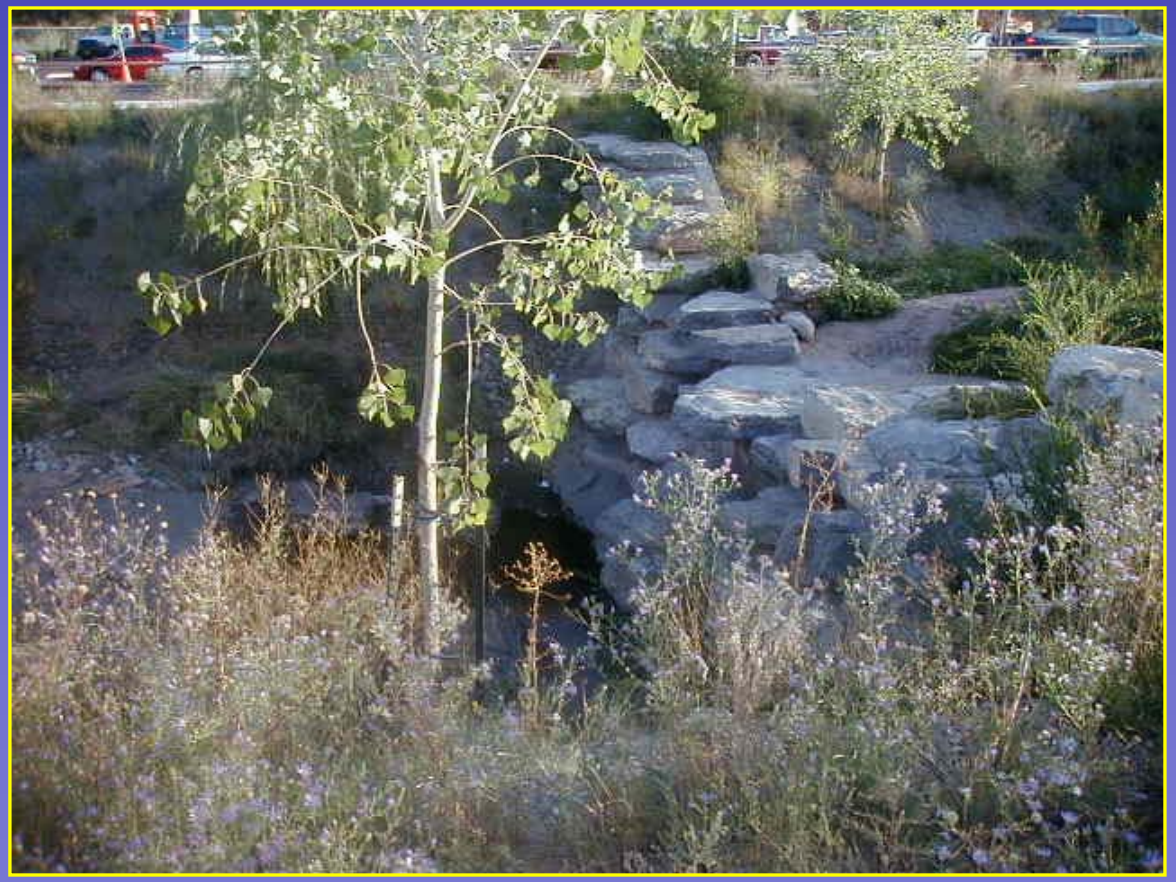
Stream Stability: Countermeasures

- Drop Structure



Stream Stability: Countermeasures

- Drop Structure



Stream Stability: Countermeasures

- Wood Fence Retarder

Stream Stability: Countermeasures

- Extend Bridge

Stream Stability: Countermeasures

- Downstream View

Stream Stability: Countermeasures

- AJACKS

Issue: Drainage

- Florida DOT Pipe Policy
  - Permanent Pipe - Service Life > 100 yrs
    - Not Replace Pipe
    - Developing Criteria
  - Non-Permanent Pipe – Service Life > 50 yrs
    - Replace Pipe
      - Driveways

Issue: Drainage

- Florida DOT Research
  - Soil Box
    - 20 ft x 7.5 ft x 7 ft
    - Test Steel Reinforced and Fiber Reinforced Concrete Pipe
    - Load Test until Failure
    - Variables:
      - Compaction level
      - Soil saturation level
      - Depth of overburden

Issue: Environment

- Water Quality
  - Research Centers
  - Projects
- Fish Passage
- Stream Restoration

Environment: Water Quality

- Research Centers
  - AL DOT – Center on Coastal Transportation Engineering
    - University of South Alabama
    - Research:
      - Coastal Roadways
      - Water Quality Issues
  - FL DOT – Stormwater Management Academy
    - University of Central Florida
    - Research:
      - Stormwater Management Principles

Environment: Water Quality

- Research Centers
  - NC DOT – Center for Transportation and Environment
    - North Carolina State University
    - Research:
      - Methodology to Estimate Non-Point Source Pollutant Loadings from North Carolina Highways
        - GIS
        - Statistical
      - Measures to Reduce Erosion and Turbidity in Construction Site Runoff
        - Polyacrylamide

Environment: Water Quality

- Research Centers
  - Texas DOT – Center for Transportation Research
    - University of Texas at Austin
    - Research:
      - Effectiveness of Permanent Highway Runoff Controls: Grass Swales and Sedimentation/ Filtration Systems
        - Grass Swales
          - Length, Depth, Season Determine Efficiency
        - Buffer Strips
          - Consistent all the time
        - Filtration Systems
          - Detention Time and Maintenance Critical

Environment: Water Quality

- Research Centers
  - Texas DOT – Texas Transportation Institute
    - Texas A&M University
    - Research:
      - Performance of Low-End Stormwater Quality Structures
        - Consider Water Quality Structures Early On
        - Use 90 Percent Rule to Size
        - Use Vegetated Roadside and Medians
        - Use Detention instead of Infiltration

Environment: Water Quality

- Texas DOT – Proposed Research
  - Non-Proprietary, Small Footprint Stormwater Quality Structures for Use in Urban Areas
    - Limited Space and Head
    - Detention Strategies
    - Off-the-shelf RCP and Boxes

Environment: Water Quality

- PROJECT: I-65 Widening
  - KYTC
  - Mammoth Cave
  - Green River plus Underground Streams
  - Karst Topography
  - BMP's
    - Cap Sinkholes in Right-of-Way
    - Trap and Filter All Flow to Sinkholes within 150 ft
      - Filter traps and swales

Environment: Water Quality

- PROJECT: Multi-Compartmental Filtration Basin
  - NMSHTD
  - First Compartment –
    - First Flush (2 yr)
    - Trap Debris, Oil, Sediments
    - Concrete Lined
  - Second Compartment –
    - Separated by Metal Weir
    - 100 yr Flood Capacity
    - Unlined

Environment: Water Quality

- Filtration Basin

Environment: Fish Passage

- Georgia DOT
  - Bottomless culverts
  - Modified Culvert
- North Carolina DOT
  - Baffles

Environment: Fish Passage

- Bottomless Culvert

Environment: Fish Passage

- Modified Culvert – Upstream View

Environment: Fish Passage

- Modified Culvert – Downstream View

Environment: Fish Passage

- Culvert with Baffles

Environment: Stream Restoration

- North Carolina DOT
  - Stream Banking
    - 1 to 1 onsite
    - 2 to 1 offsite
  - Rosgen Techniques
    - J – Hooks
    - Rock Vanes
    - Coir Bundles
    - Root Wads

Environment: Stream Restoration

- J – Hook

Environment: Stream Restoration

- Rock Vane with Log

Environment: Stream Restoration

- Coir Bundle and Root Wad

Southern States: Issues

- Hydrology
- Scour
- Stream Stability
- Drainage
- Environment

Further Information:

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