THOUGHTS ON BAY INFLOWS AND ADAPTIVE BAY MANAGEMENT

Presentation to Sabine and Neches Rivers and Sabine Lake Basin and Bay Expert Science Team (BBEST)
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OVERVIEW

- **Sound Ecological Environment**
- **Changes to Texas Bays**
- **Sediment Supply**
- **Nutrients from the Trinity River**
- **Inflow Regime**
- **Adaptive Bay Management**

SOUND ECOLOGICAL ENVIRONMENT

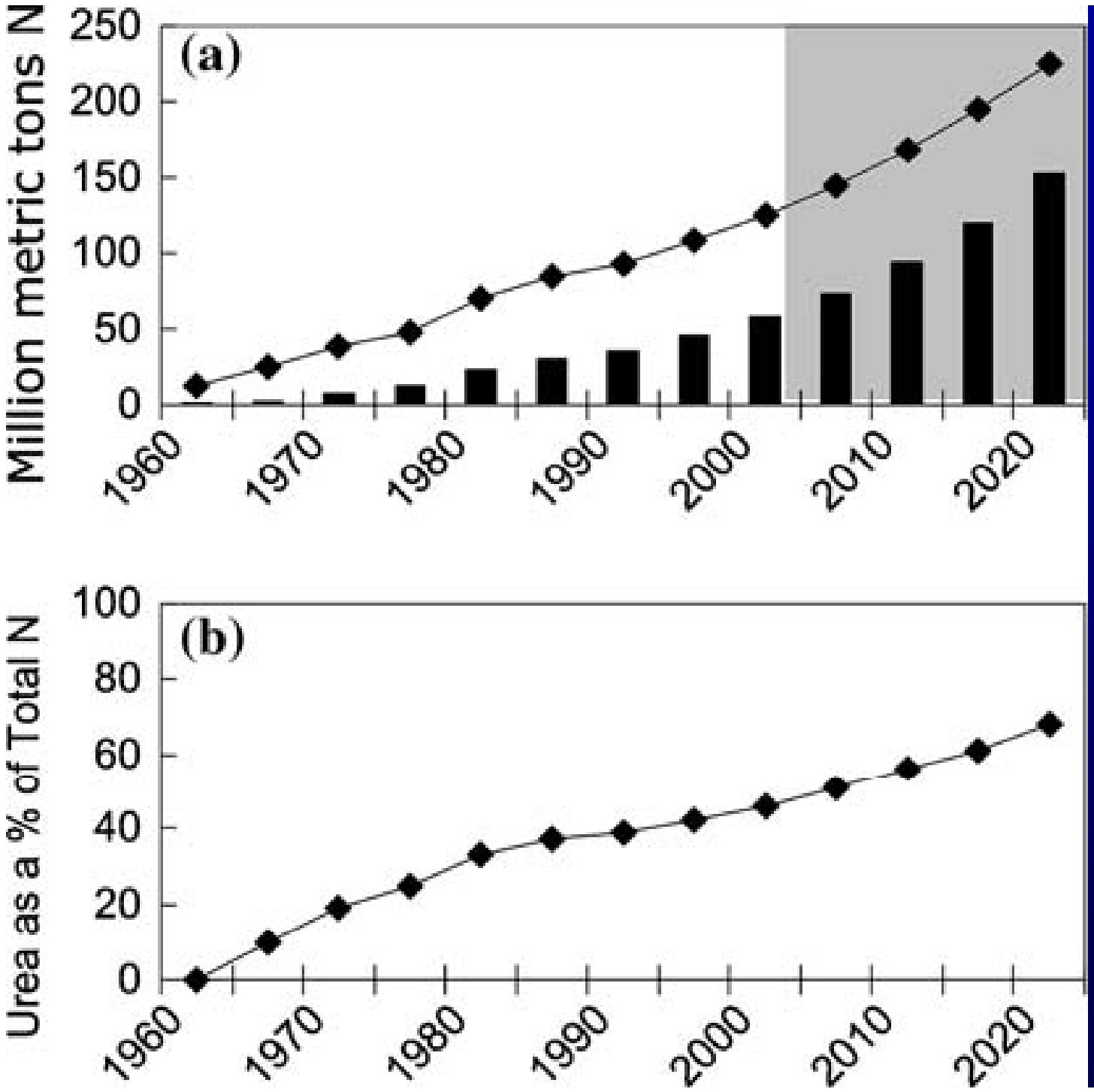
- Widely accepted goal
- Providing conditions to support a sustainable and productive bay ecosystem
- The studies and science that are available to define the widely accepted goal were done after most of the modifications

TEXAS BAYS ARE NOT ENTIRELY NATURAL SYSTEMS

- **Some of the watersheds were heavily modified by agricultural activity**
- **Navigation channels were constructed and inlets stabilized**
- **The bays were physically modified by shell dredging and subsidence**
- **Commercial fisheries began to make a significant impact on the systems**
- **Inflows were regulated**
- **Waste discharges became large enough to have an impact**

WATERSHED CHANGES

- Changes from natural to agricultural or pasture land use began before Civil War
- Increase in urban land use is more recent
- Major changes in runoff characteristics are produced by land use changes
- More recently changes in agricultural practices is changing nature of nutrients



Total N Use as fertilizer

Urea Use as fertilizer

Urea % of Total

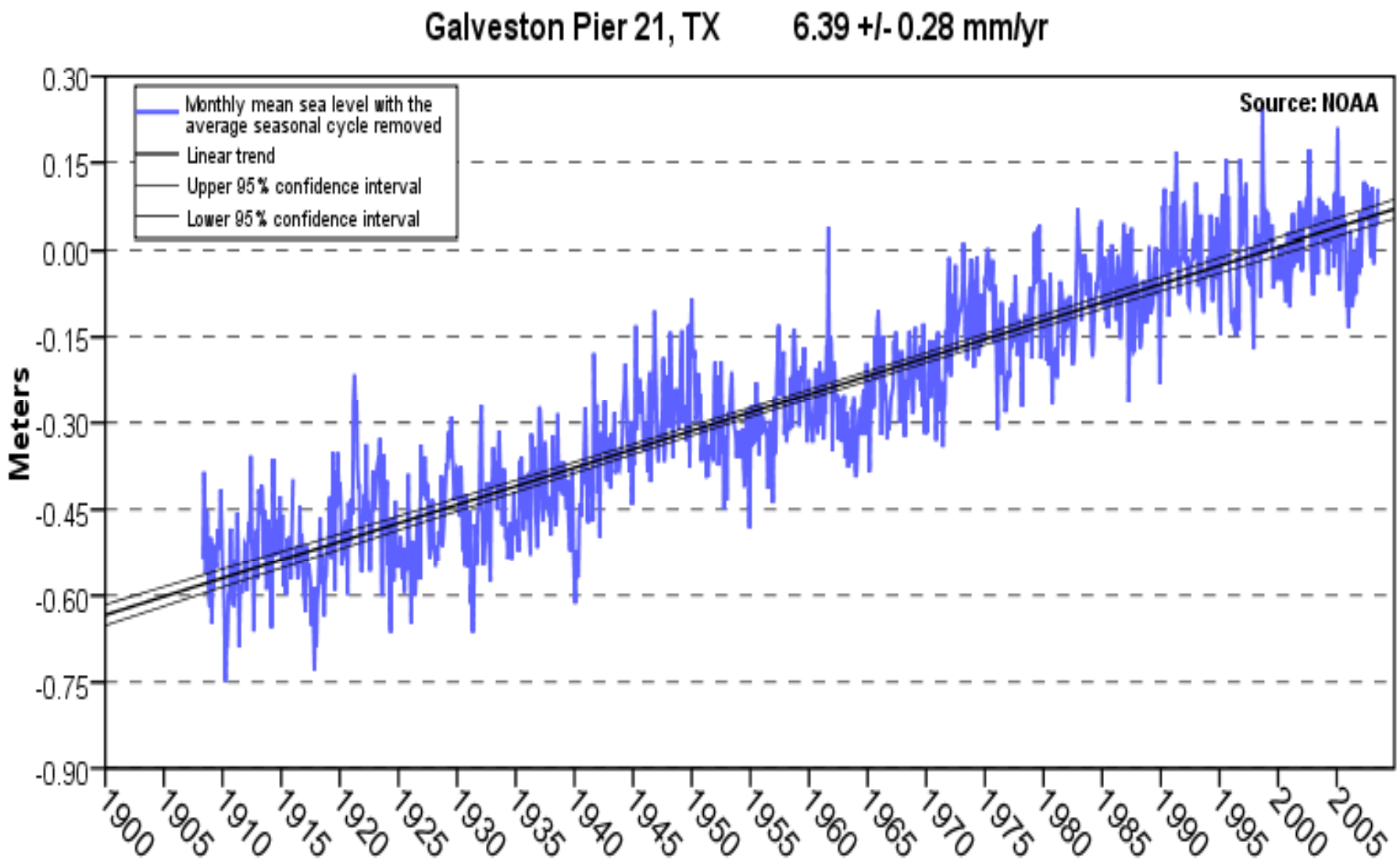
Source: Glibert et al. 2006

NAVIGATION CHANNELS

- Starting well over a century ago, inlets stabilized and deep draft channels dredged
- Stable inlets allow greater tidal exchange, particularly in dry periods
- Dredged channels allow greater exchange with Gulf and higher salinity transport up the bays
- Overall effect is more salt added and nutrient concentrations reduced

PHYSICAL CHANGES

- Starting over a century ago, we have modified the bays by dredging channels and oyster reefs
- We've also been inducing some subsidence
- Relative sea level has been increasing, possibly with a little help from Texans
- Changes have been large and will possibly be getting larger


Galveston Pier 21, TX
6.39 +/- 0.28 mm/yr
Monthly mean sea level with the average seasonal cycle removed
Linear trend
Upper 95% confidence interval
Lower 95% confidence interval
Source: NOAA
Meters
0.30
0.15
0.00
-0.15
-0.30
-0.45
-0.60
-0.75
-0.90
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

FISHING PRESSURE

- The rise in commercial fishing in the early 20th century put major pressure on the estuarine community
- Keeping this fishing pressure from having overfishing effects is critical
- Major ongoing role of TPWD

RESERVOIR DEVELOPMENT

- Provides essential services for growing population
  - Water supply
  - Flood control
- Controls extremes of high and low flows to bays-may benefit biology
- Every bay basin has seen extensive reservoir development
- In addition to changes in flow patterns, there are at least two quality changes—sediment and nutrients

SEDIMENT SUPPLY

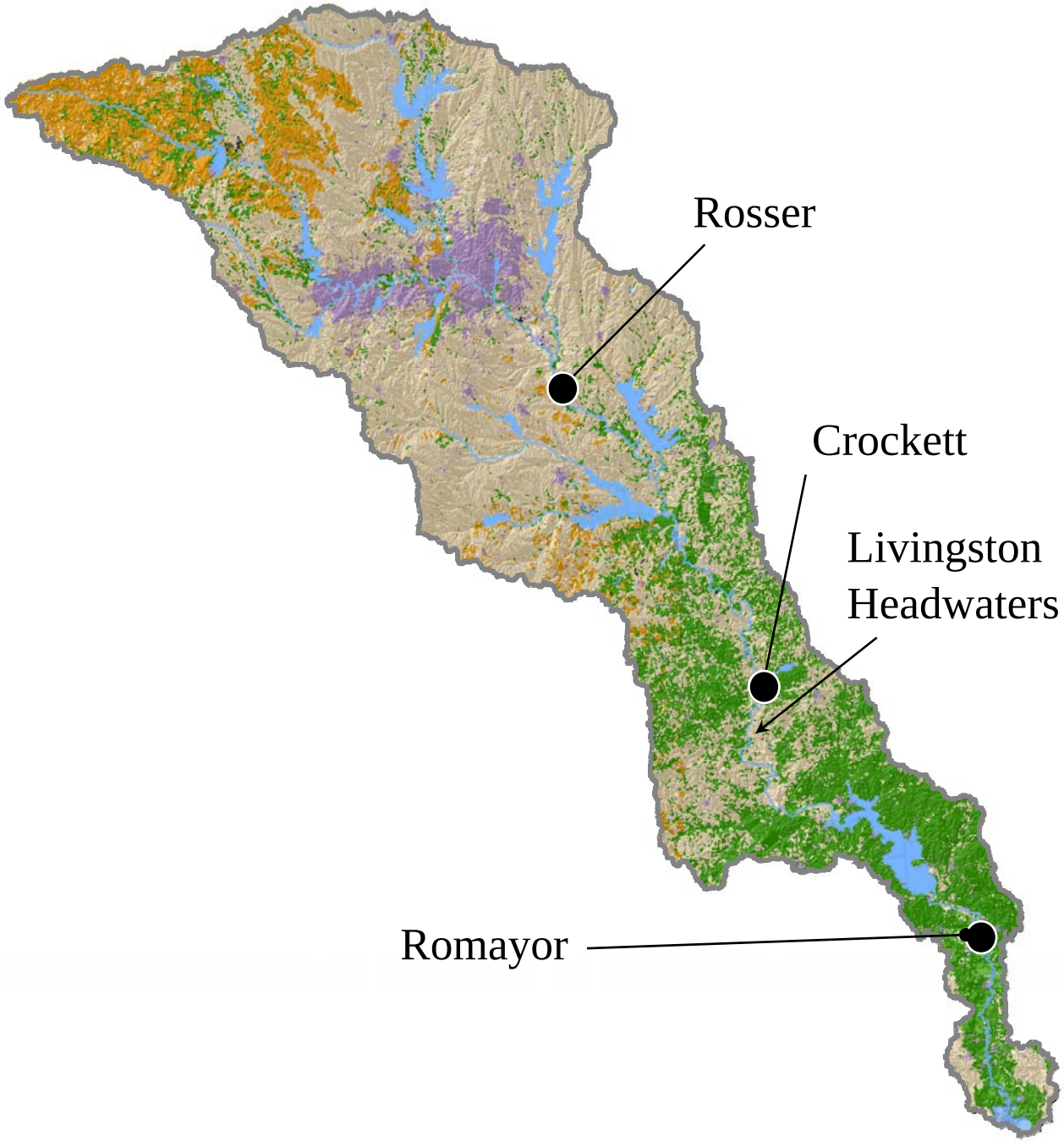
- Reservoirs are very effective at removing sediment
- Downstream of reservoirs, the reduced magnitude and frequency of flood flows reduces the supply of sediment carried to the bays and coast
- In Brazos River, the reduction from major reservoirs has been calculated to be about 76%
- There are many SCS and smaller reservoirs in most basins

NUTRIENT SUPPLY

- A substantial part of the nutrient supply is in particulate form and like sediment, removed by reservoirs
- Reservoirs also allow removal of dissolved nutrients by providing time for plant uptake and settling
- The amount of removal can be determined from upstream and downstream data
- An example for nitrogen on the Trinity-San Jacinto is presented

PROCESSES AFFECTING NITROGEN LOADS TO GALVESTON BAY

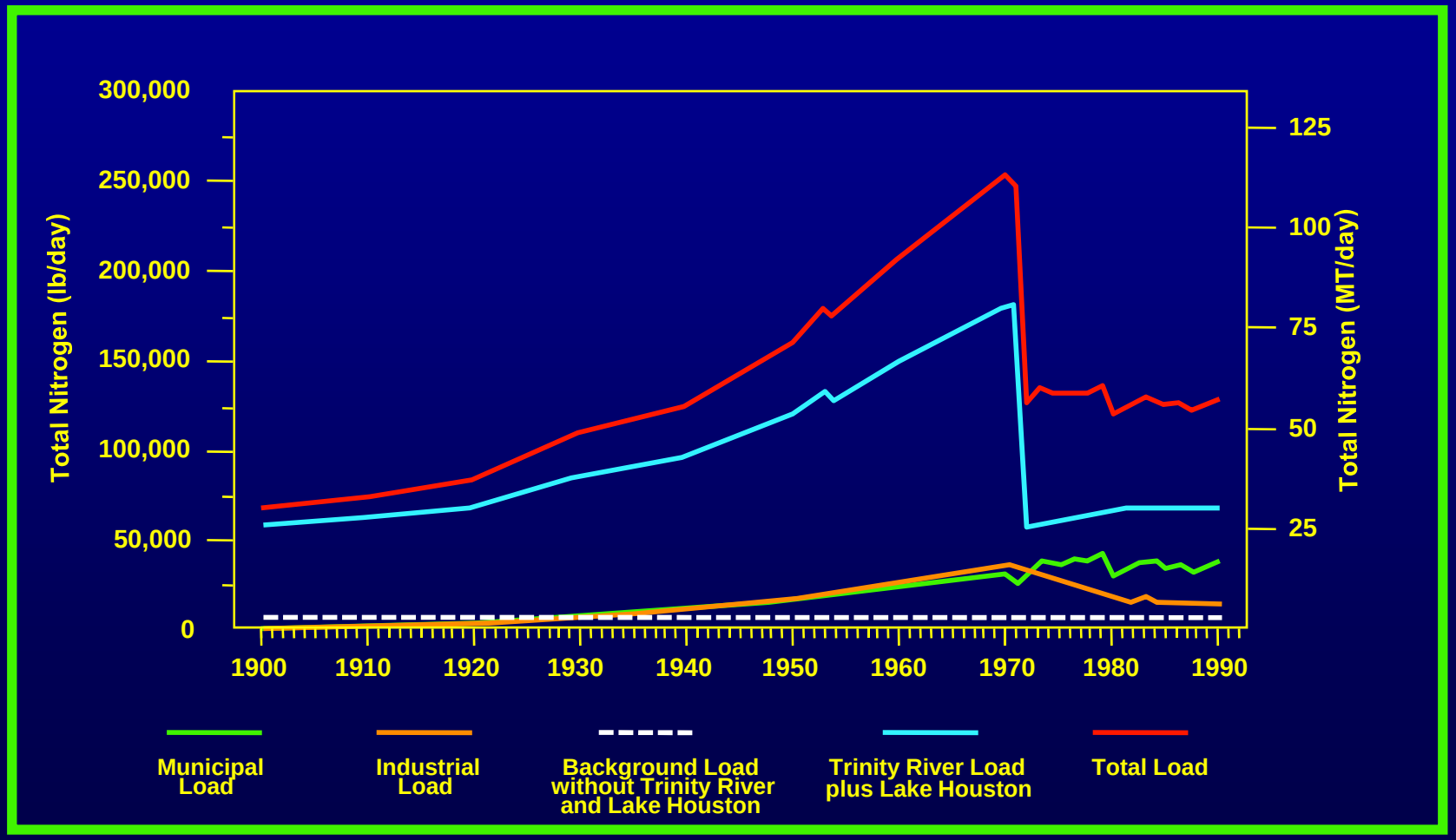
- WATERSHED LAND USE
- RAIN CONCENTRATIONS
- GULF EXCHANGES
- RESERVOIR DEVELOPMENT
- URBAN RUNOFF
- WASTEWATER VOLUME
- WASTEWATER QUALITY


Rosser
Crockett
Livingston
Headwaters
Romayor

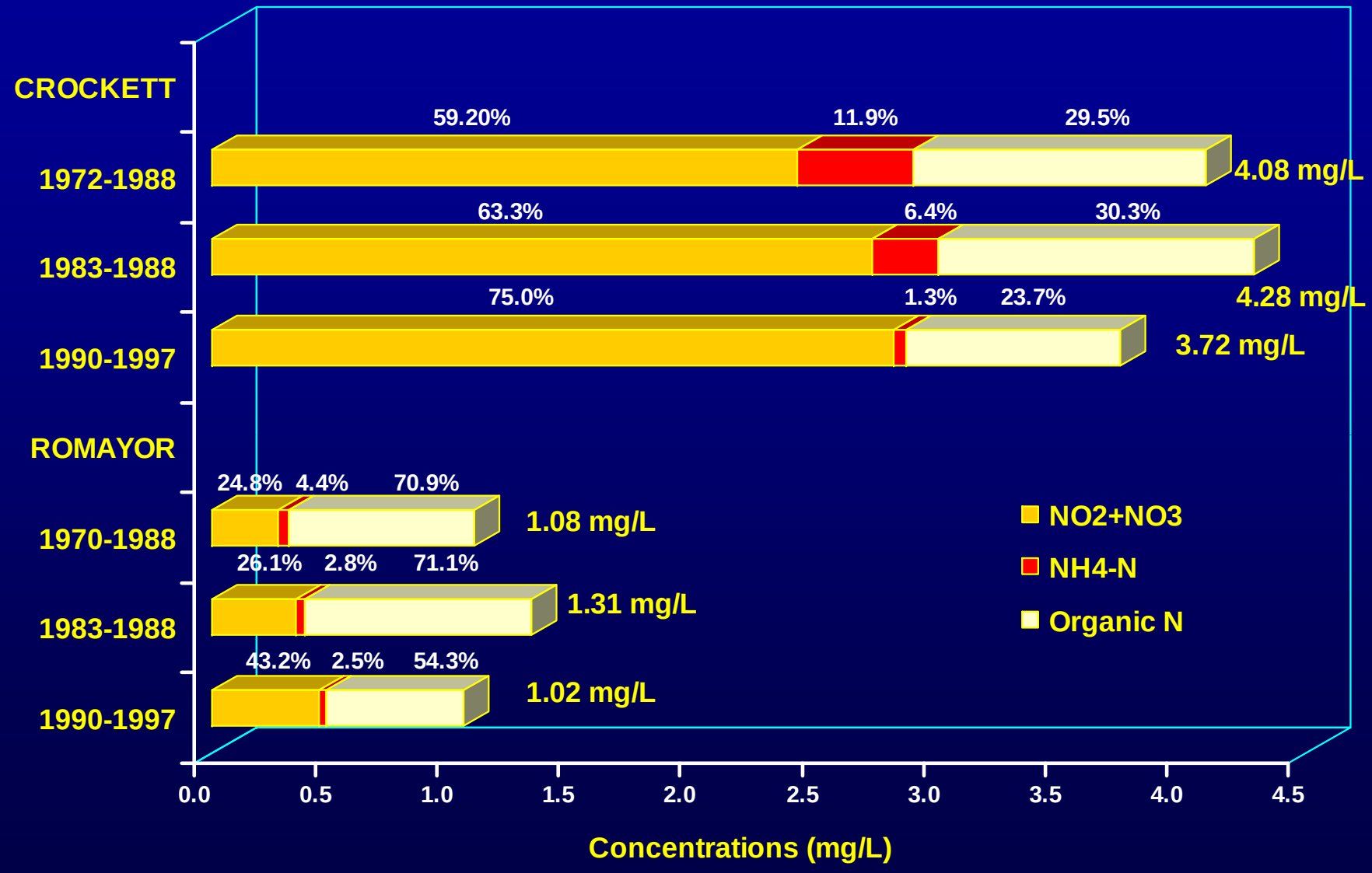
1991 ESTIMATE OF NITROGEN TRENDS

- Increases in runoff and WW loads with population
- Reductions in tributary loads with reservoirs
- Reductions with higher level of WW treatment
- Estimated 1990 loads = 1940 loads

GALVESTON BAY NITROGEN LOADS FROM 1991 PAPER



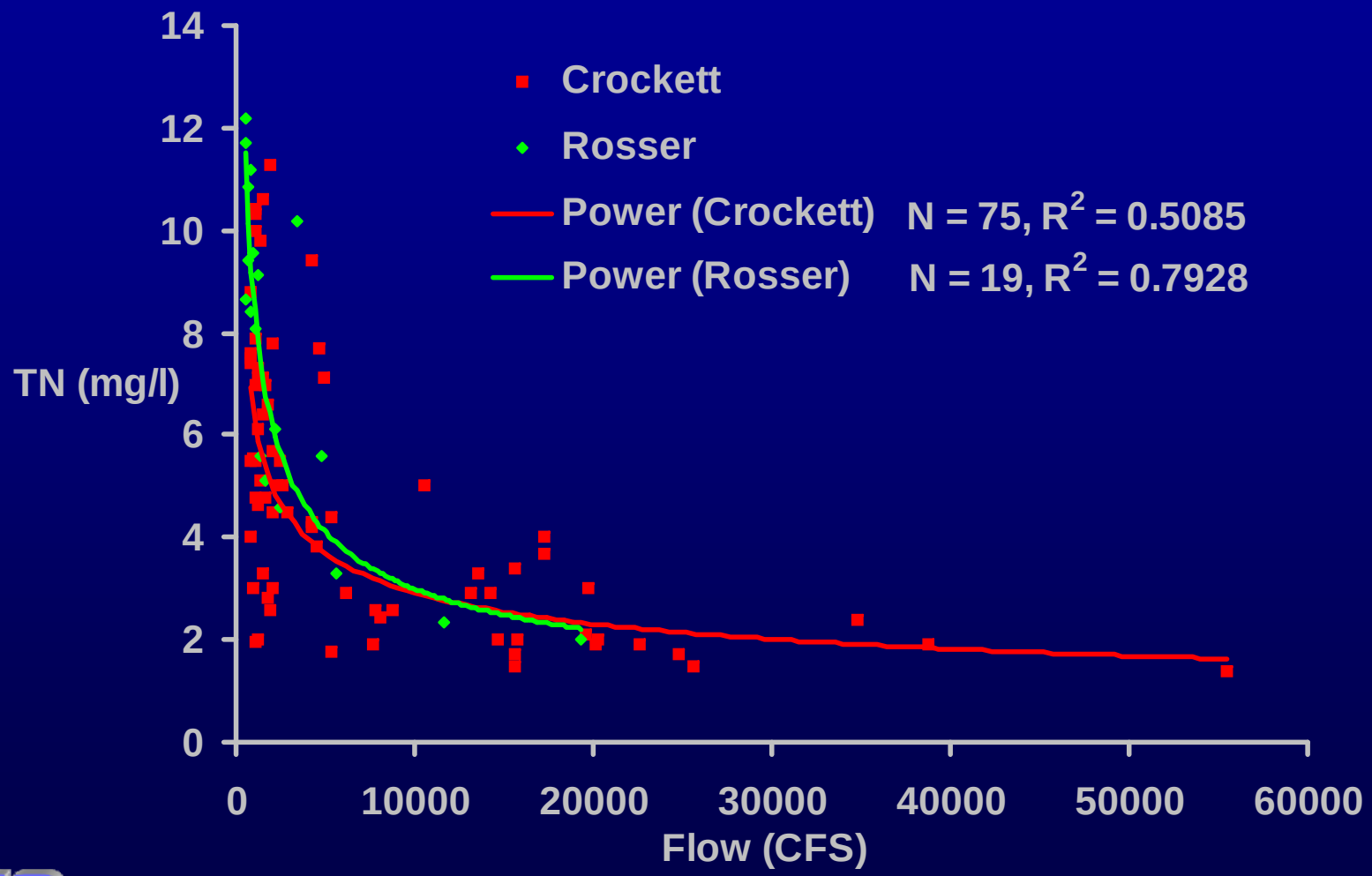
TRINITY RIVER NITROGEN LEVELS



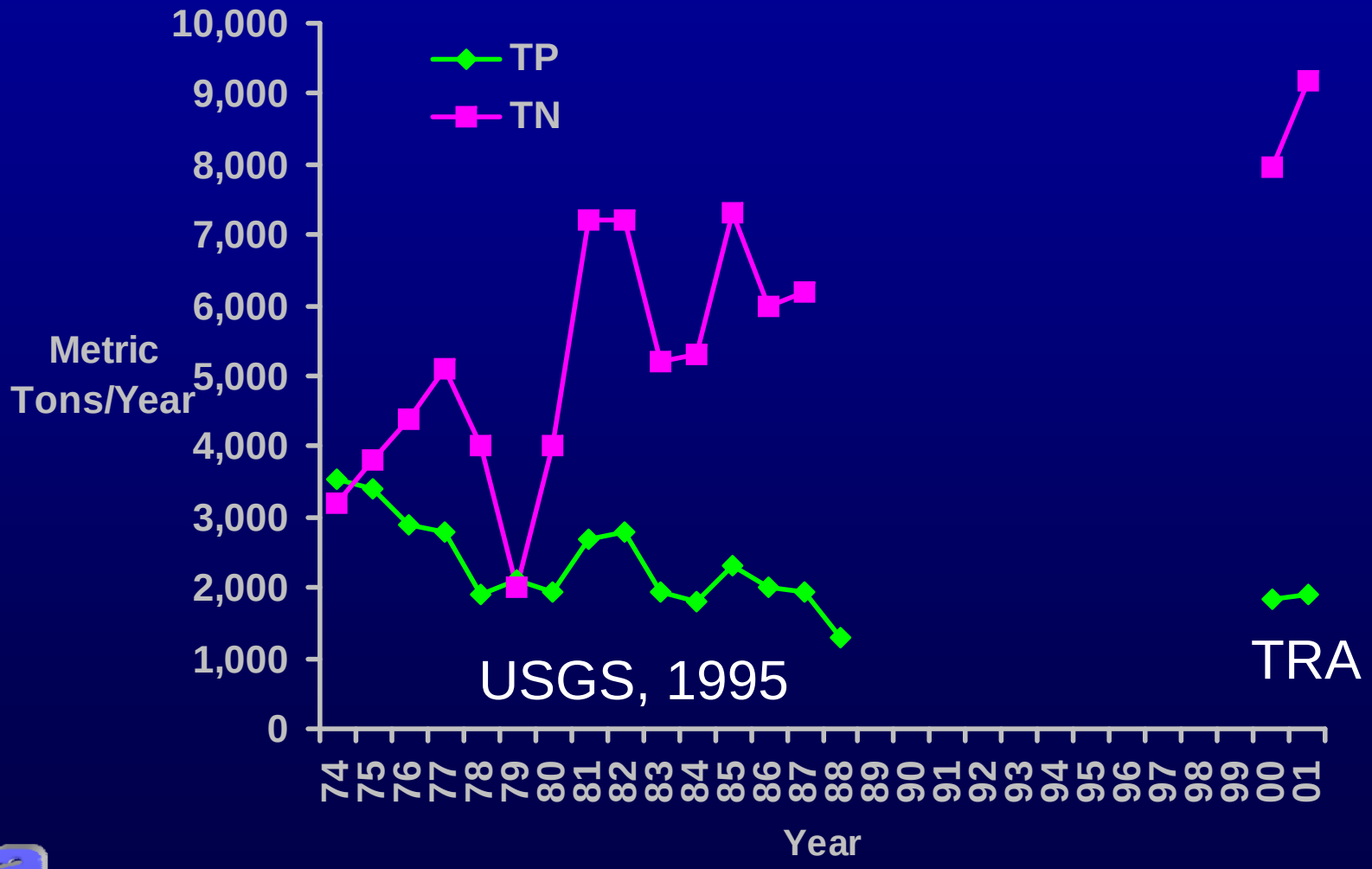
MORE DETAILED ANALYSIS OF TRINITY BASIN LOADS

- **Point sources**
- **Immediate watershed to Lake Livingston**
- **Performed by TRA personnel**

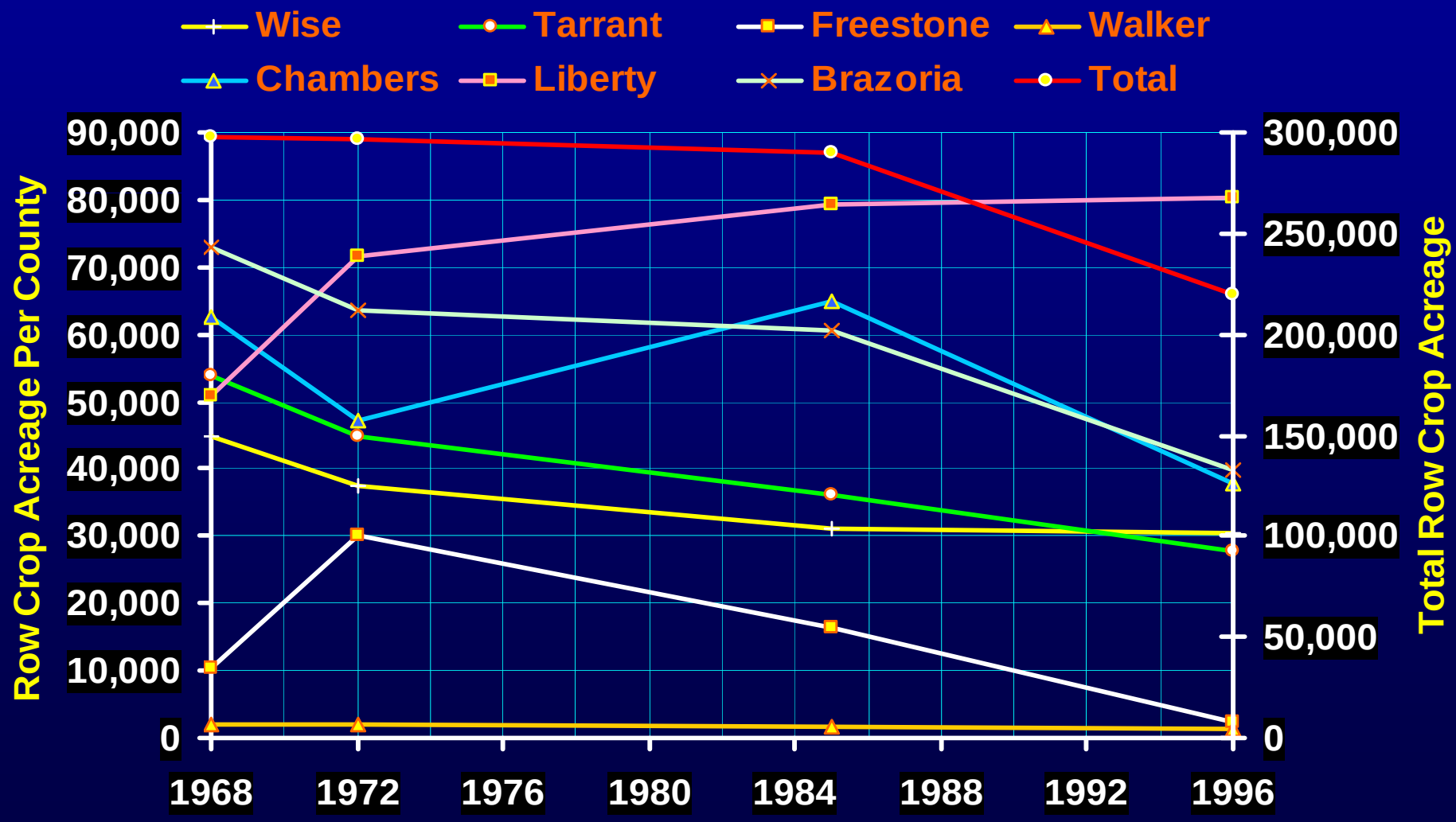
TN Concentration vs Flow in Trinity River



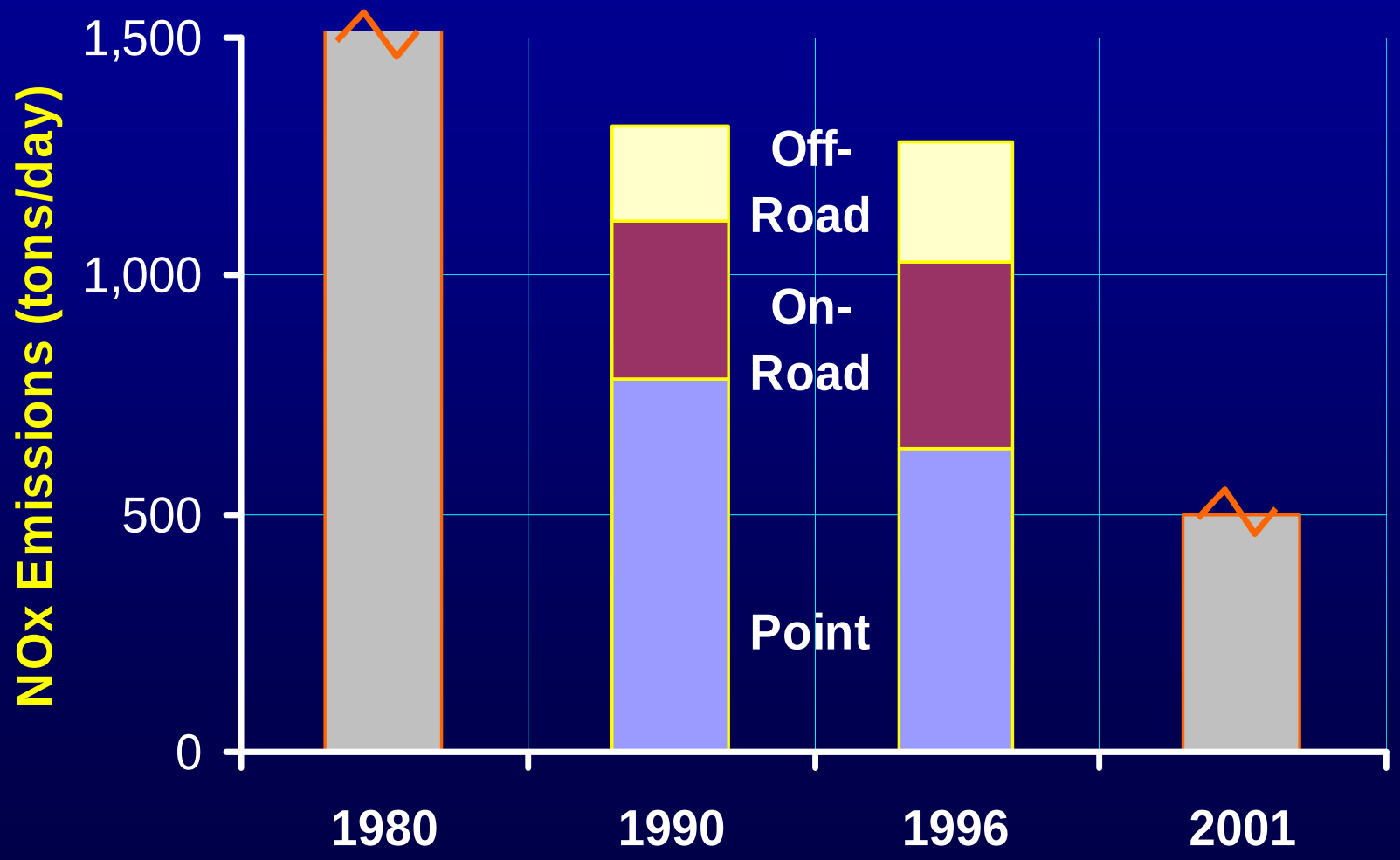
TN and TP Removal through Lake Livingston



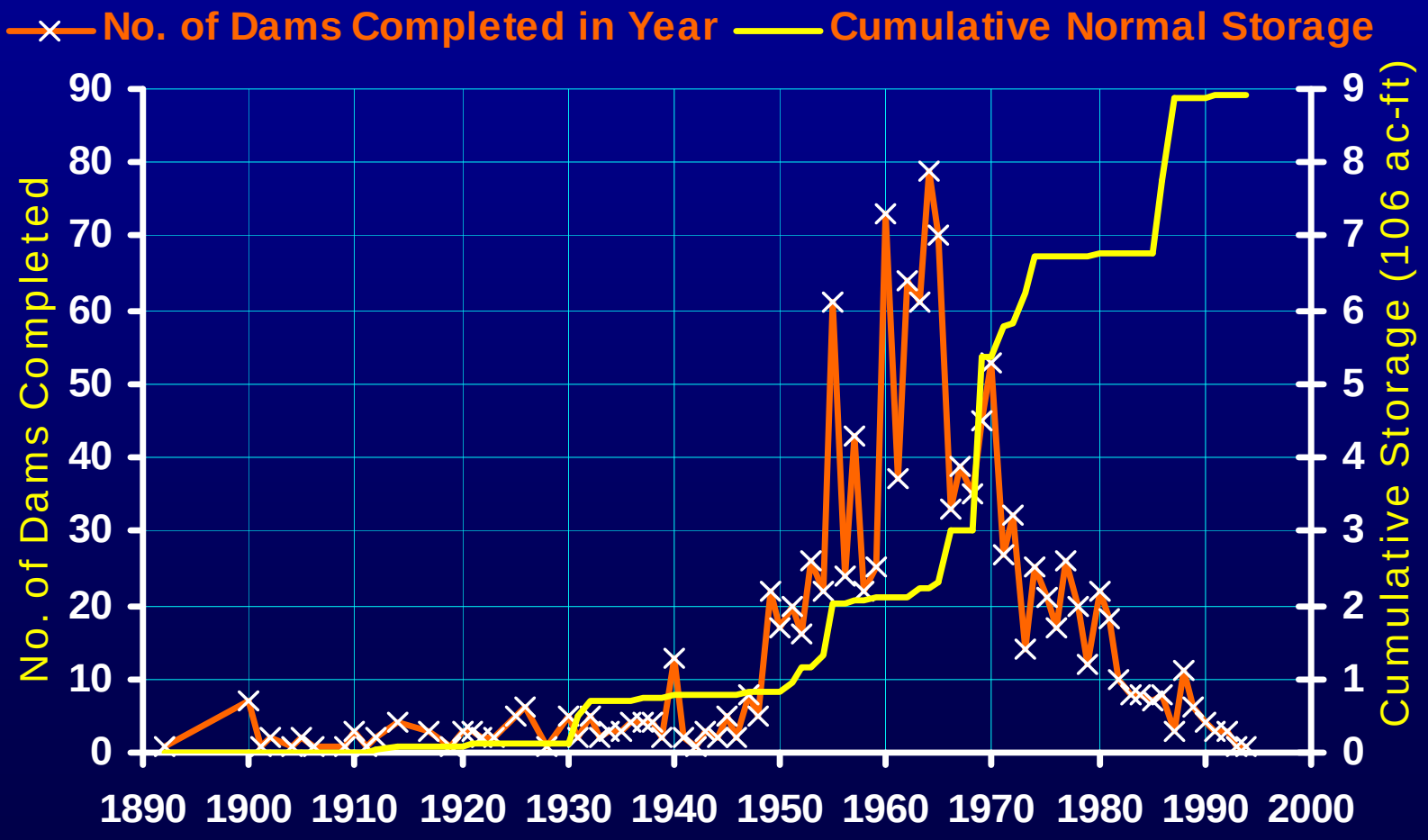
ROW CROP ACREAGE IN BASIN COUNTIES



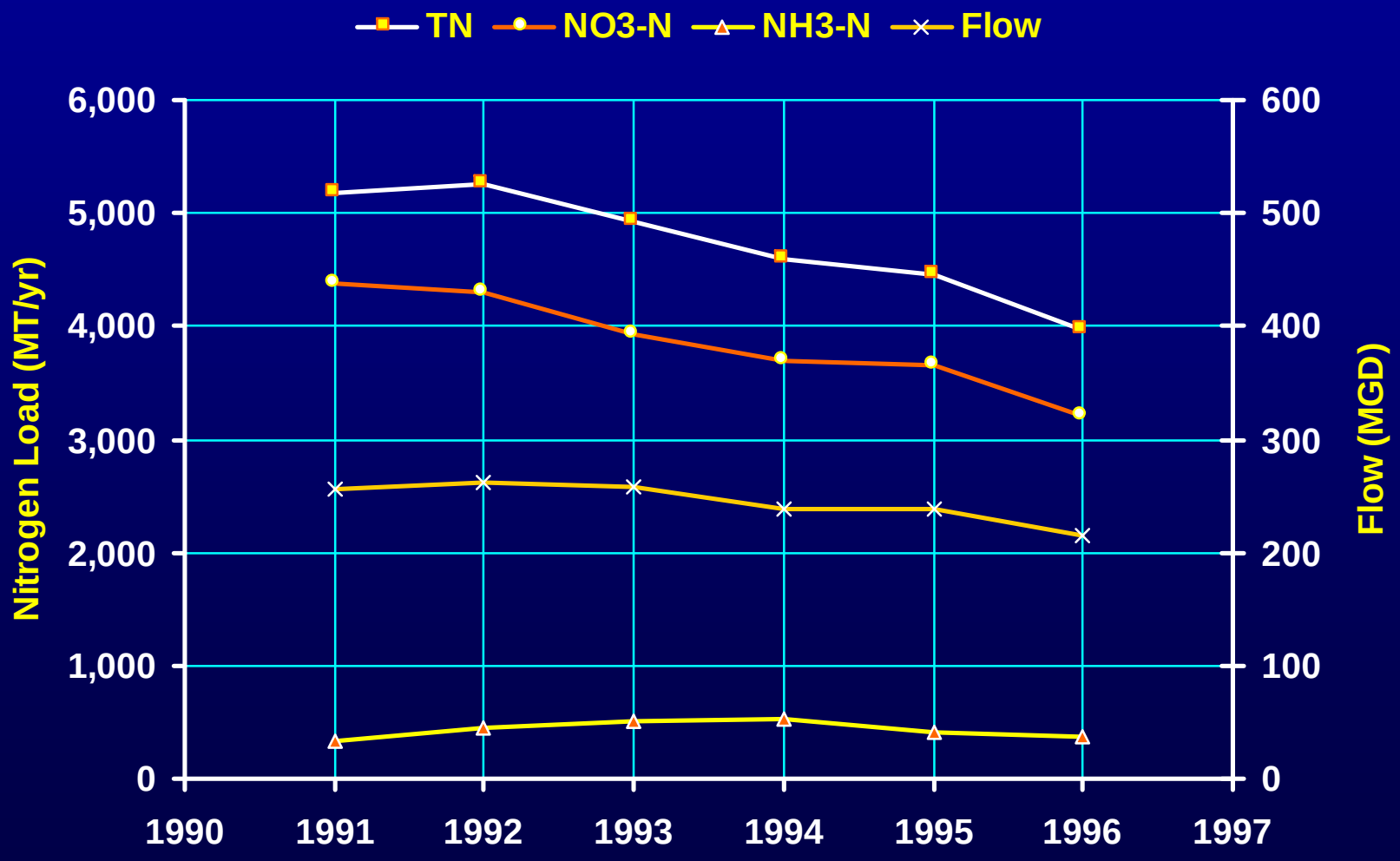
HOUSTON-GALVESTON NOx EMISSIONS



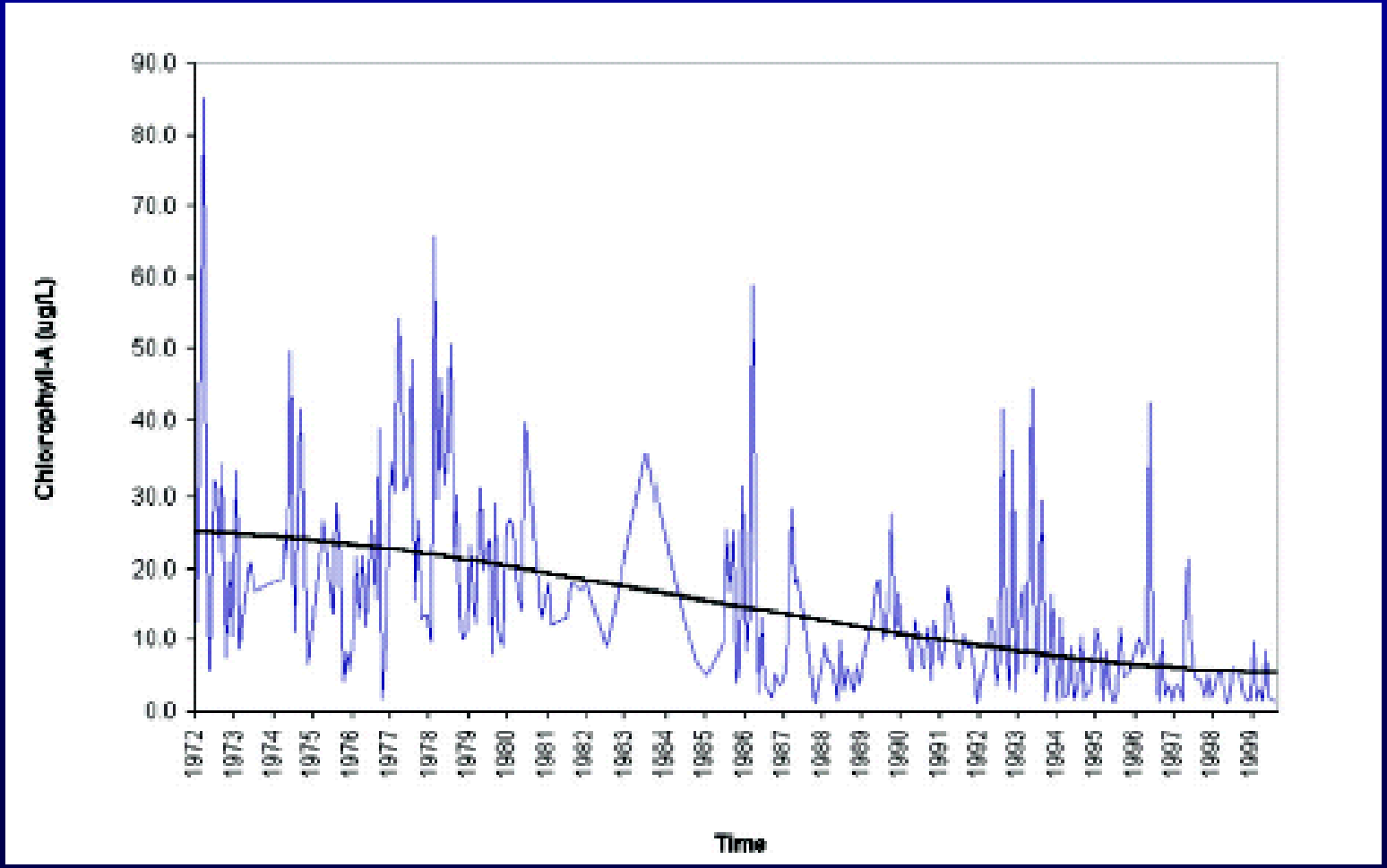
DAM COMPLETIONS IN SAN JACINTO AND TRINITY RIVER BASINS



FLOW AND NITROGEN LOADS FROM HOUSTON WWTPs



Monthly Average Chlorophyll *a* Concentration in Galveston Bay



Source: Lester and Gonzales (2002), citing from Criner and Johnican (2001)

TRENDS IN FISHERIES

Species	Method	Trend
Southern flounder	Bag Seine	Stable
Brown shrimp	Bag Seine	Stable
Brown shrimp	Trawl	Stable
White shrimp	Bag Seine	Decline
White shrimp	Trawl	Decline
Blue crab	Trawl	Decline
Gulf menhaden	Bag Seine	Decline in last 10 years
Atlantic croaker	Trawl	Increase
Spotted seatrout	Gill net	Increase
Oysters	Reef area	Uncertain

Source: Lester & Gonzales, 2002

NUTRIENT SUMMARY

- In 1970, original Galveston Bay project found the Bay to be healthy and productive
- Nitrogen is the nutrient most likely to be limiting in bay
- Major reductions in nitrogen inputs have been made in last 30+ years for reasons unrelated to bay health or productivity
- Significant additional reductions continue, again without consideration of the bay

NUTRIENT SUMMARY CONTINUED

- **Major and significant reduction in chlorophyll *a,* a measure of water column primary production, has been documented**
- **Declines in a number of important fisheries are indicated**
- **Is fishery use degraded? Maybe, but estuaries can tolerate wide variations in many parameters**

SUMMARY OF CHANGES TO BAYS

- **We've made many changes to bays that have affected habitat, quality, and productivity**
- **The changes can be considered as movement of management levers done independently with little attempt at coordination**
- **In streams and rivers, flow is the key term but in bays, flow is only one of many levers**
- **The levers can be expected to be moved more in the future**

INFLOW REGIME

- **The SAC responsibility is to advise on the science of inflow needs**
- **There appears to be a consensus that an inflow regime is needed rather than a single flow target**
- **One question is how to pick the inflow regime?**
- **Another is what historical inflow condition should be the goal?**

INFLOW REGIME ALTERNATIVES

- **State Methodology**
- **IHA**
- **Detailed Studies**
- **Representative period for historical flows**
- **A key point is that for most bays, the inflows we experienced in recent years are the basis for what we now think is a sound ecological environment**

ADAPTIVE BAY MANAGEMENT

- **Adaptive Management is an important term that does not have an operational definition**
- **Our responsibility in the SAC under SB3 is to advise on Adaptive Management work plans**
- **Alternatives are discussed**

ALTERNATIVE APPROACHES TO ADAPTIVE MANAGEMENT

- Focus on inflows only or include all management levers
- Define expectation based on historical experience or make decisions for new conditions as new information comes available
- Place contingencies on expectations with “teeth” or focus on building consensus on new conditions and actions

IMPLEMENTATION ALTERNATIVES

- **New state Bay Management Agency?**
- **Assigning adaptive management function to Bay/Basin Stakeholder Committee?**
- **Other?**