# Analysis of current and historical sediment loads in the Mississippi River to support restoration of the delta

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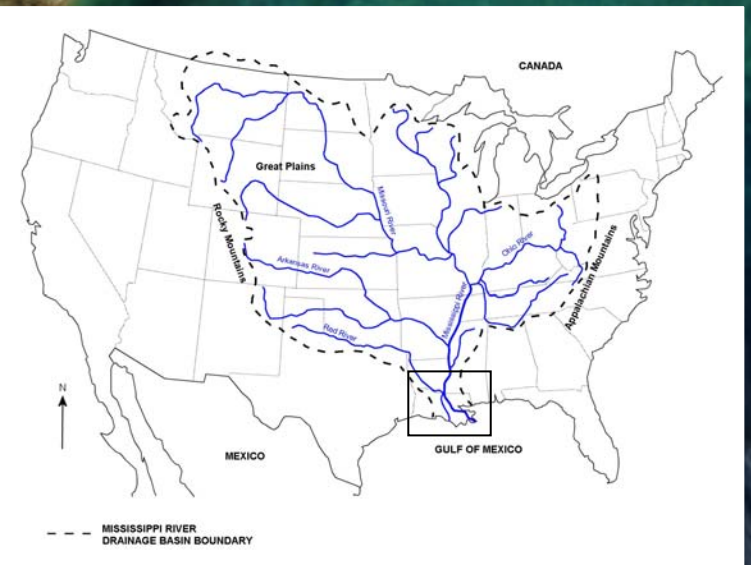
# Introduction

- Coastal erosion and habitat loss in the Delta is of national importance
- Loss in Louisiana represents 80% of US coastal land loss
- Plans for sediment diversion from Mississippi River raise questions regarding temporal trends in sediment load

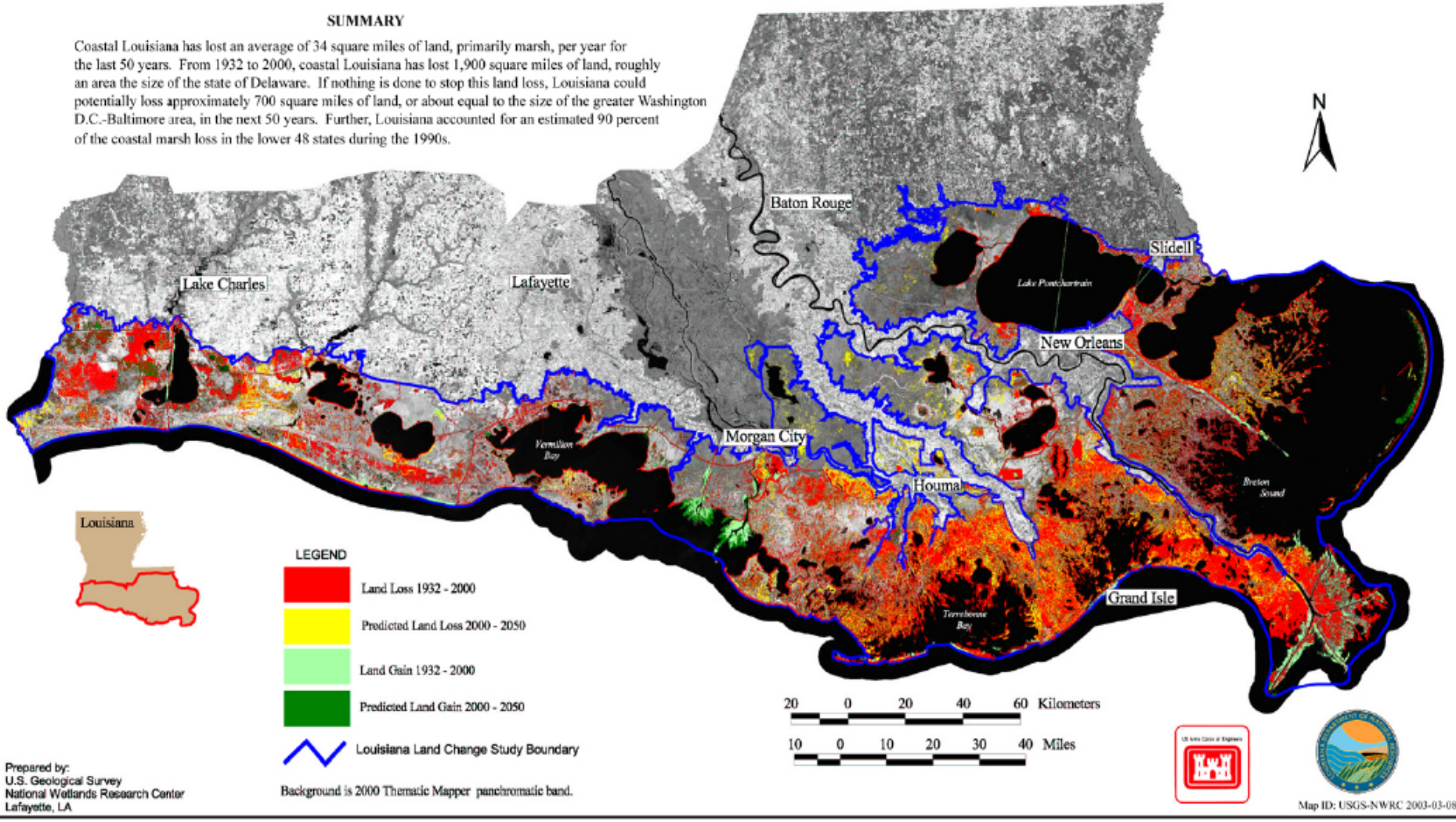
Mississippi River

New Orleans

Mississippi River Delta



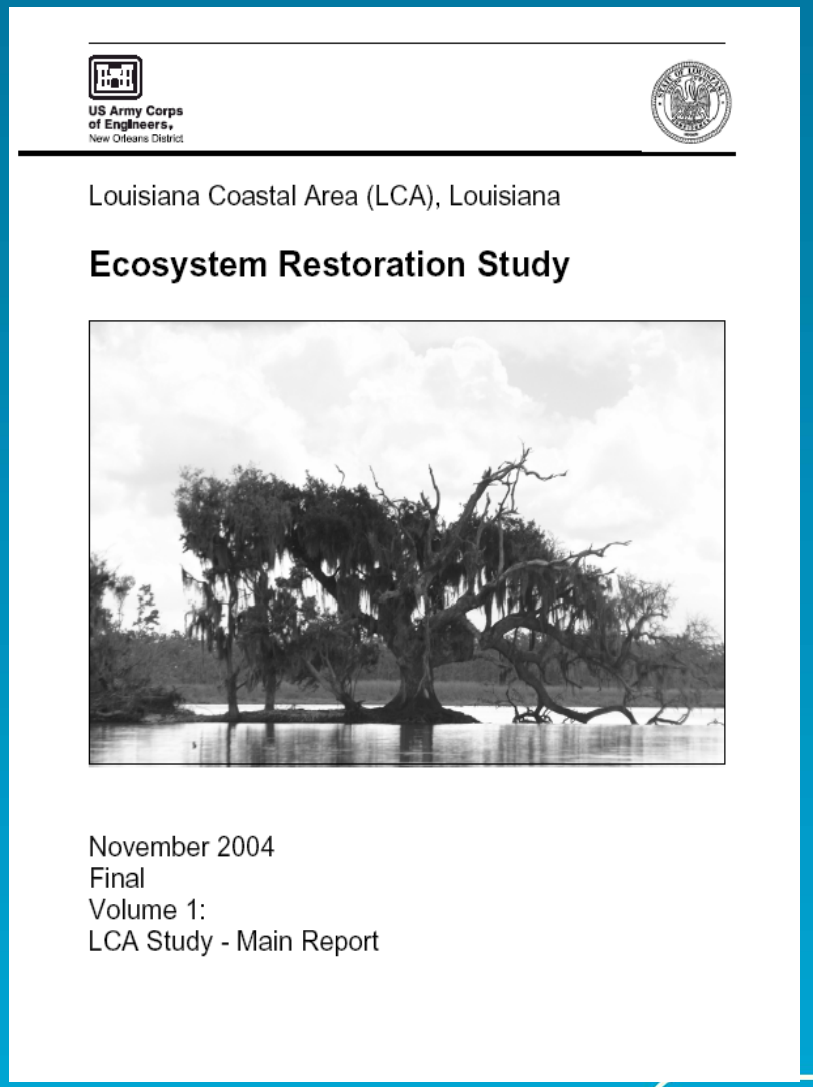
# Introduction



# Outline of the restoration scheme

## Louisiana Coastal Area Plan (2004)

- 23 diversions of water and sediment
- 1 000 – 15 000 cfs each
- Cumulative design capacity 150 000 – 200 000 cfs
- Additional ‘Third Delta’ diversion – capacity 120 000 – 240 000
- LCA diversions potentially greater than that to Atchafalaya at the Old River

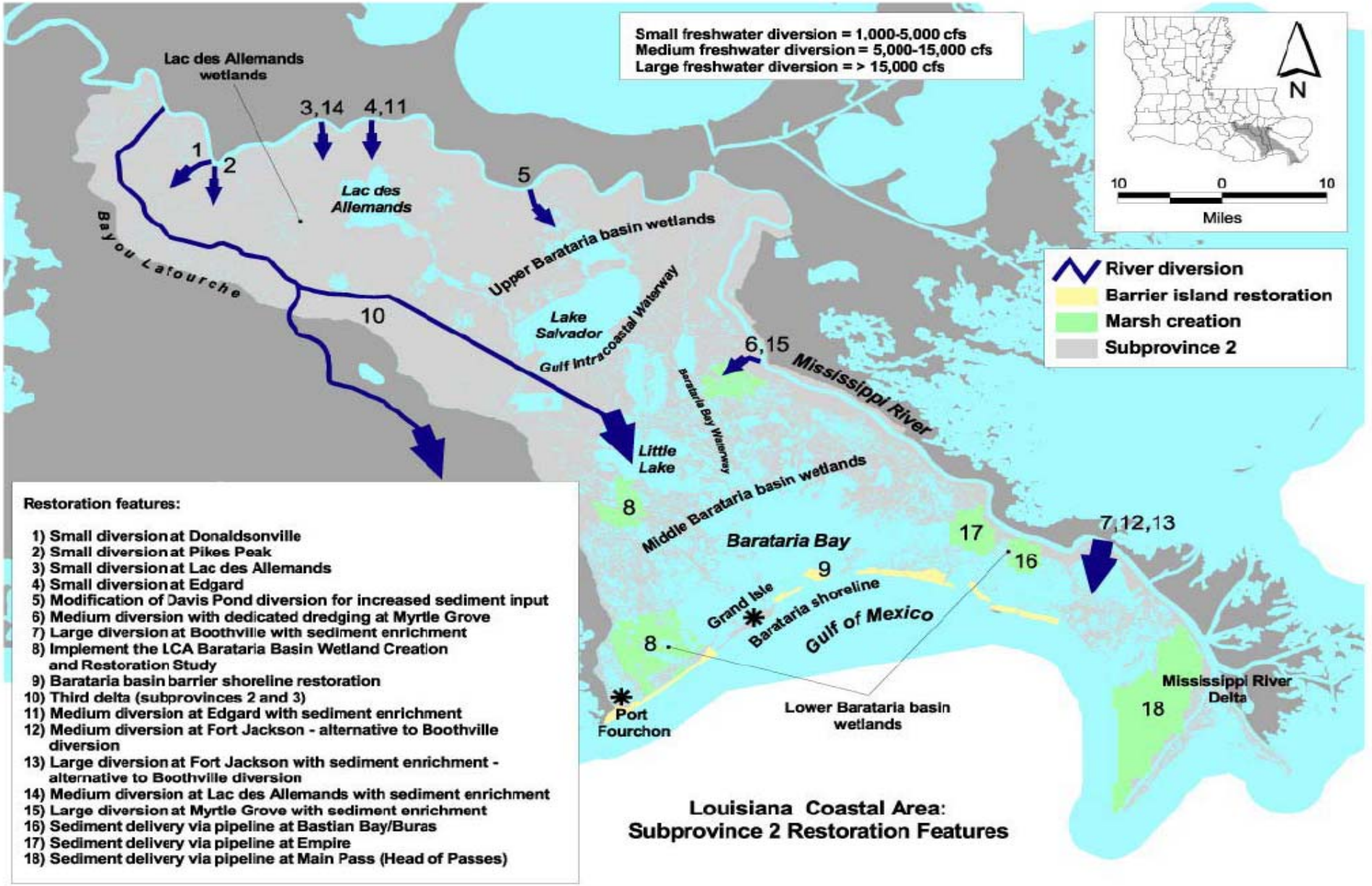

US Army Corps of Engineers, New Orleans District

Louisiana Coastal Area (LCA), Louisiana

**Ecosystem Restoration Study**

November 2004
Final
Volume 1:
LCA Study - Main Report

# Outline of restoration scheme




**Restoration features:**

1) Small diversion at Donaldsonville
2) Small diversion at Pikes Peak
3) Small diversion at Lac des Allemands
4) Small diversion at Edgard
5) Modification of Davis Pond diversion for increased sediment input
6) Medium diversion with dedicated dredging at Myrtle Grove
7) Large diversion at Boothville with sediment enrichment
8) Implement the LCA Barataria Basin Wetland Creation and Restoration Study
9) Barataria basin barrier shoreline restoration
10) Third delta (subprovinces 2 and 3)
11) Medium diversion at Edgard with sediment enrichment
12) Medium diversion at Fort Jackson - alternative to Boothville diversion
13) Large diversion at Fort Jackson with sediment enrichment - alternative to Boothville diversion
14) Medium diversion at Lac des Allemands with sediment enrichment
15) Large diversion at Myrtle Grove with sediment enrichment
16) Sediment delivery via pipeline at Bastian Bay/Buras
17) Sediment delivery via pipeline at Empire
18) Sediment delivery via pipeline at Main Pass (Head of Passes)

**Louisiana Coastal Area: Subprovince 2 Restoration Features**

# Research Need – Existing Knowledge

- Past studies report large a decrease in measured loads during last 150 years.
- But no consensus: degree of reduction, current and future trends
- Different methods used to calculate loads and non-standard reporting
- Little attention paid to uncertainty
- Lack of information on seasonal, inter-annual and decadal variability

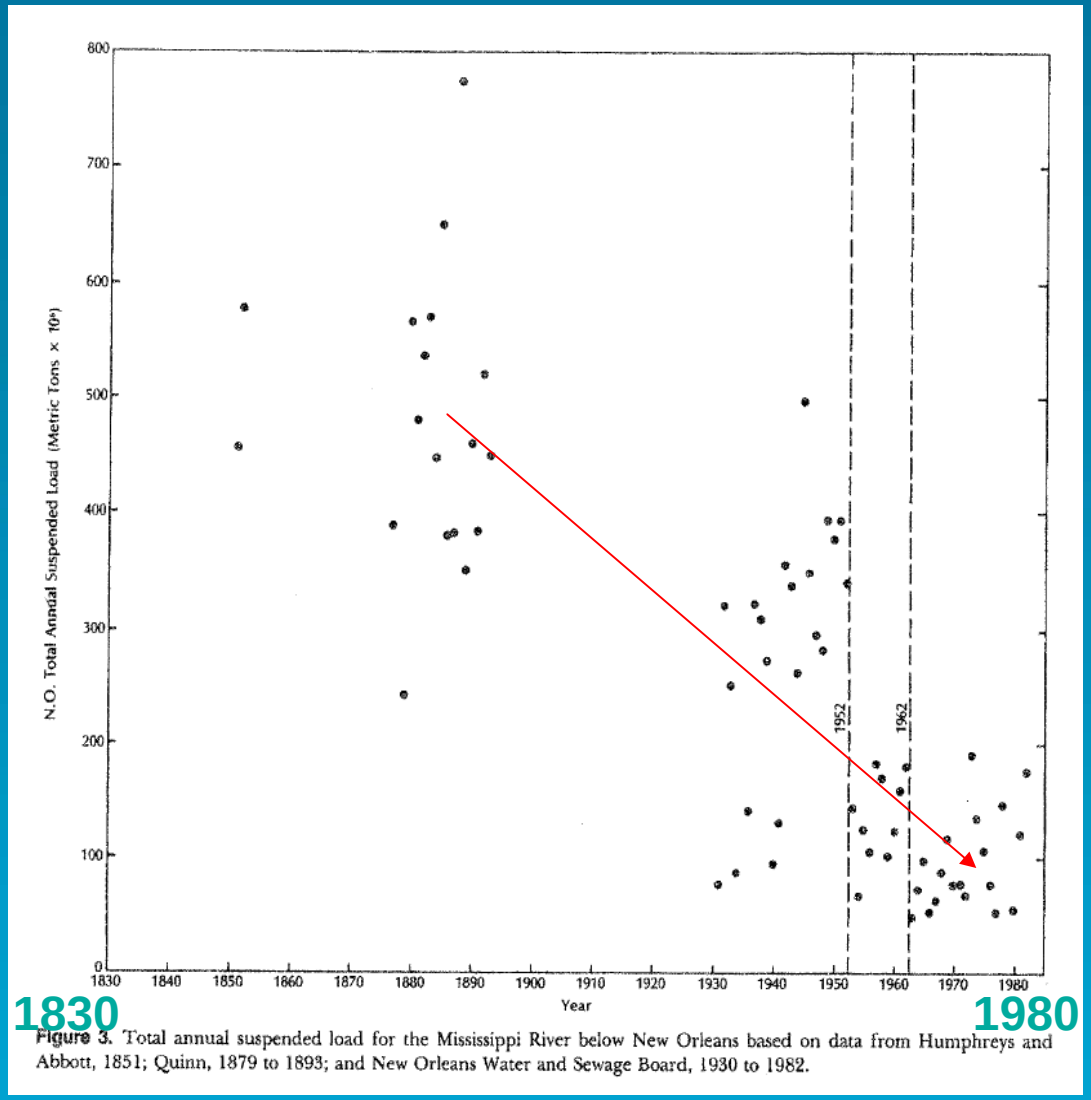


Figure 3. Total annual suspended load for the Mississippi River below New Orleans based on data from Humphreys and Abbott, 1851; Quinn, 1879 to 1893; and New Orleans Water and Sewage Board, 1930 to 1982.

*Kesel, 1989*

# Research Need: River Management

Changes in sediment supply to the delta:

**Neotectonics:**

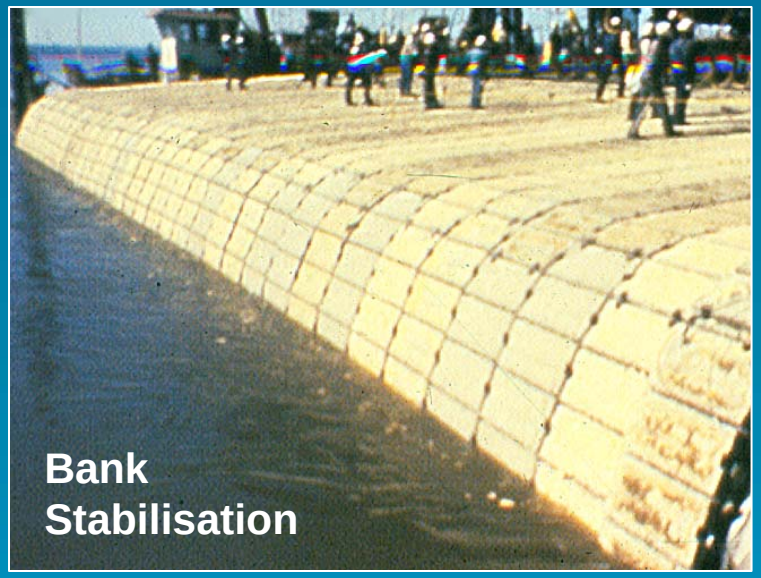
- New Madrid earthquake 1811

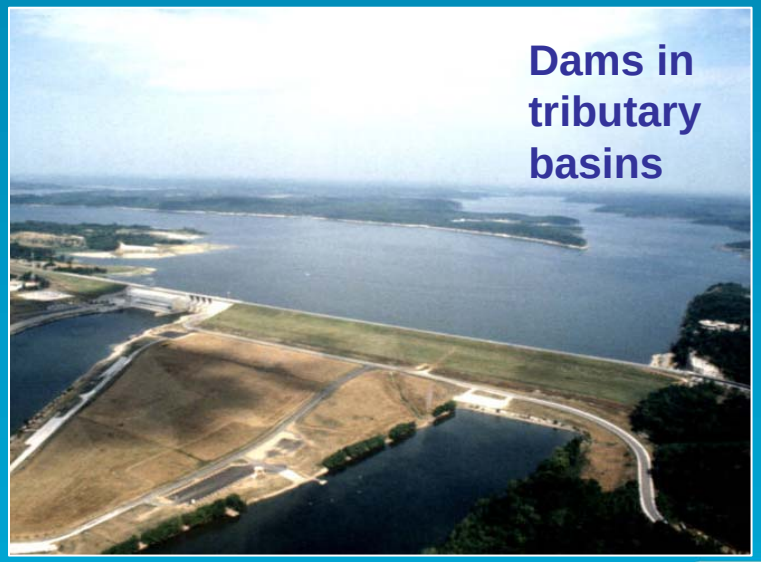
**Land use:**

- Riparian vegetation clearance in 19th centry
- Soil conservation in late twentieth century

**River management:**

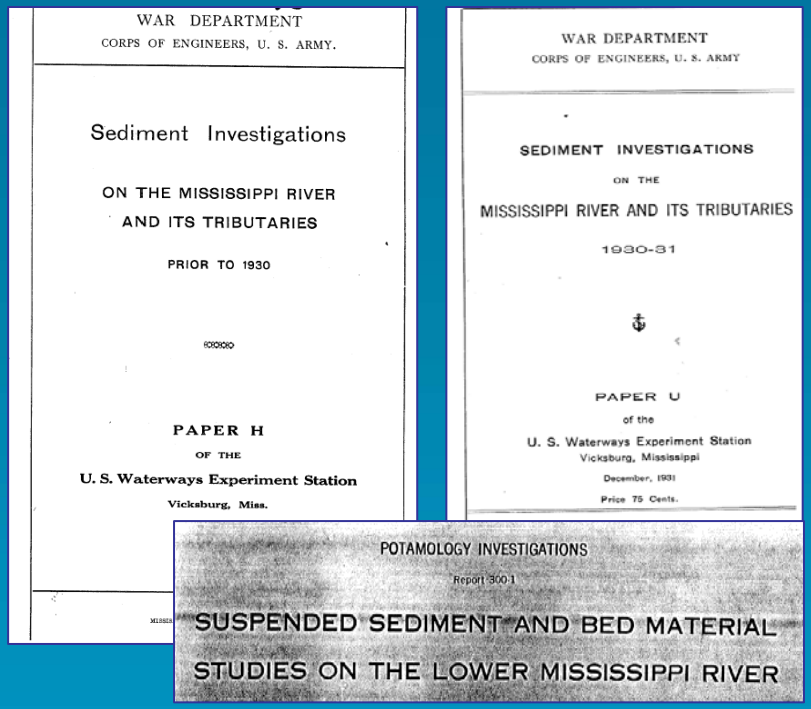
- Dam on tributaries as part of MR&T project
- Bank stabilisation
- Levees ‘disconnect’ river from deltaic plain



# Research need: Data and Analysis

- How have sediment loads changed through time?
- How much sediment is available for redistribution?
- How does sediment availability vary seasonally, annually and over longer periods?
- What is the uncertainties associated with the data?
- Where are the missing data identified by Thorne and Harmar in 2001 but never located?




# Research Approach: Data collation

Data: USACE, USGS, and other available records:

- Suspended sediment concentration and particle size
- Suspended sediment discharge
- flow velocity
- sampler type
- sampling strategy
- sampling date

Digital and paper records

Raw and processed data

Records back to 1850s

***Records fragmentary and incomplete, especially pre-1930s measurements***

| Name of Gauging Station | Organisation | Filename | Dates | Interval |
|---|---|---|---|---|
| Tarbet Landing | USACE New Orleans District | TarDistrict.xls | 1974-1997 | 2 wks |
| | USACE New Orleans District update | | 1998-2005 | 2wks |
| | | | 1963-1967 | 2 wks |
| | USACE New Orleans District paper summaries | | 1963-1973 | 2-4 wks (est) |
| | USACE New Orleans District paper originals | | 1967-1970 and 1974 | 2-4 wks (est) |
| Red River Landing | USACE New Orleans District | RedDistrict.xls | 1973-1997 | 2 wks |
| | USACE New Orleans District paper originals | | 1959-1963 | 2-4 wks (est) |
| | USACE New Orleans District digital data | | 1959-62 | Approx 1 wk |
| St Francisville | USGS | StFranUSGS.xls | 1978-1993 | 2-4wks |
| Baton Rouge | USACE New Orleans District digital data | | 1956-1959 | Daily |
| | USACE New Orleans District digital data | | 1954 | Approx 2 wks |
| Donaldsville | USACE New Orleans District paper originals | | 1949-51 | 2-4 wks (est) |
| Other | Old River Study (USACE New Orleans District records?) | | 1949-69 | Annual load |

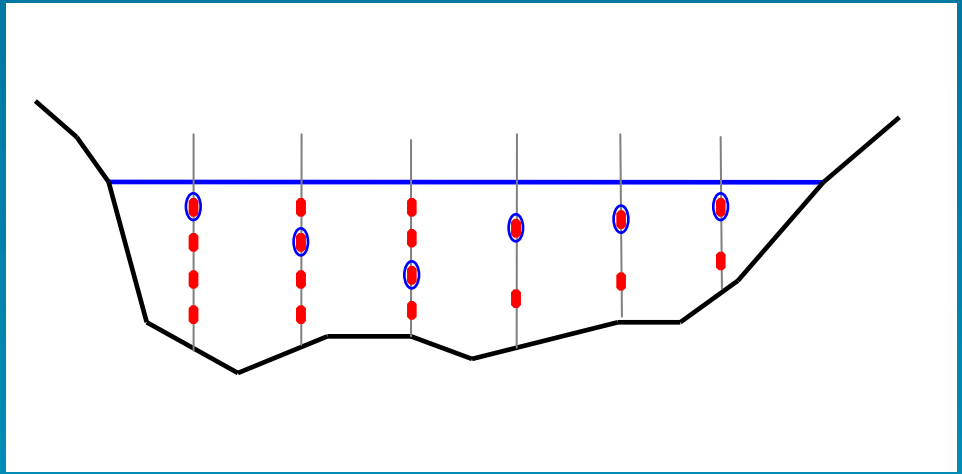
# Research Approach: Quality Checking

## Resolve data quality issues

- Manual checks and automated quality flagging procedure to filter unreliable data

## Investigate uncertainties

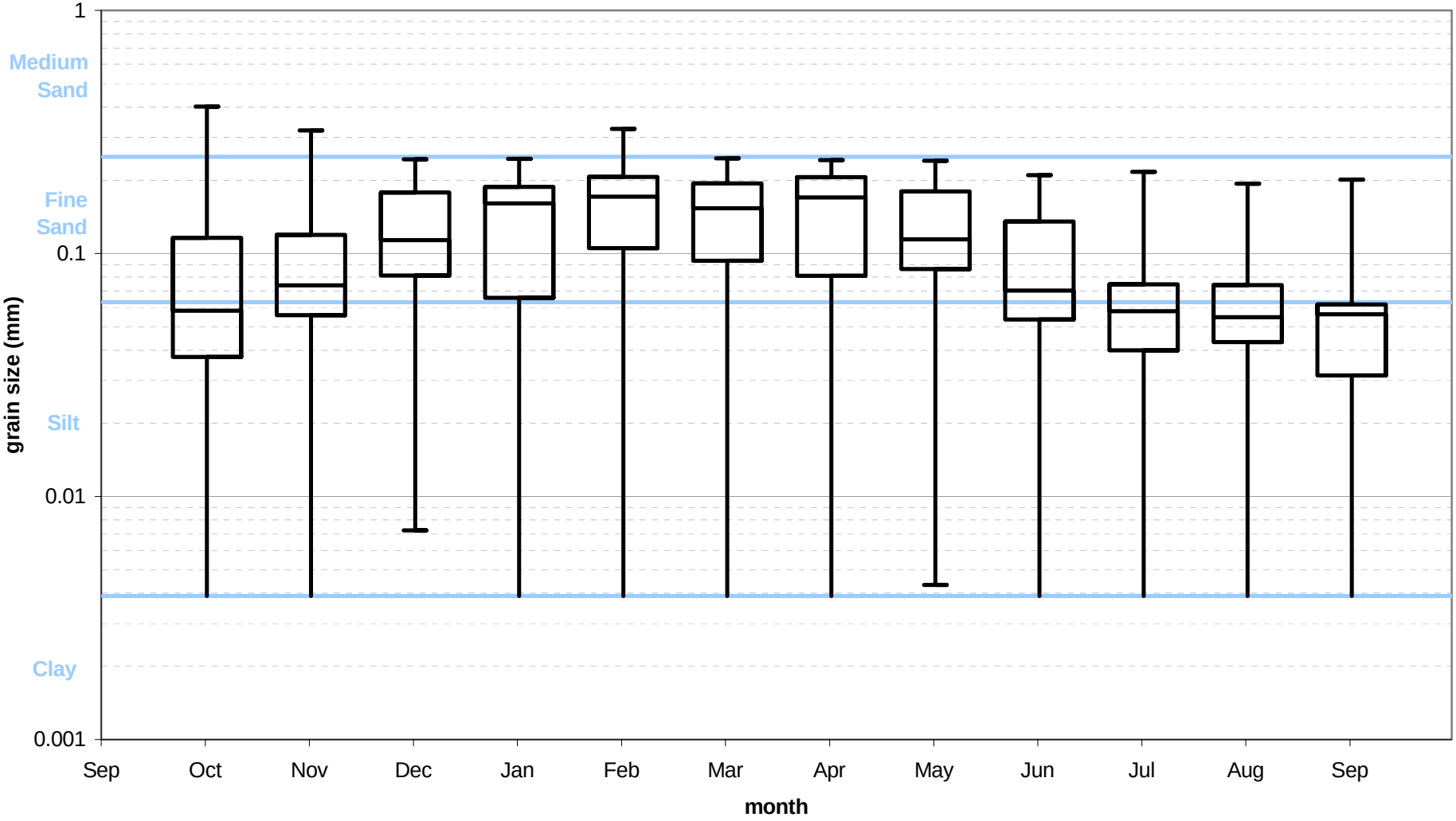
- Sampling strategies
- Sampling procedures
- Calculating sediment transport rates from point concentrations
- Calculating annual loads from measurements taken periodically through a single year



| Date | Verticals | Samples per Vertical | Sample Depths | Samples |
|---|---|---|---|---|
| 03/05/90 | 4 | 2 | 0.5 and 0.7 | 8 |
| 3/19/90 | 4 | 2 | 0.5 and 0.7 | 8 |
| 04/02/90 | 4 | 2 | 0.5 and 0.7 | 8 |
| 4/16/90 | 4 | 2 | 0.5 and 0.7 | 8 |
| 4/30/90 | 4 | 3 | 0.5, 0.7 and 0.95 | 12 |
| 5/14/90 | 8 | 5 | 0.15, 0.3, 0.5, 0.7 and 0.95 | 40 |
| 5/29/90 | 4 | 3 | 0.5, 0.7 and 0.95 | 12 |
| 06/11/90 | 8 | 5 | 0.15, 0.3, 0.5, 0.7 and 0.95 | 40 |

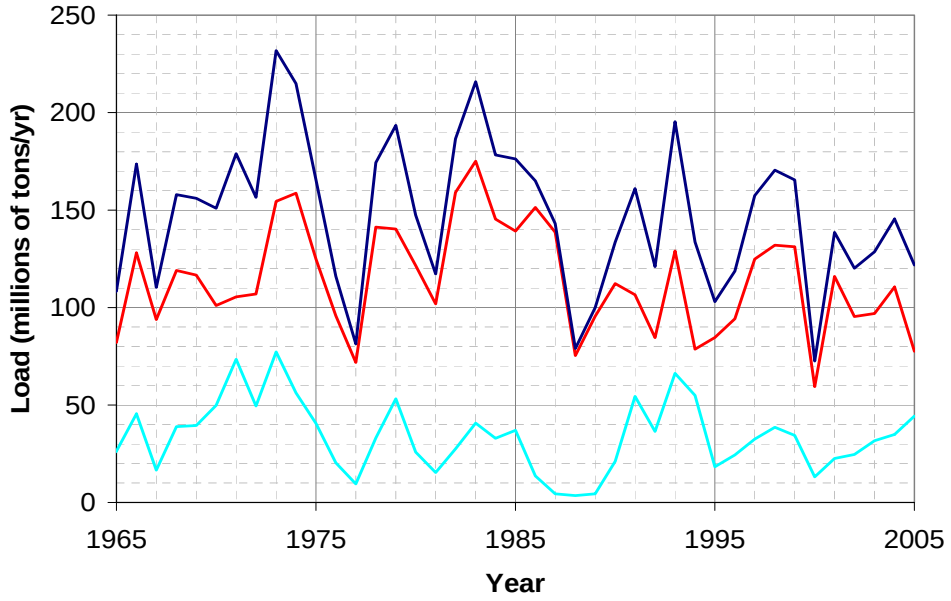
# Results: seasonal variations

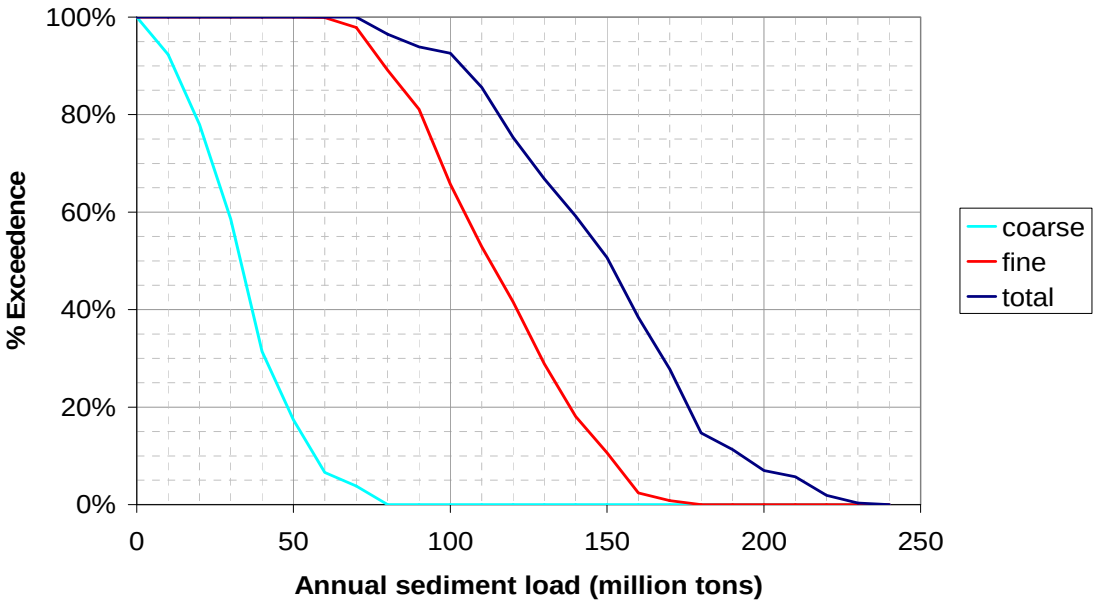
## Tarbert Landing – Seasonal Variation in $D_{90}$



# Results: Interannual variability 1965 - 2005

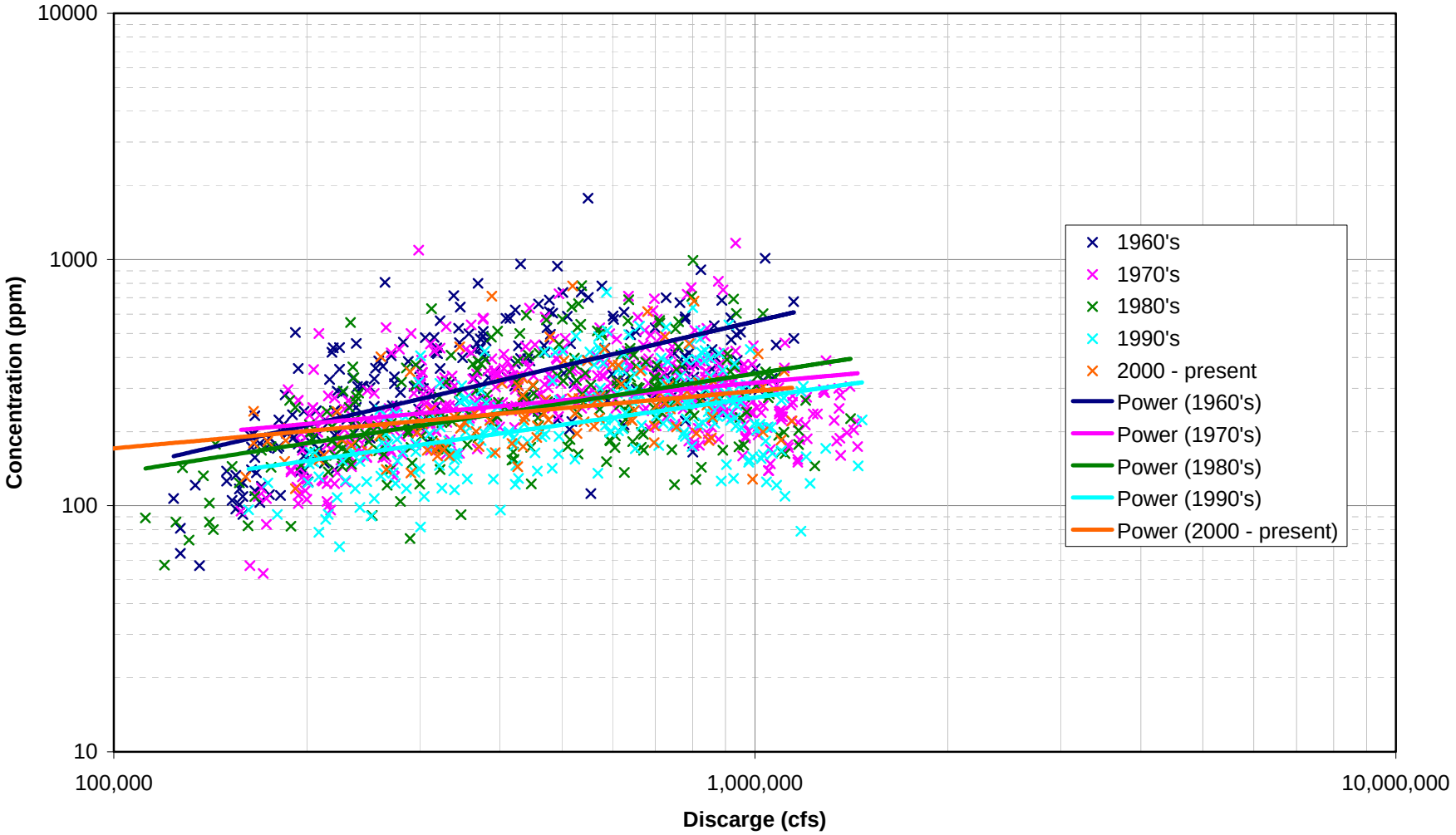
- Average suspended sediment load at Tarbert Landing = 150 M tons/yr
- Annual suspended load varies between 70 - 230 M tons/yr
- Average coarse suspended sediment load = 34 Mt/yr
- In any 5 year period total suspended load is between 580 - 960 M tons
- We are now estimating the uncertainties in these averages and ranges



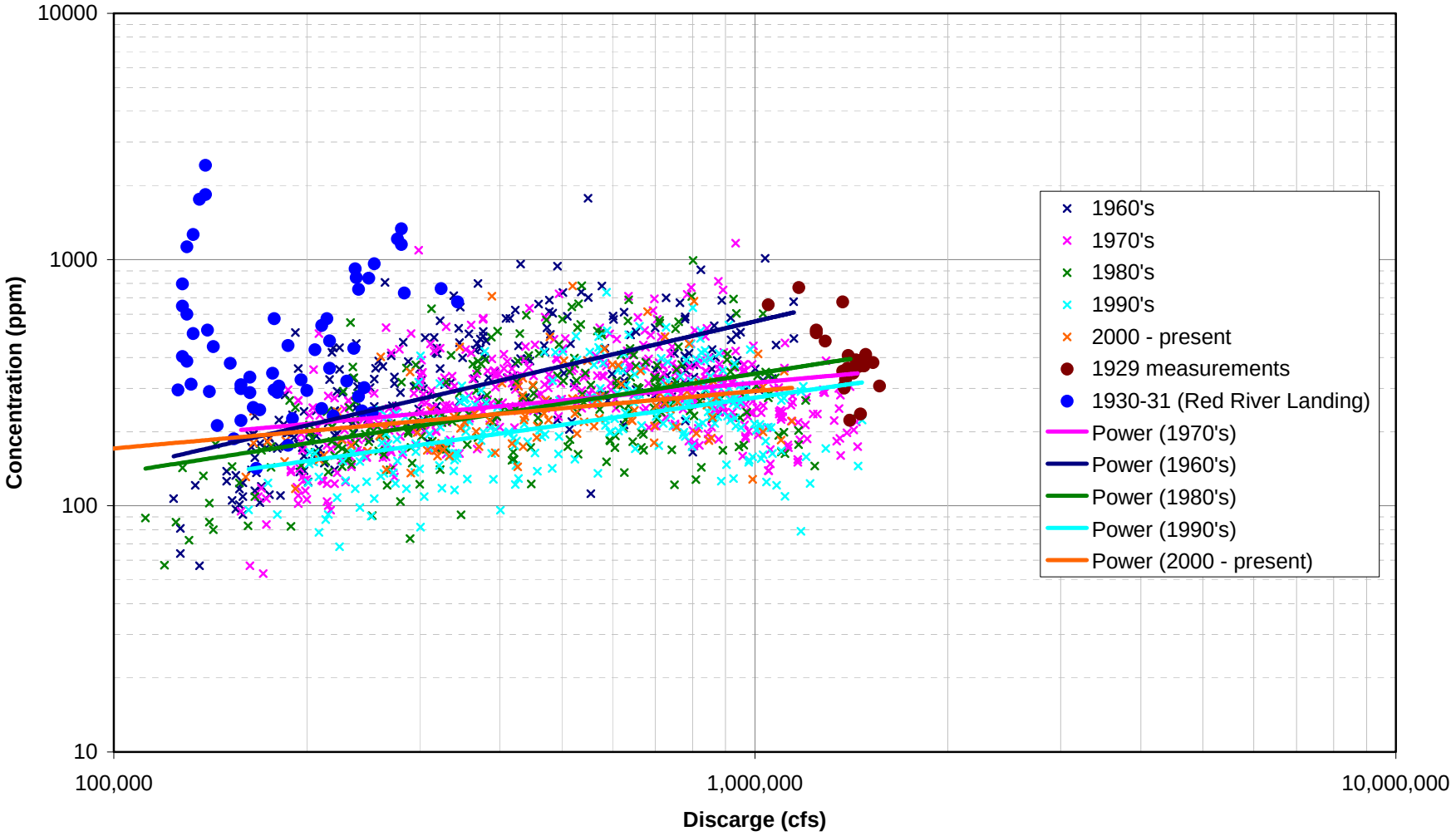
# Results: long-term variations

## Tarbert Landing – Long term Variation in sediment concentration



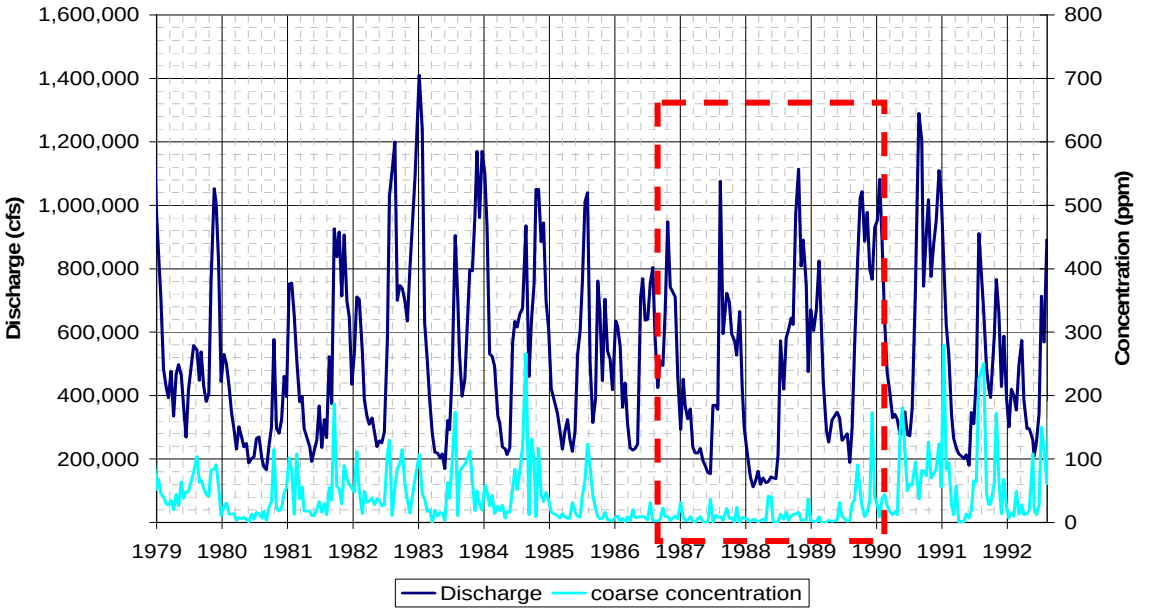
# Results: Older data

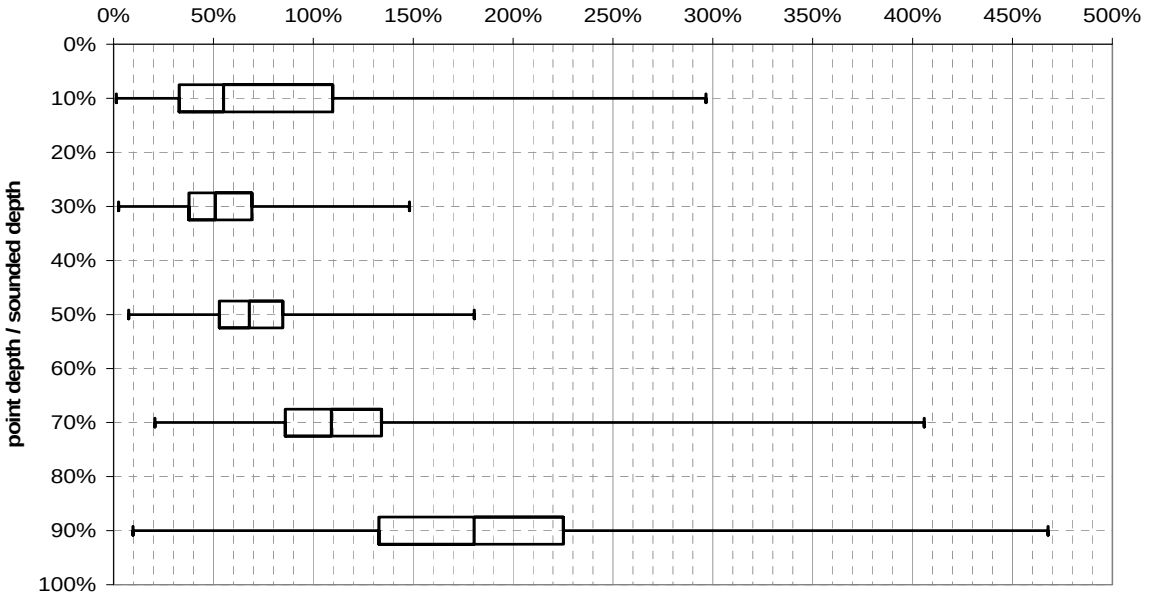
## Tarbert Landing – Interannual variation



# Results: uncertainty analyses

- Sampling strategy
- Frequent changes in sampling strategy at Tarbert Landing – the longest data record
- Coarse concentrations much more sensitive than fine concentrations
- Coarse sediment load may be particularly sensitive to changes in the depth of the deepest sample
- Analysis of Tarbert point sample data used to estimate systematic impacts of different sampling strategies



# Results: uncertainty analyses

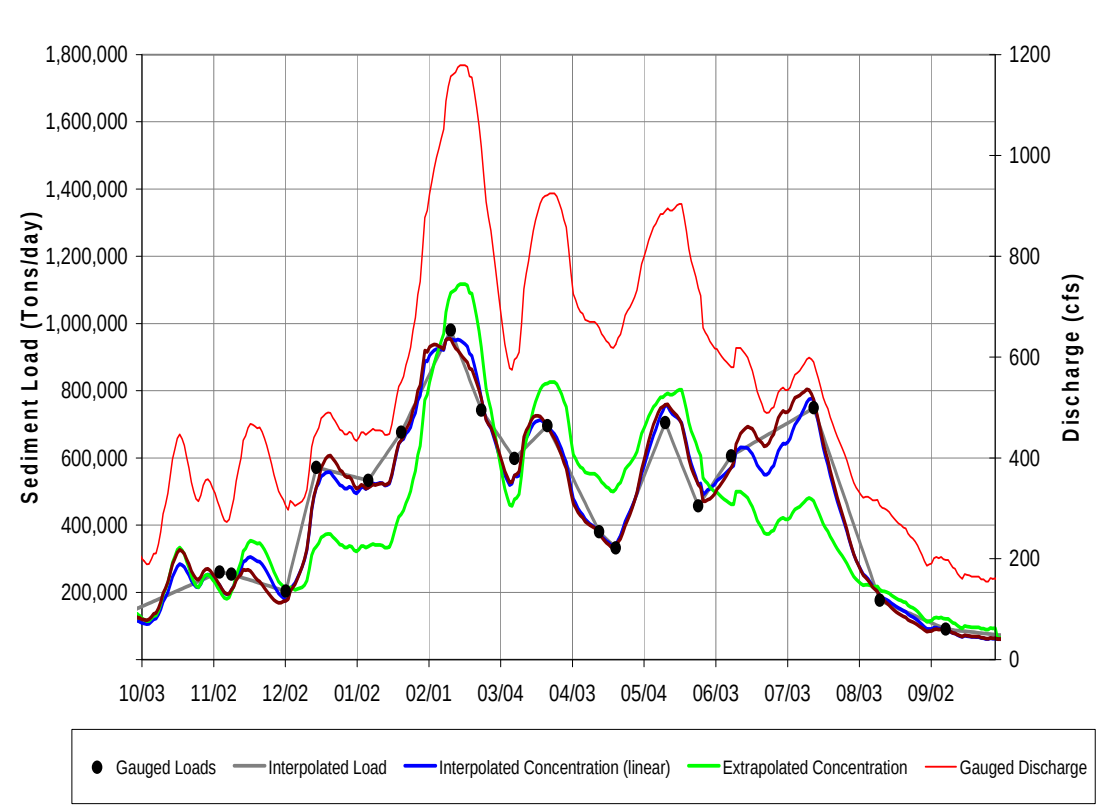
## Calculating the annual load

**Tested 3 methods:**

- Interpolation of load
- Interpolation of conc.
- Extrapolation using rating curves

**No one method is intrinsically more accurate but process may introduce up to 15% uncertainty**

**Uncertainty depends on number of measurements in the year**



# Ongoing research

Quantifying uncertainties to allow error bars to be added to long term records

1. Monte Carlo type analysis to combine different sources of uncertainty e.g.
   - sampling strategy,
   - sampling equipment,
   - estimating annual loads
2. Reconcile changes in load against published accounts
3. Further analysis into the significance of major floods and wet or dry periods

# Interim Conclusions

- Study is providing baseline scientific understanding of historic and current sediment loads in the lower Mississippi River.
- This is critical to appraising the feasibility of planned flow and sediment diversions in the Mississippi delta
- Further work is required to:
  - Establish sediment performance of existing diversions (e.g. Old River Diversion)
  - Extend analyses to other gauging stations where long records exist
  - Compare estimates of measured concentration to ADCP backscatter measurements to provide robust assessment of uncertainty