Chromophoric Dissolved Organic Matter (CDOM) in United States Estuaries

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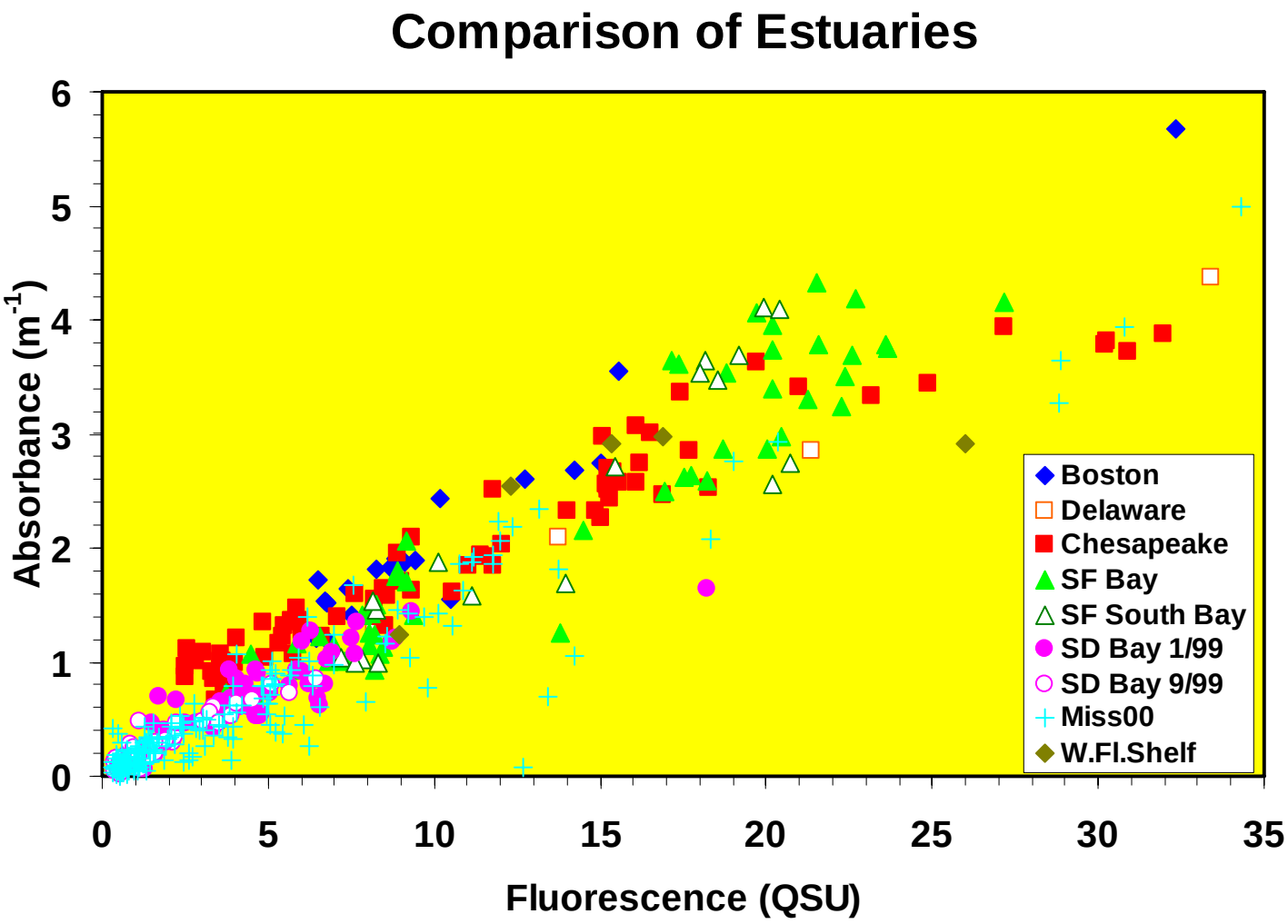
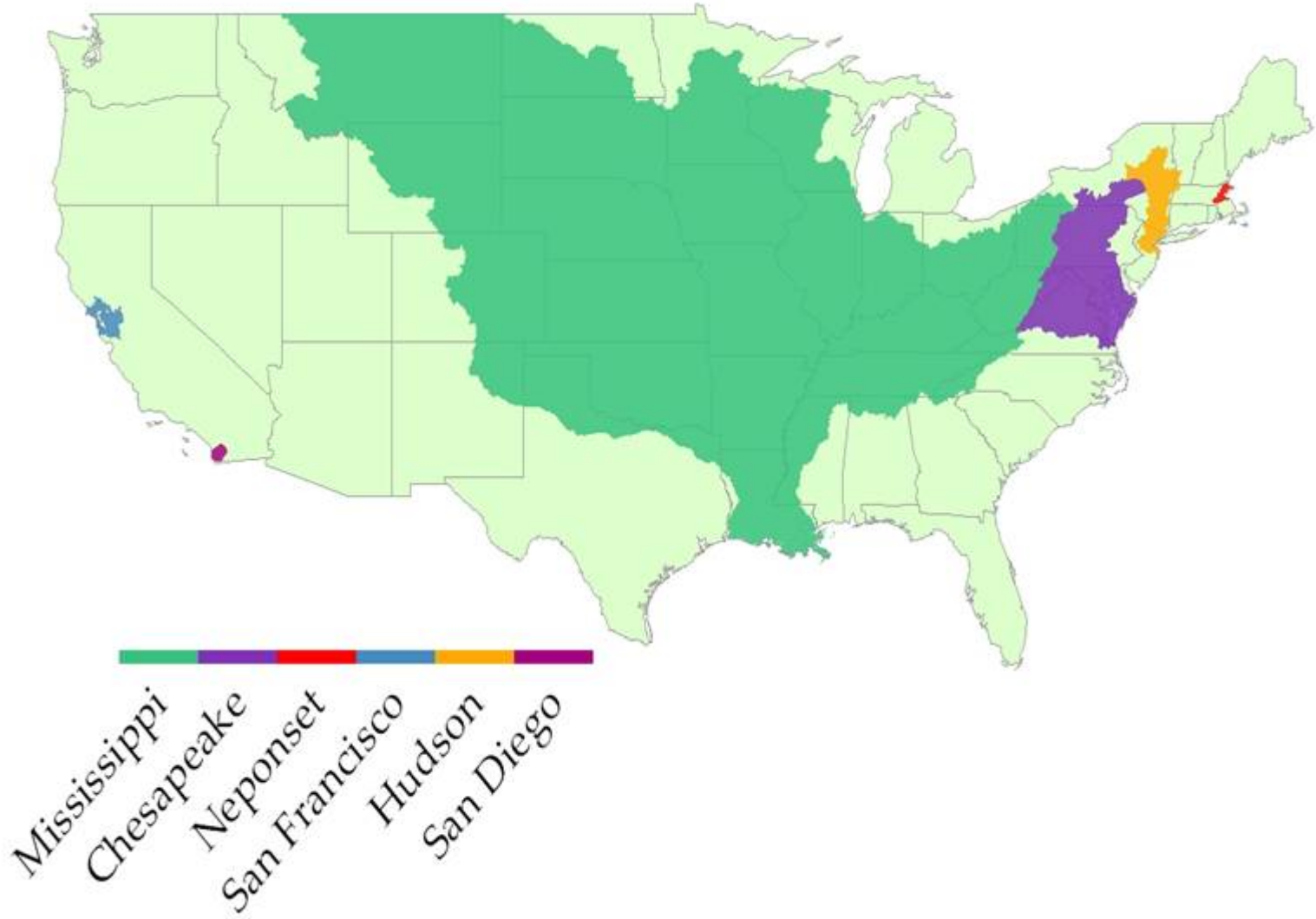
CDOM in Coastal Waters

- Chromophoric Dissolved Organic Matter (CDOM)
  - Absorbs light
  - Affects remote sensing of Chlorophyll
  - Tracer of total dissolved organic carbon (DOC)
  - Coastal carbon cycling
  - Easily measured: seawater fluoresces

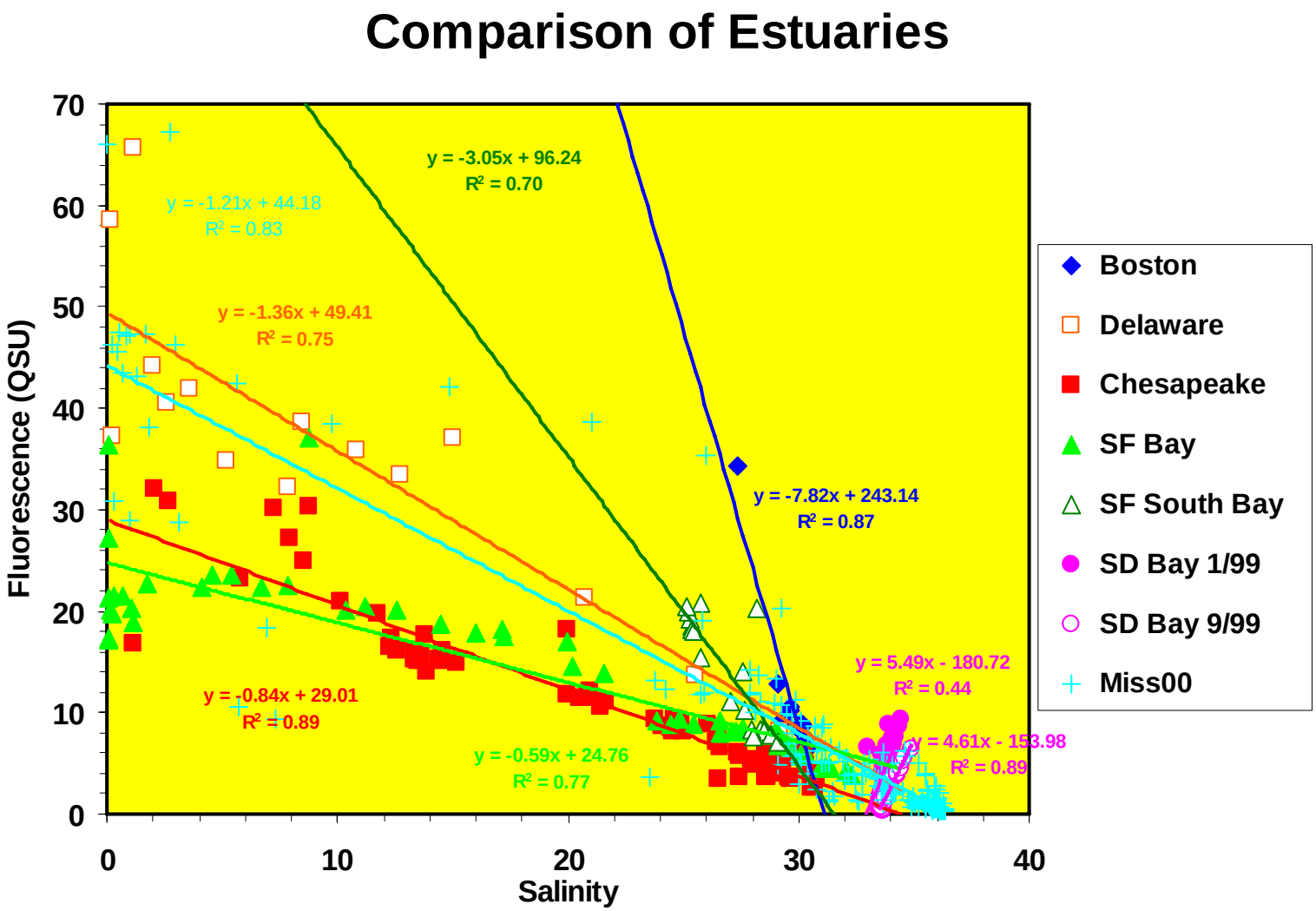
Fluorescence vs. Absorbance



United States Estuaries Studied



CDOM vs. Salinity



Observations

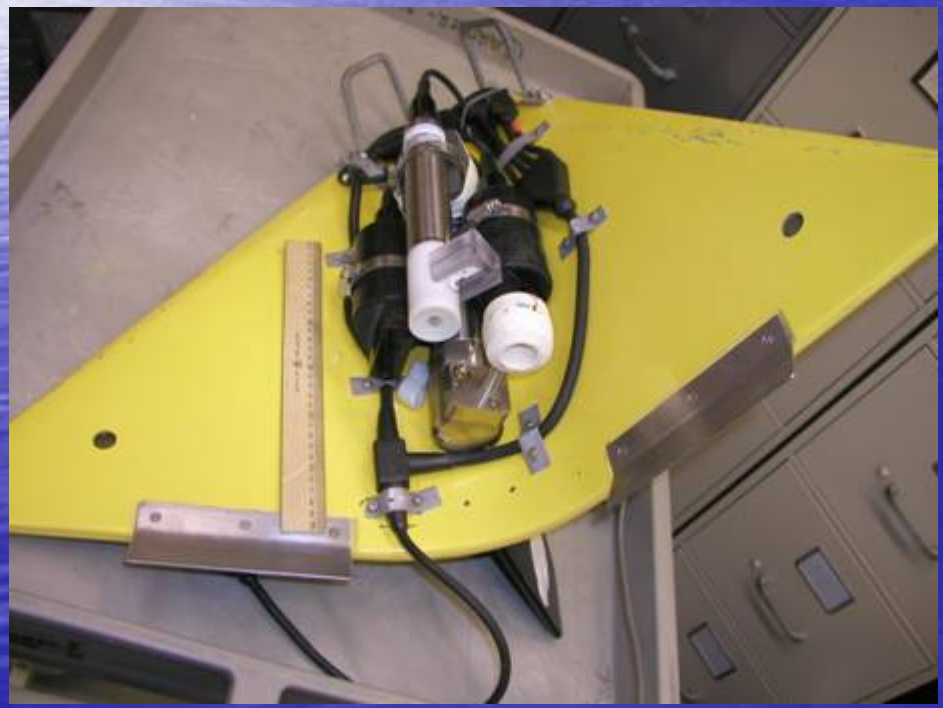
- CDOM is generally conservative
  - Linear CDOM vs. Salinity relationships
- Non-linear relationships suggest in situ production or degradation
  - Wetlands
  - Sewage
  - Photodegradation
- Freshwater endmembers depend on watershed characteristics
- High resolution allows better understanding

The Integrated Coastal Observation System (ICOS

- ECOShuttle
- 8 knots underway
- T, S, DO, Chl, CDOM, OPC
- Pumping System
- Adaptive or Continuous Sampling
- TOC/TN, nutrients
- 2-30 meters

Mini-Shuttle

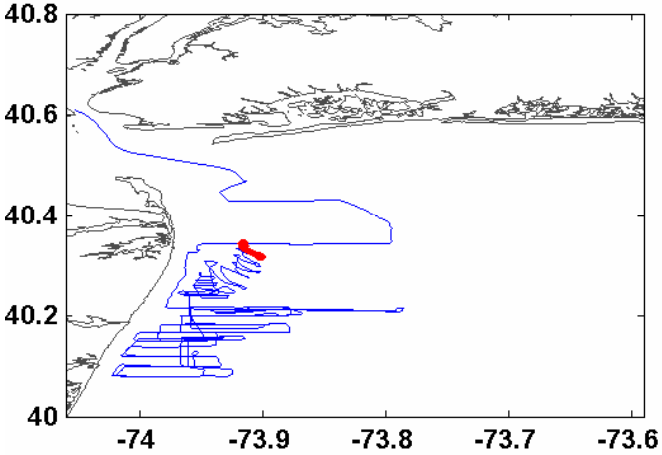
- Towed Instrument Package
  - Temperature, Salinity, CDOM, Chl
  - OBS, DO, UV radiance
  - Tow at 5 knots
  - Tow-yo to resolve vertical variation (10 cm-5 m)
  - Teflon diaphragm pump

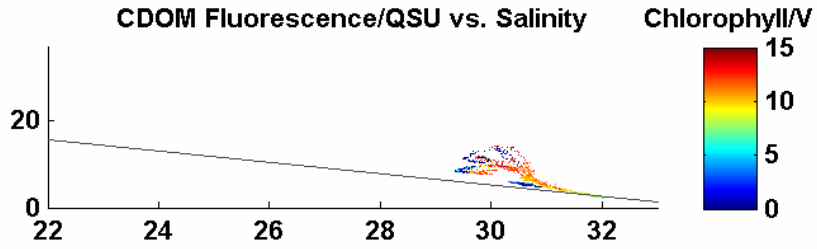


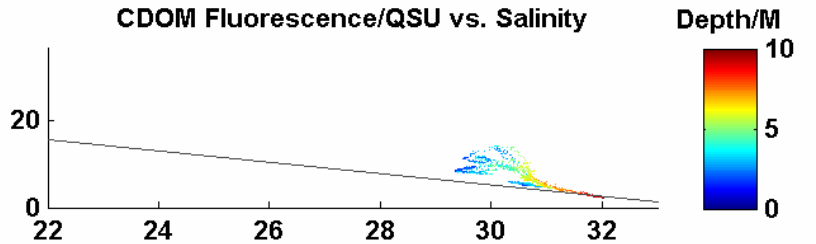
List of Estuaries Studied

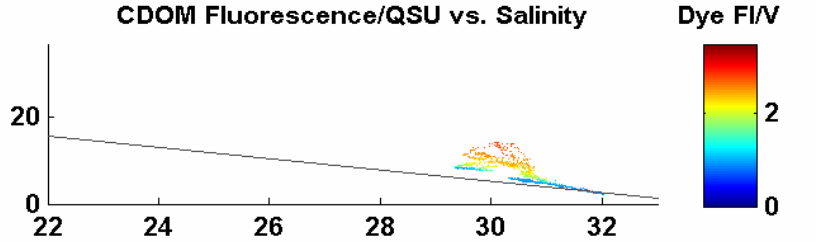
- Boston Harbor/Mass Bay: June, 1998
- Chesapeake/Delaware Bays: Aug 1998
- San Diego Bay: Jan 1999
- San Francisco Bay: June 1999, Oct 2000
- Mississippi River Plume: June 2000, Aug 2001, Aug 2007
- Plum Island: Oct 2000, July 2001
- Apalachicola Bay: Sept 2002
- Hudson River/New York Harbor: June 2003, June 2004, Sept 2004, June 2005, Oct 2006, Apr 2007
- Hudson River Plume: May 2004, Apr 2005, May 2006
- Neponset River: July, Sept, Nov, Dec 2001, Aug 2002, Apr 2003
- Santa Barbara: September 2001
- Neponset Watershed: Mar 2006-present (monthly)

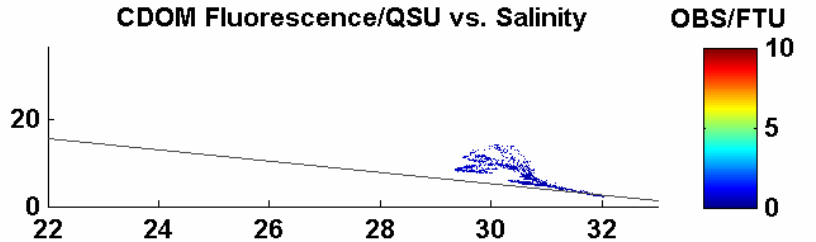
CDOM-Salinity evolution over time Hudson River Plume



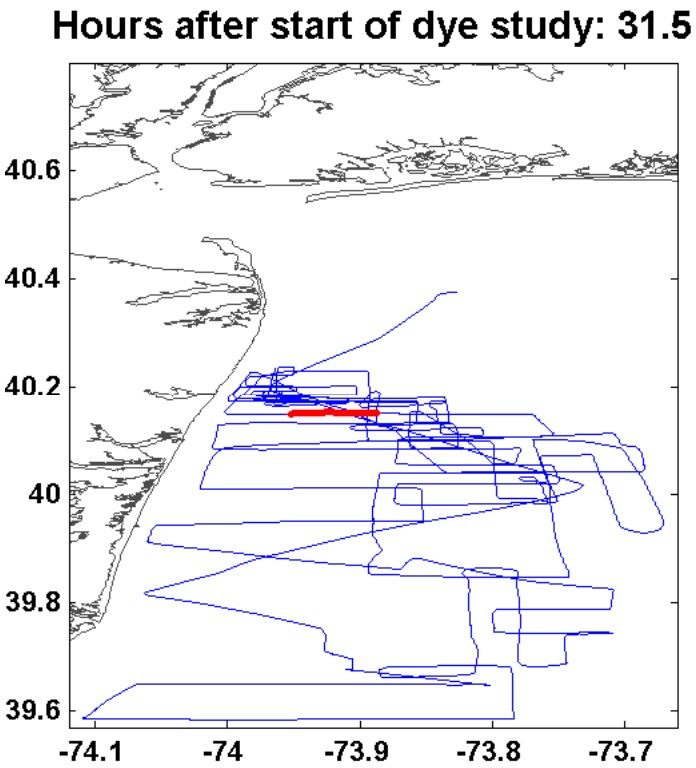


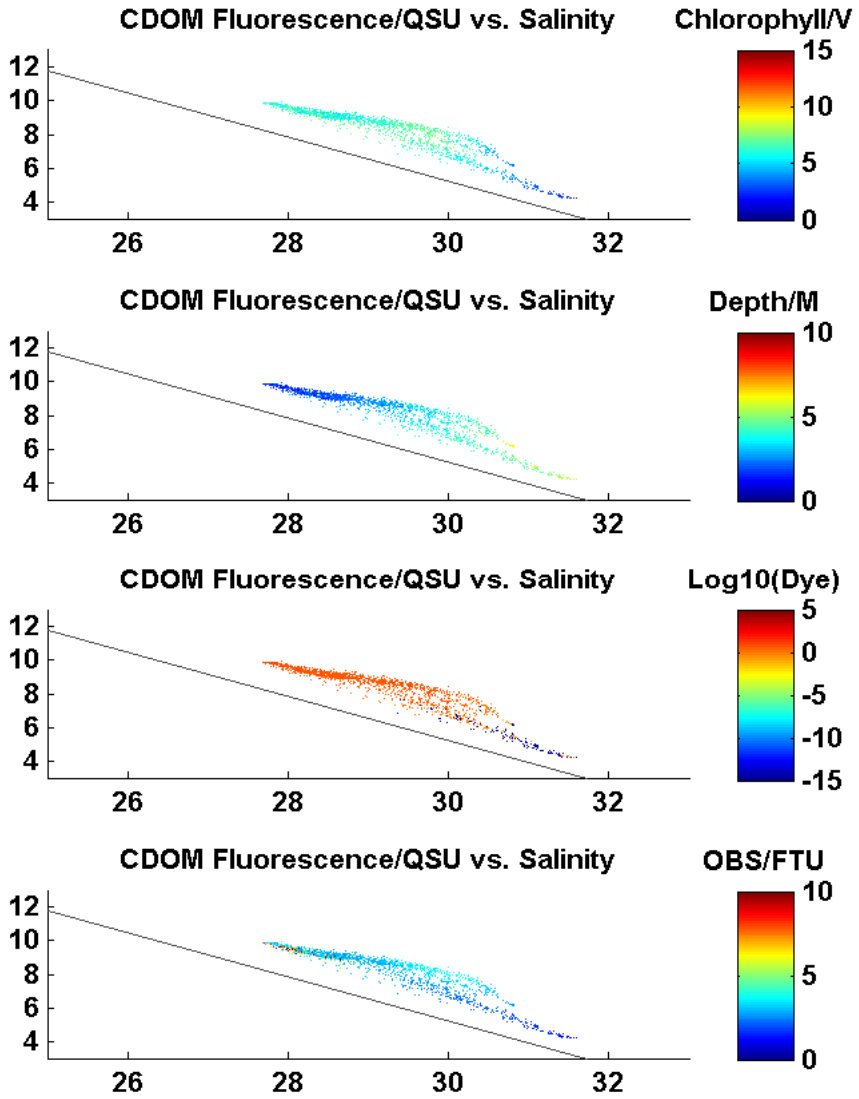




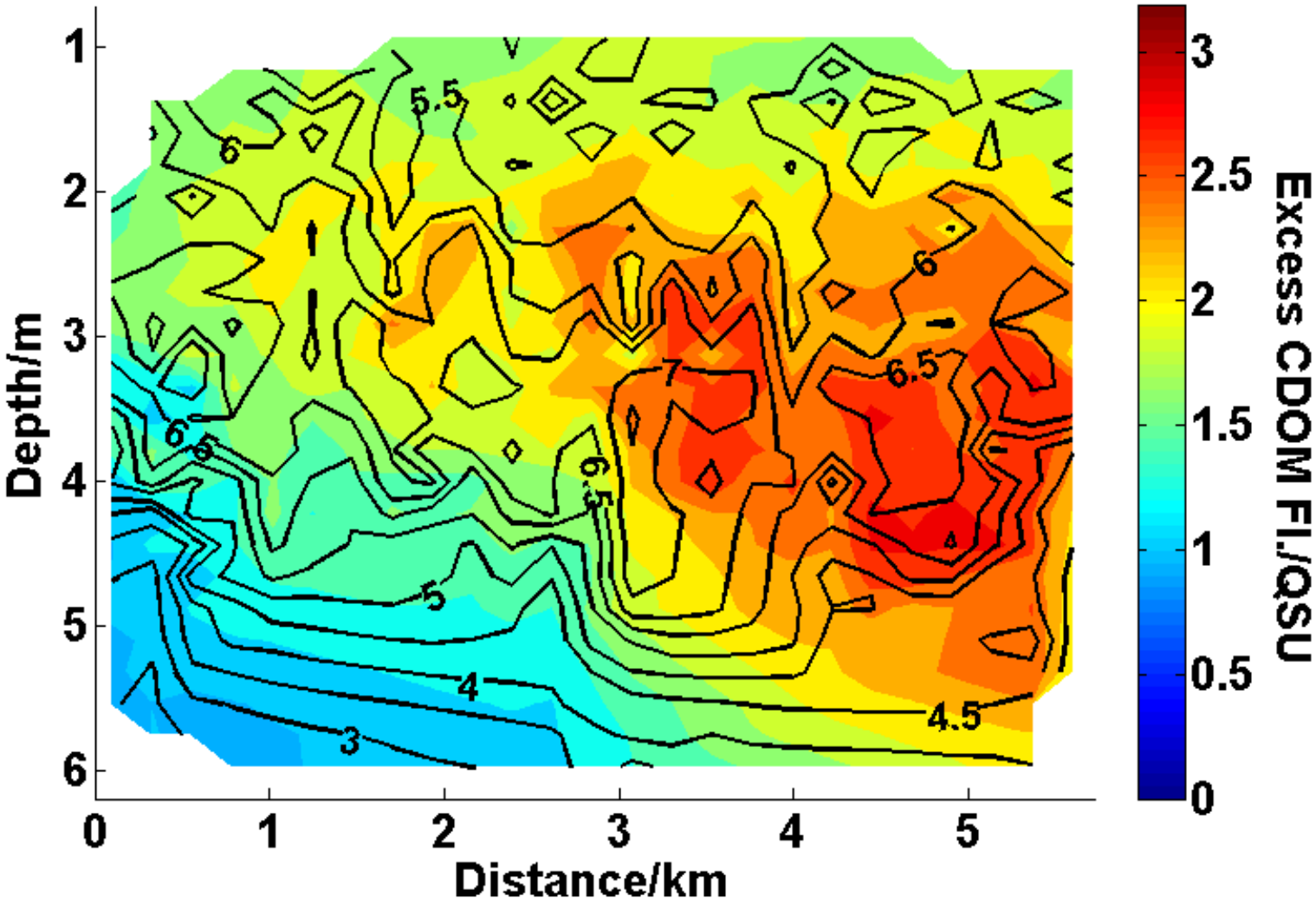


(1)-’06 Production by phytoplankton

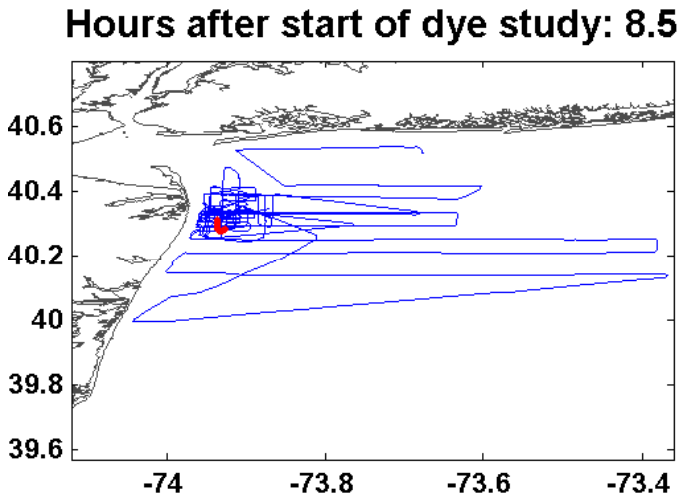


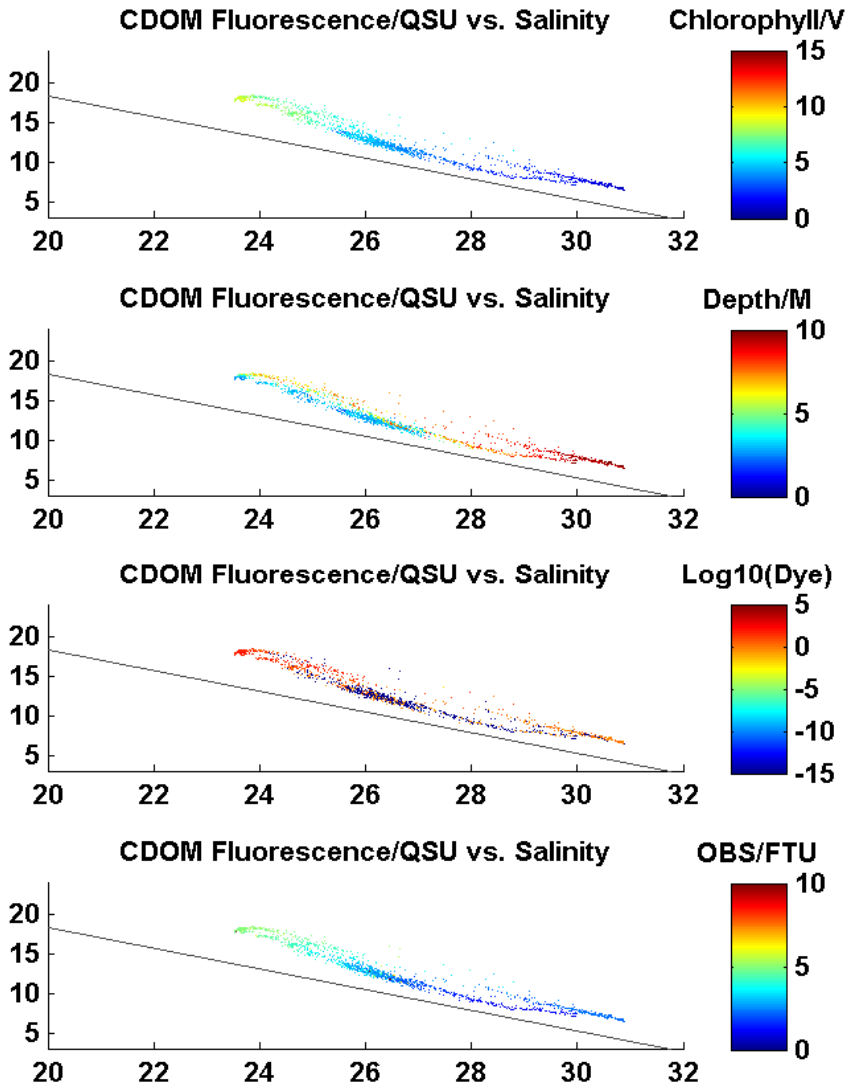


Inshore-Excess CDOM, contoured Chl

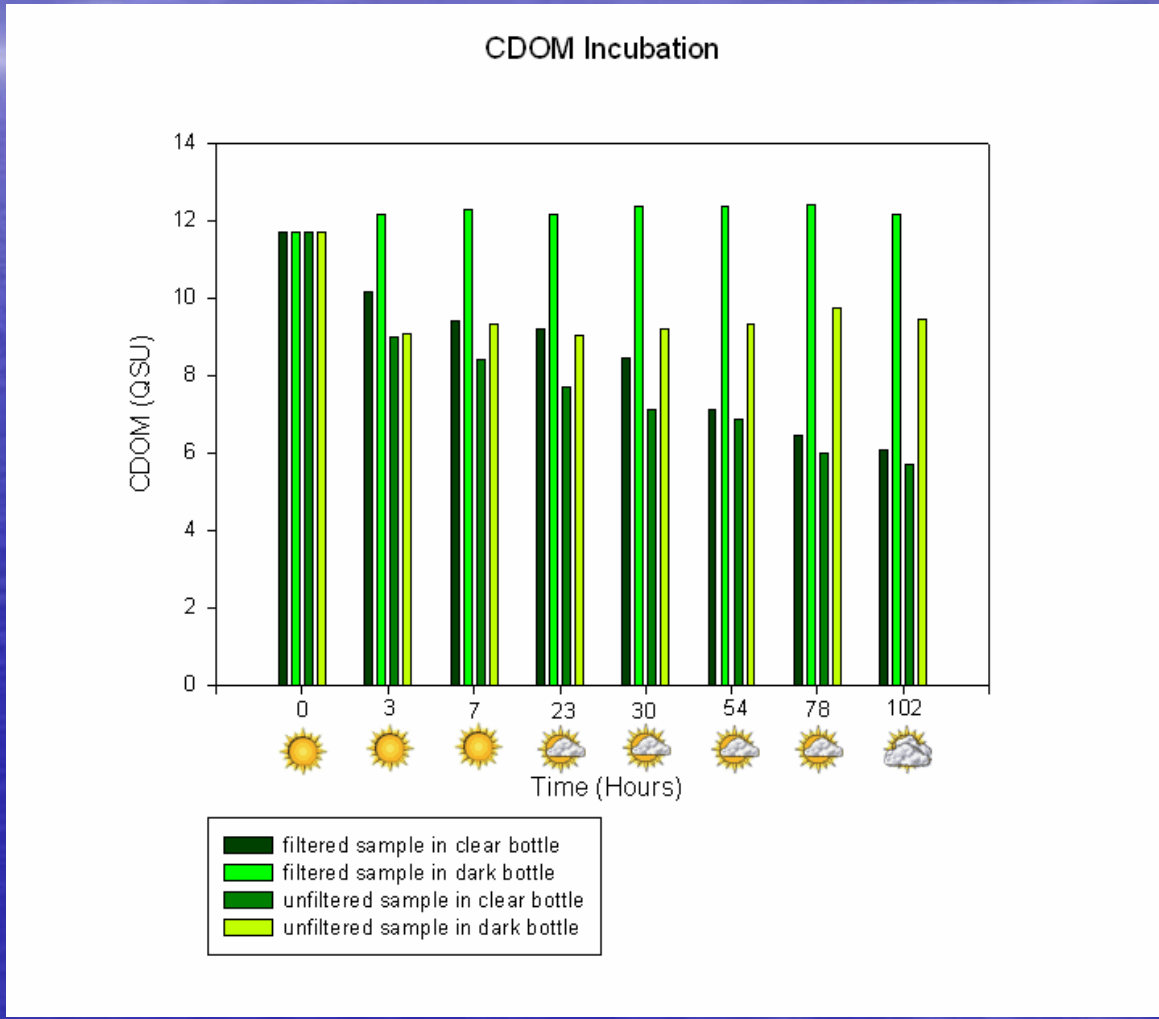


(2)-Degradation?

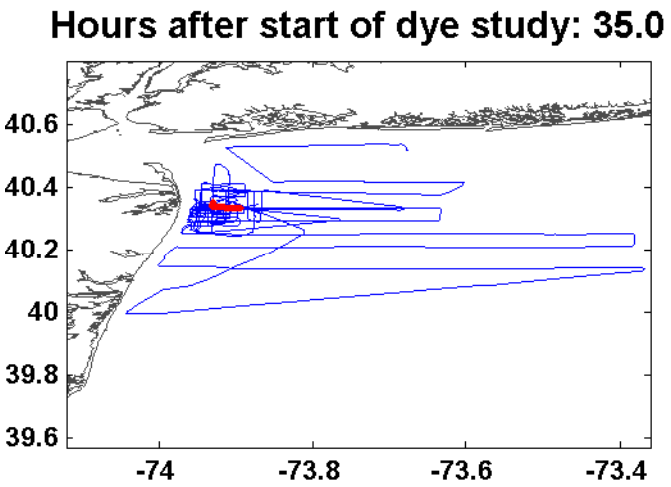


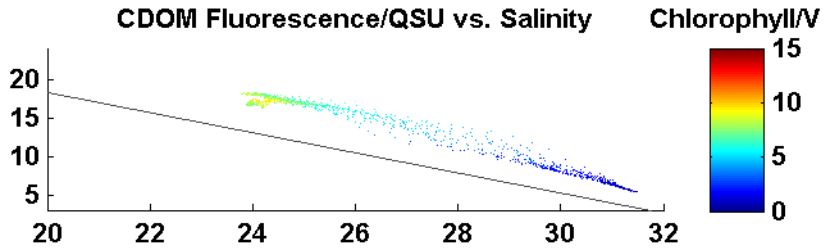


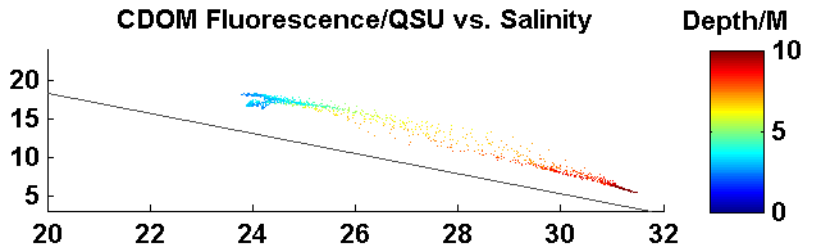
Incubations

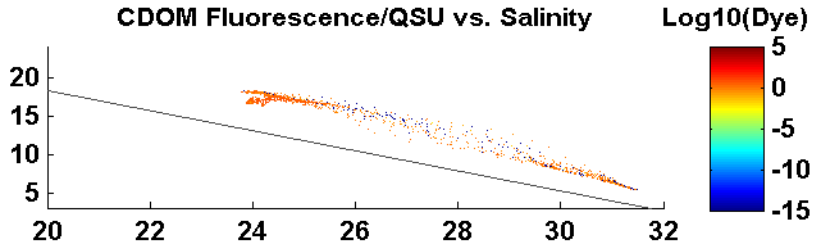


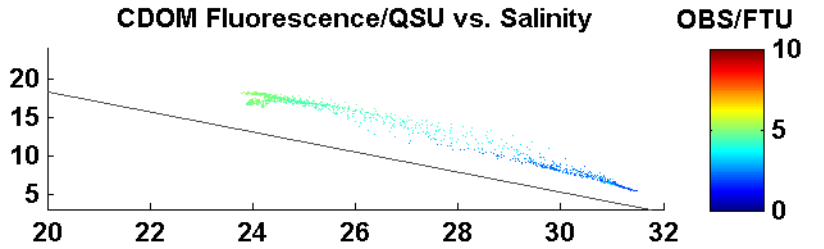
(3)-Varying Freshwater Endmember





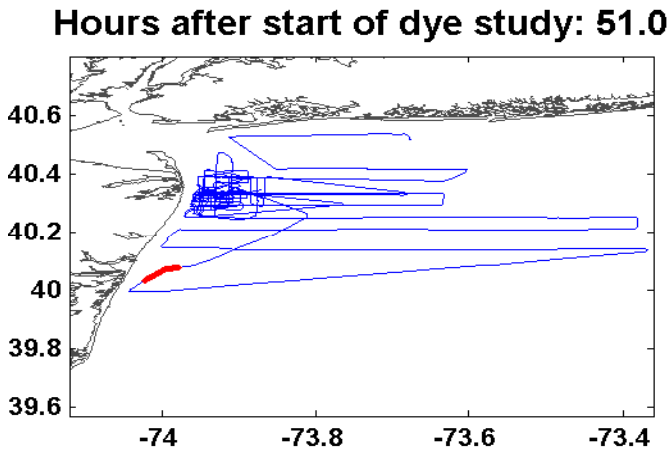


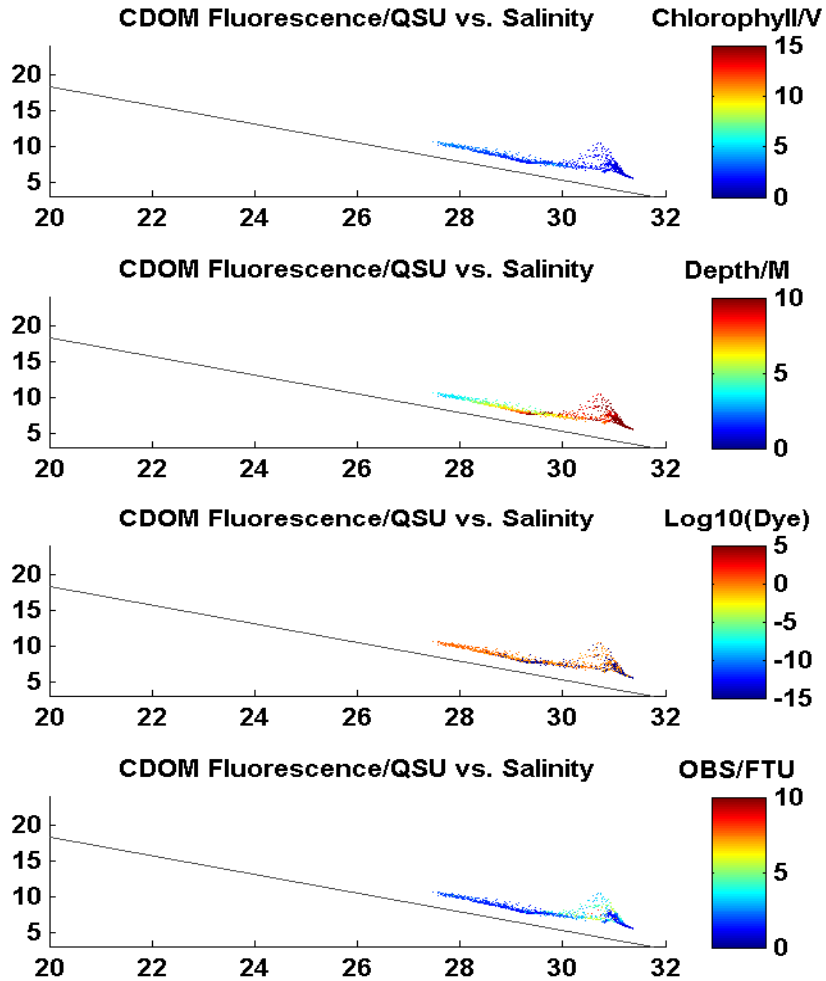




(4)-Sewage Effluent

- Ocean Counties Utility Authority
  - Northern water pollution control facility
  - Brick Township, NJ
  - 32 mg/d = 1.4 m^3/s



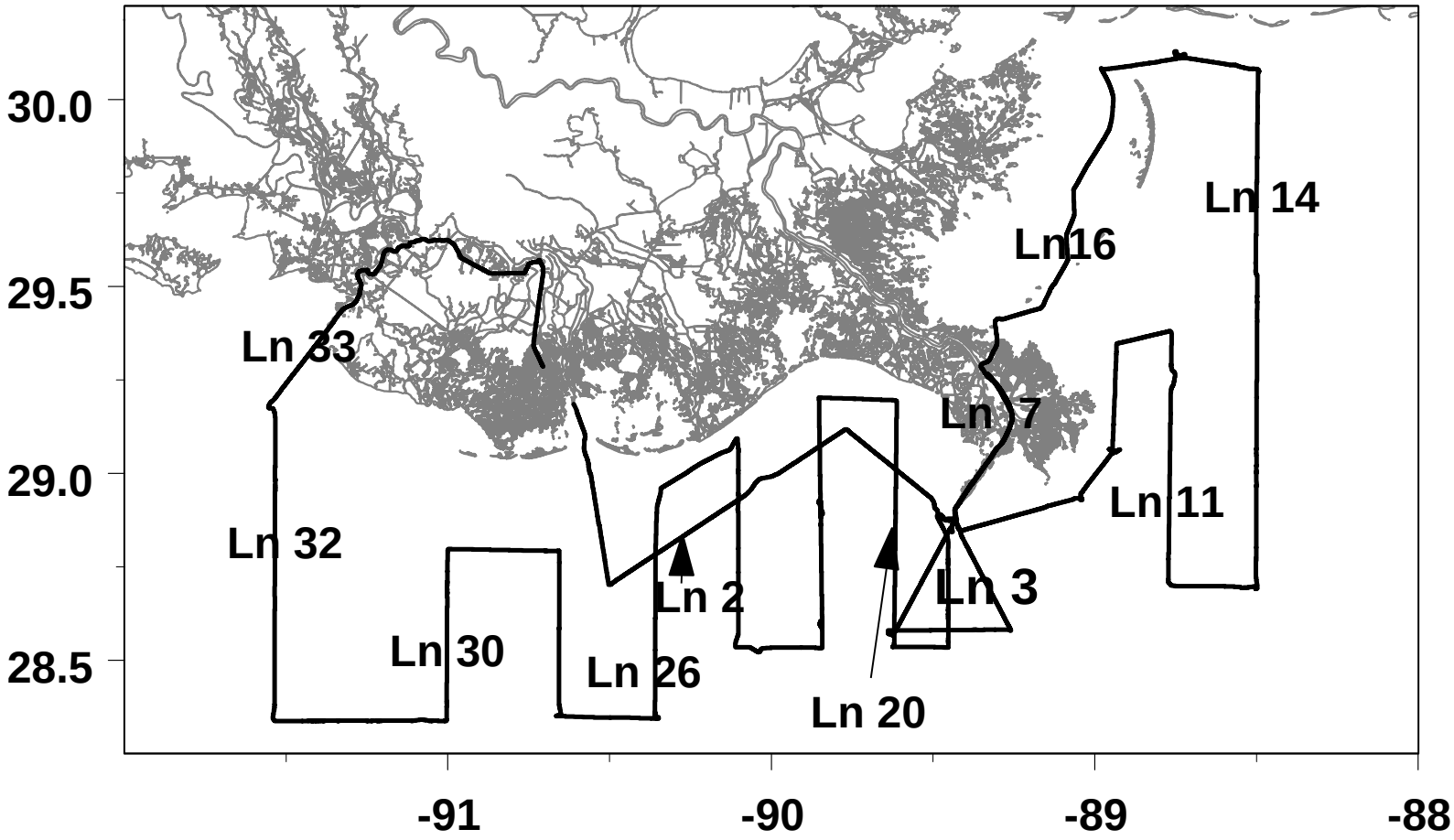


Hudson Estuary Summary

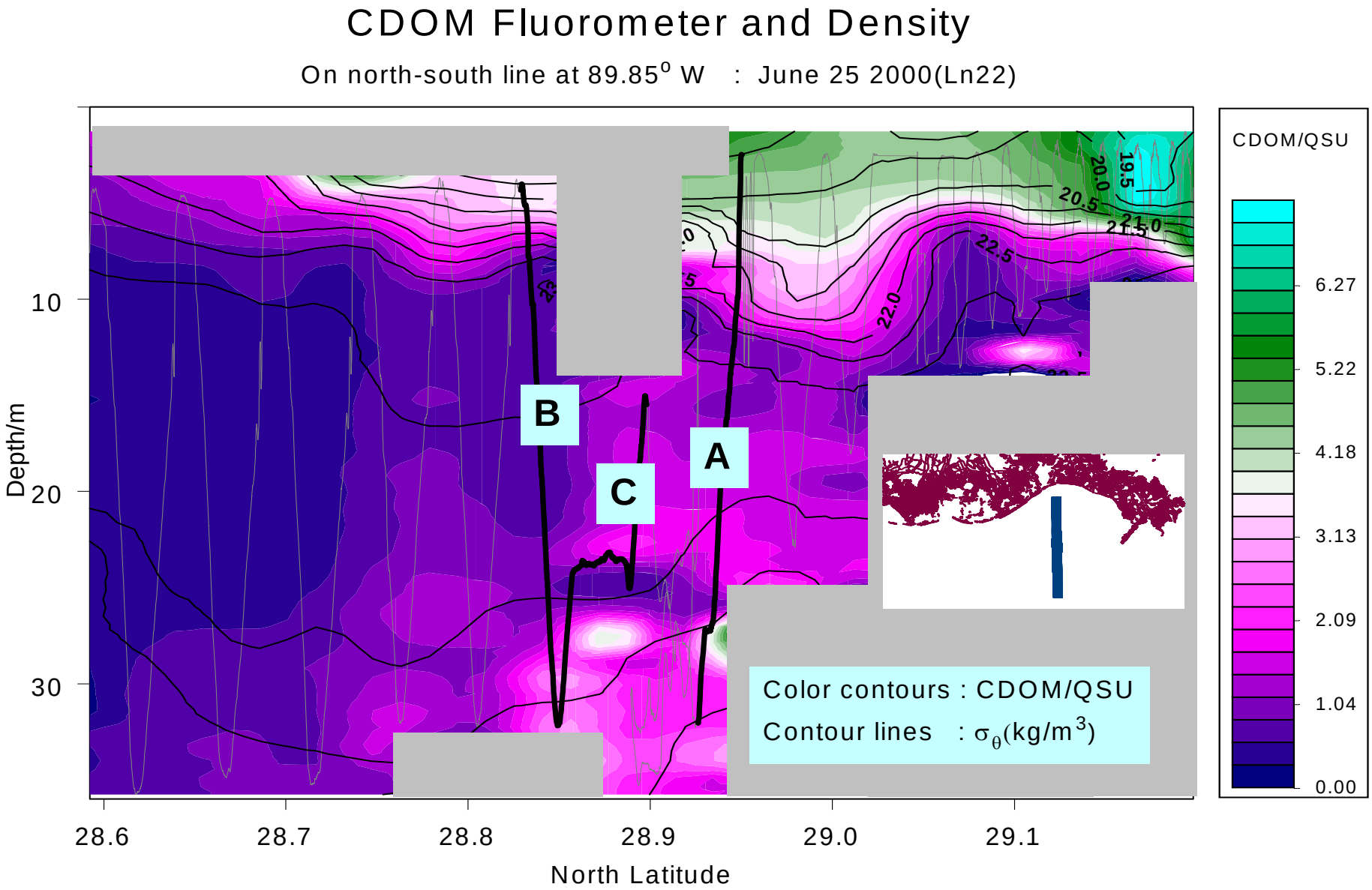
- High resolution allows examination of complex processes
- Fresh (and salt water) endmembers vary with time on the shelf
- CDOM is produced during primary production
  - Seen in 20-40% of data
  - Edge of plume—higher salinity, subsurface
  - Spatially coherent with Chlorophyll fluorescence
- CDOM is photo/bio-degraded in river plumes
  - 0-20% of data
  - More during downwelling conditions
- Anthropogenic impacts are evident on the shelf

Mississippi River Plume

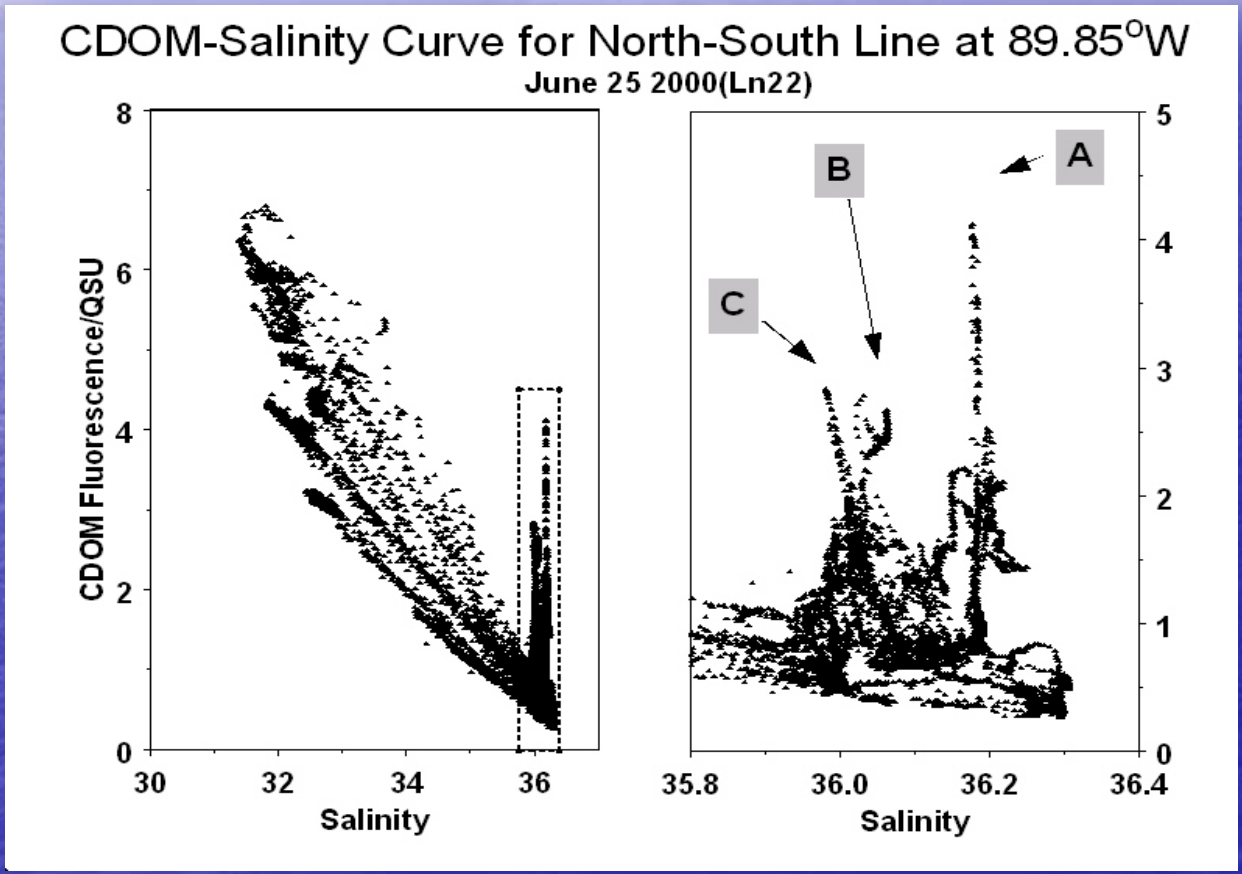
Cruise Track for June 2000 Cruise



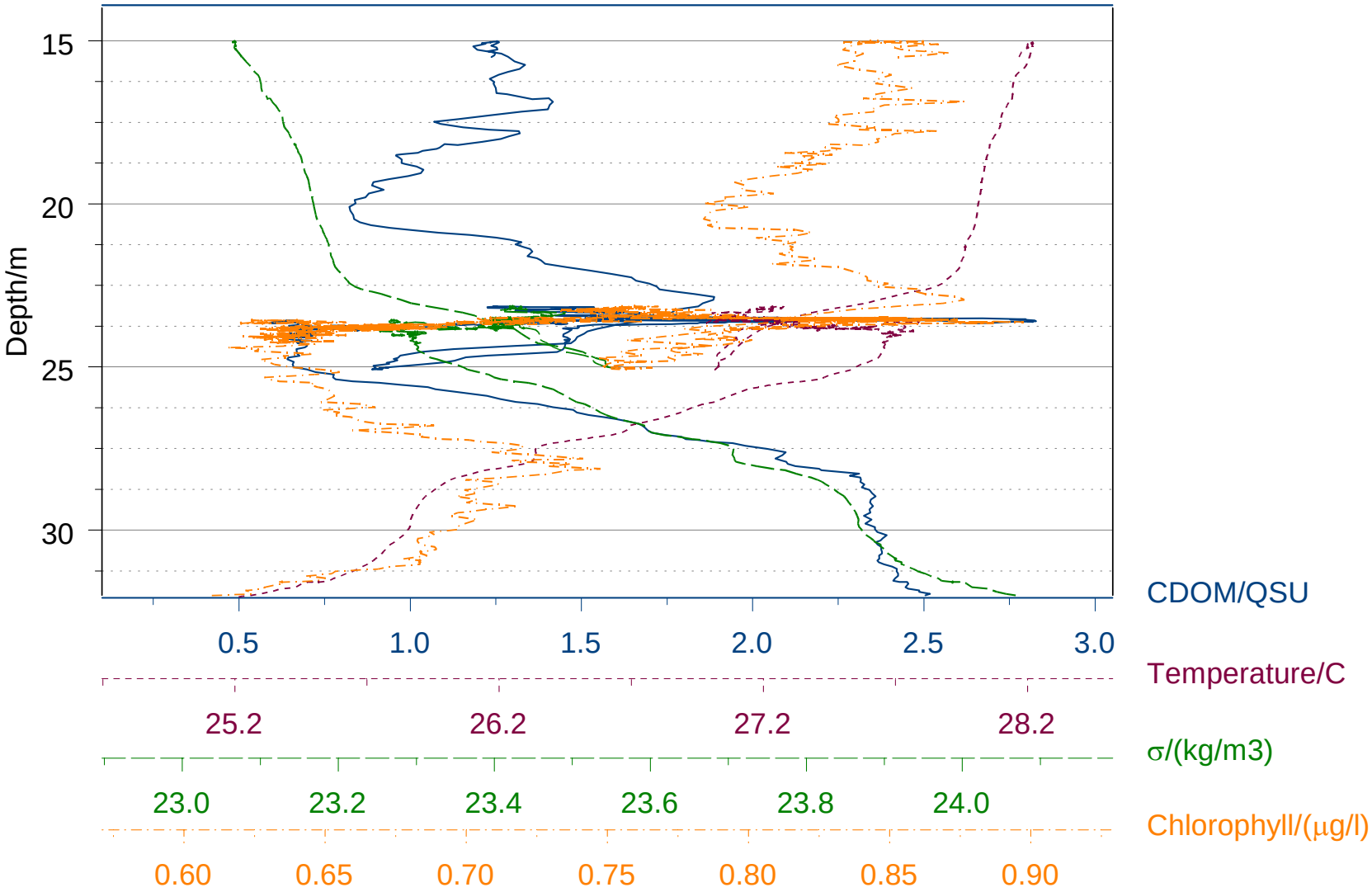
Mississippi River Plume



Thin Layers in the Gulf Of Mexico



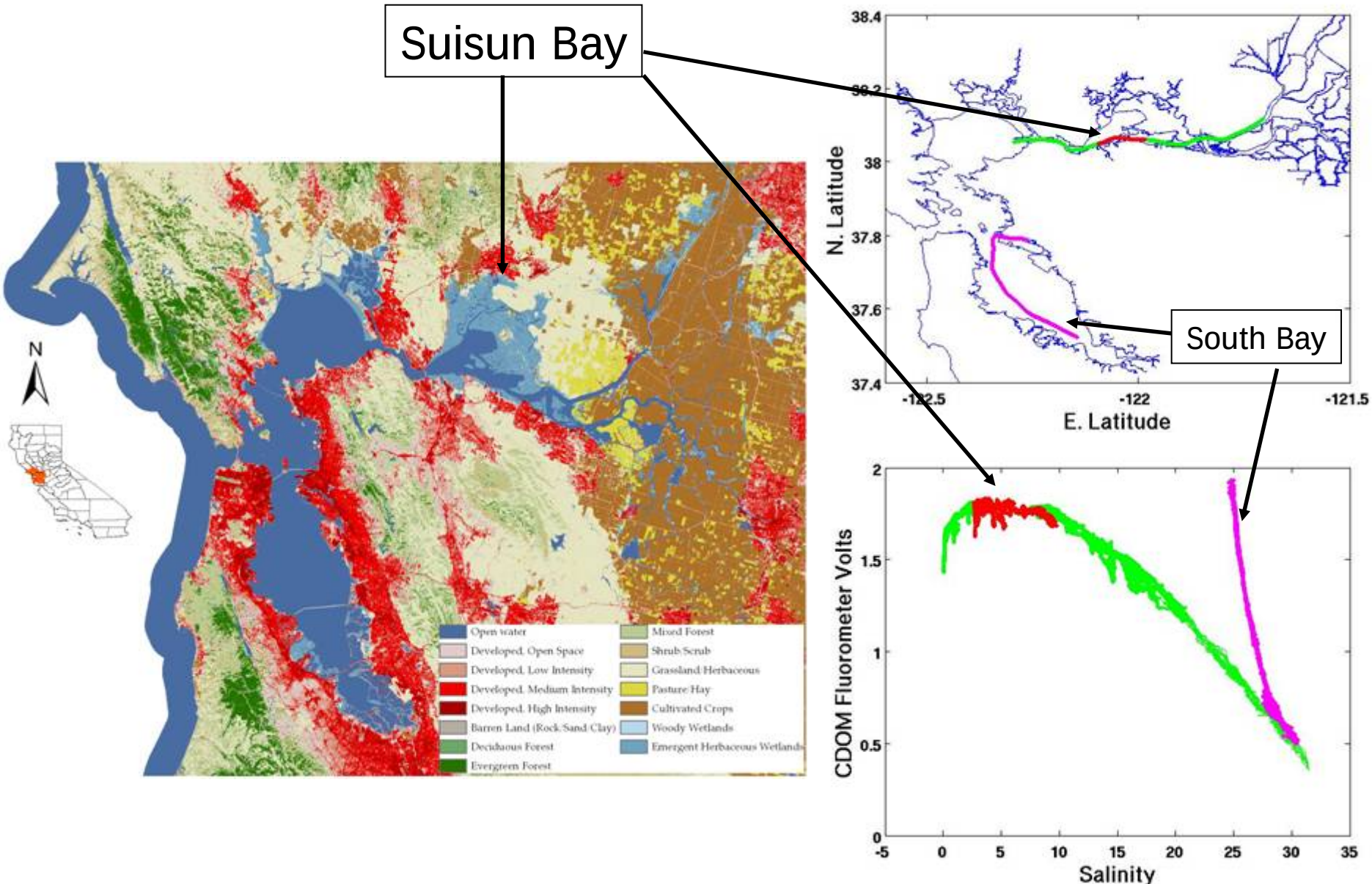
Mississippi 2000: LN 22: Profile C



Influence of Wetlands (Outwelling)

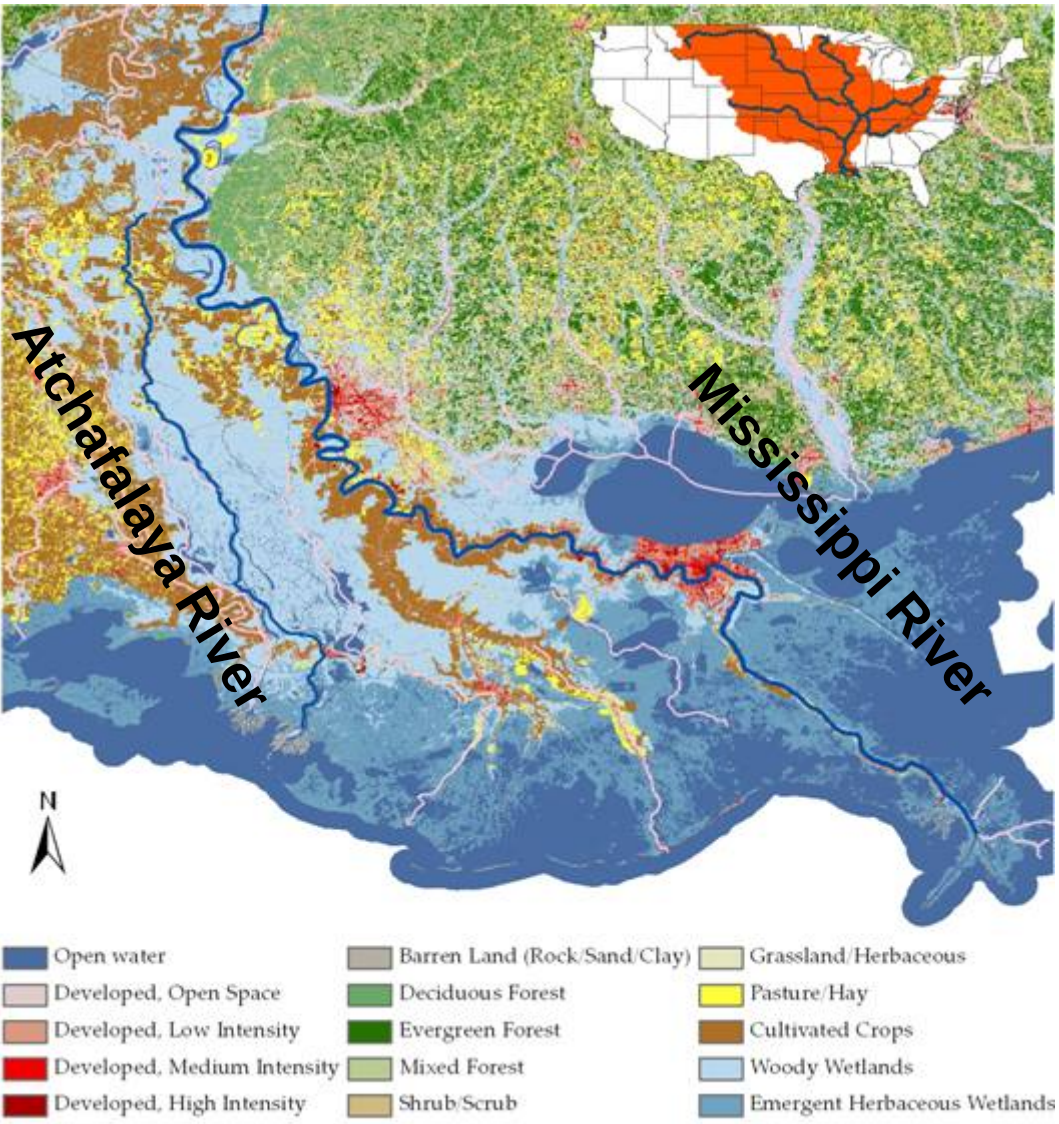
- 50% of wetlands have been destroyed in the US
- Coastal development impacts wetlands
- 7% “brown marsh” in Florida marshes
- Wetlands provide DOM to estuaries

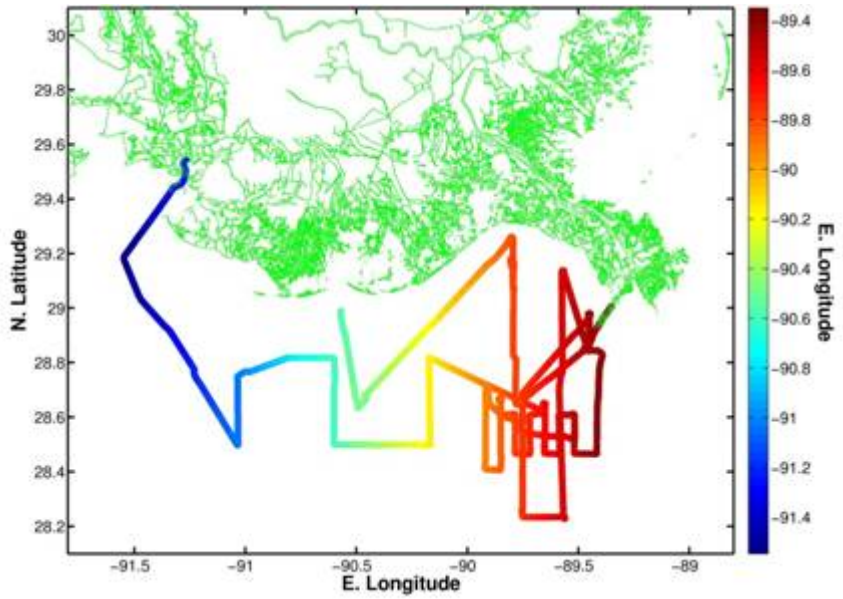
San Francisco Bay

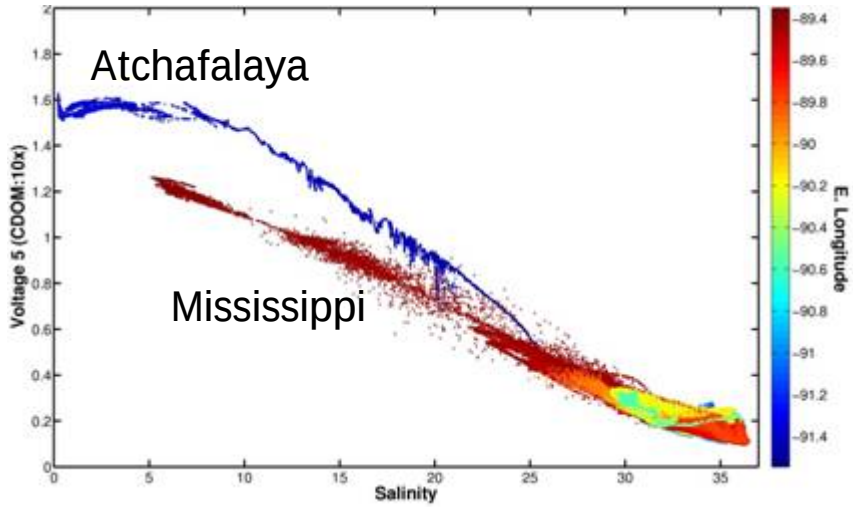


Suisun Bay drains the only salt marsh remaining in the San Francisco Bay Watershed

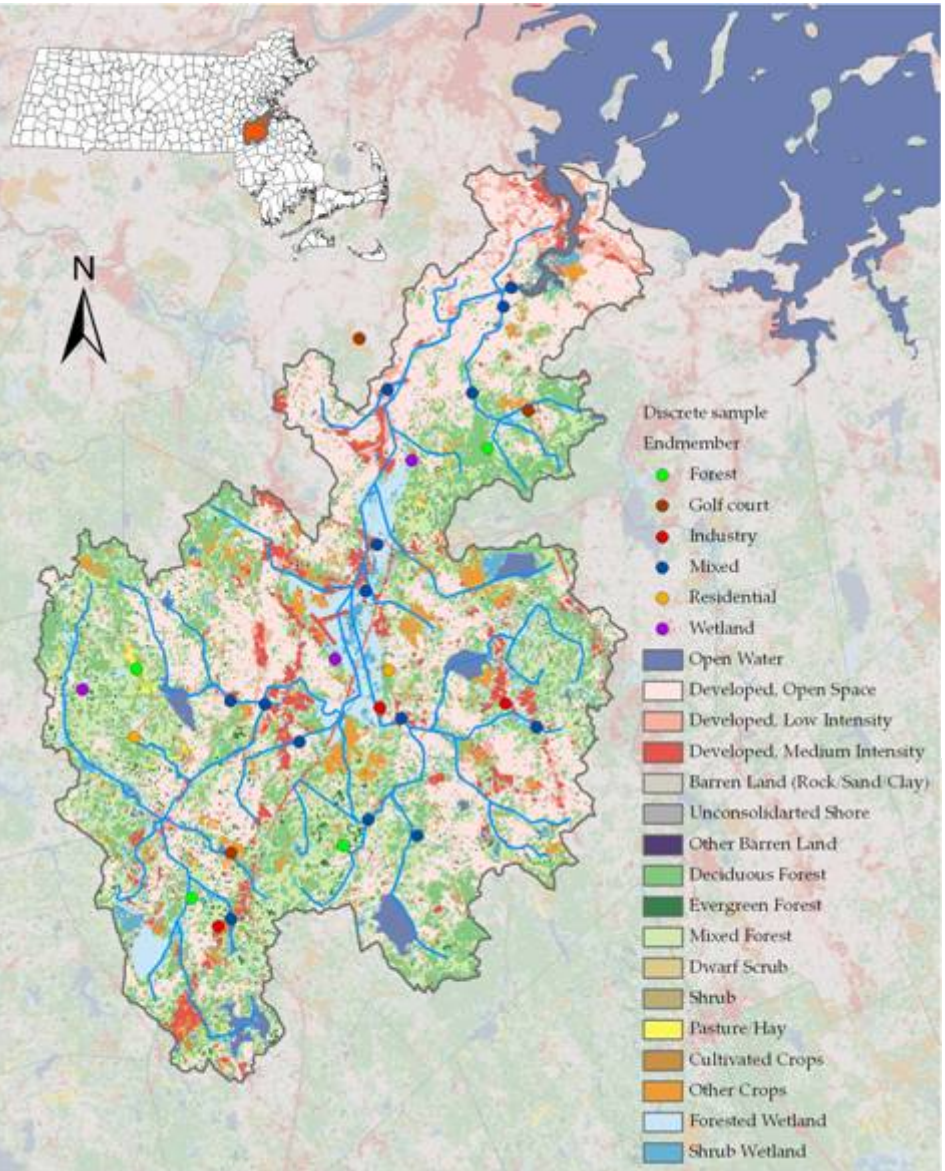
Mississippi and Atchafalaya Rivers

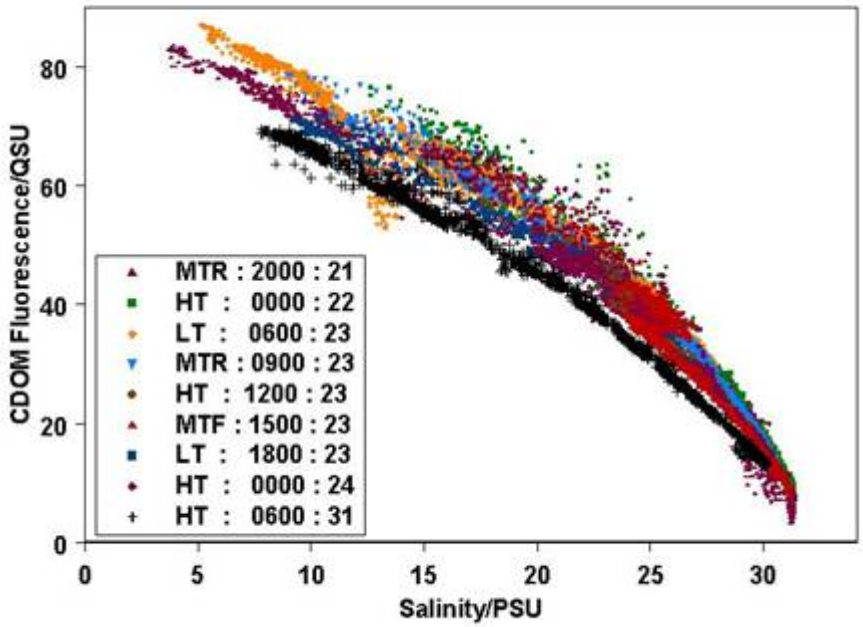






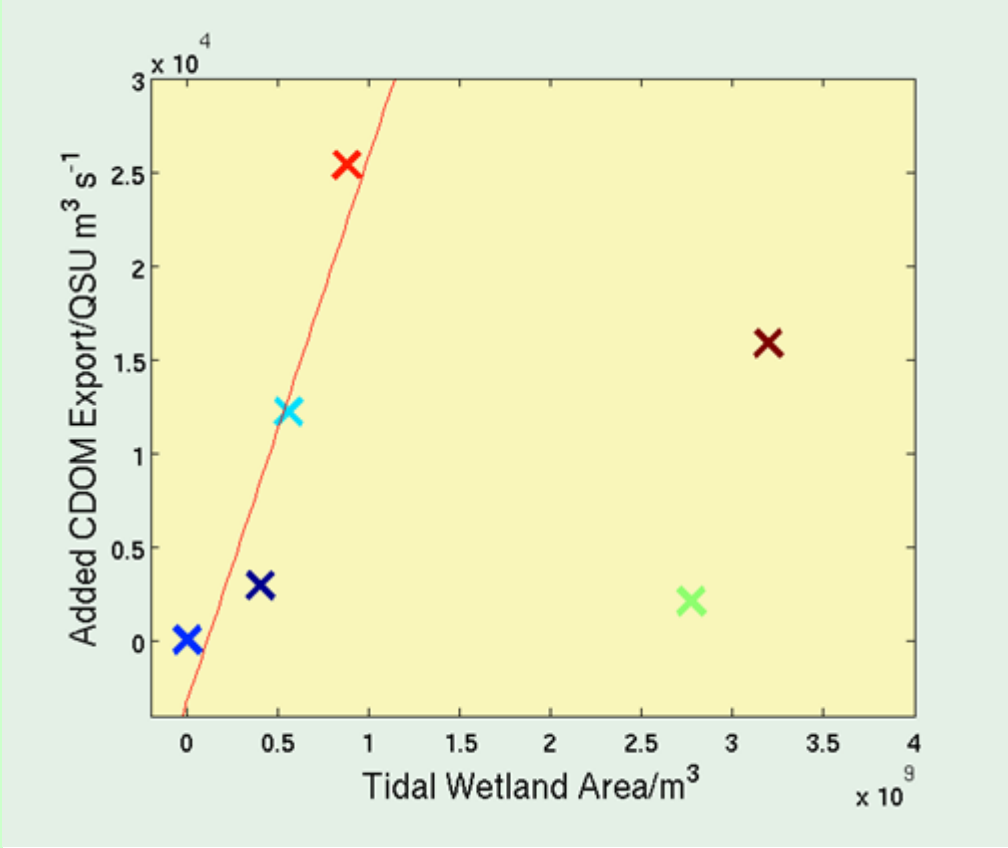
Neponset River



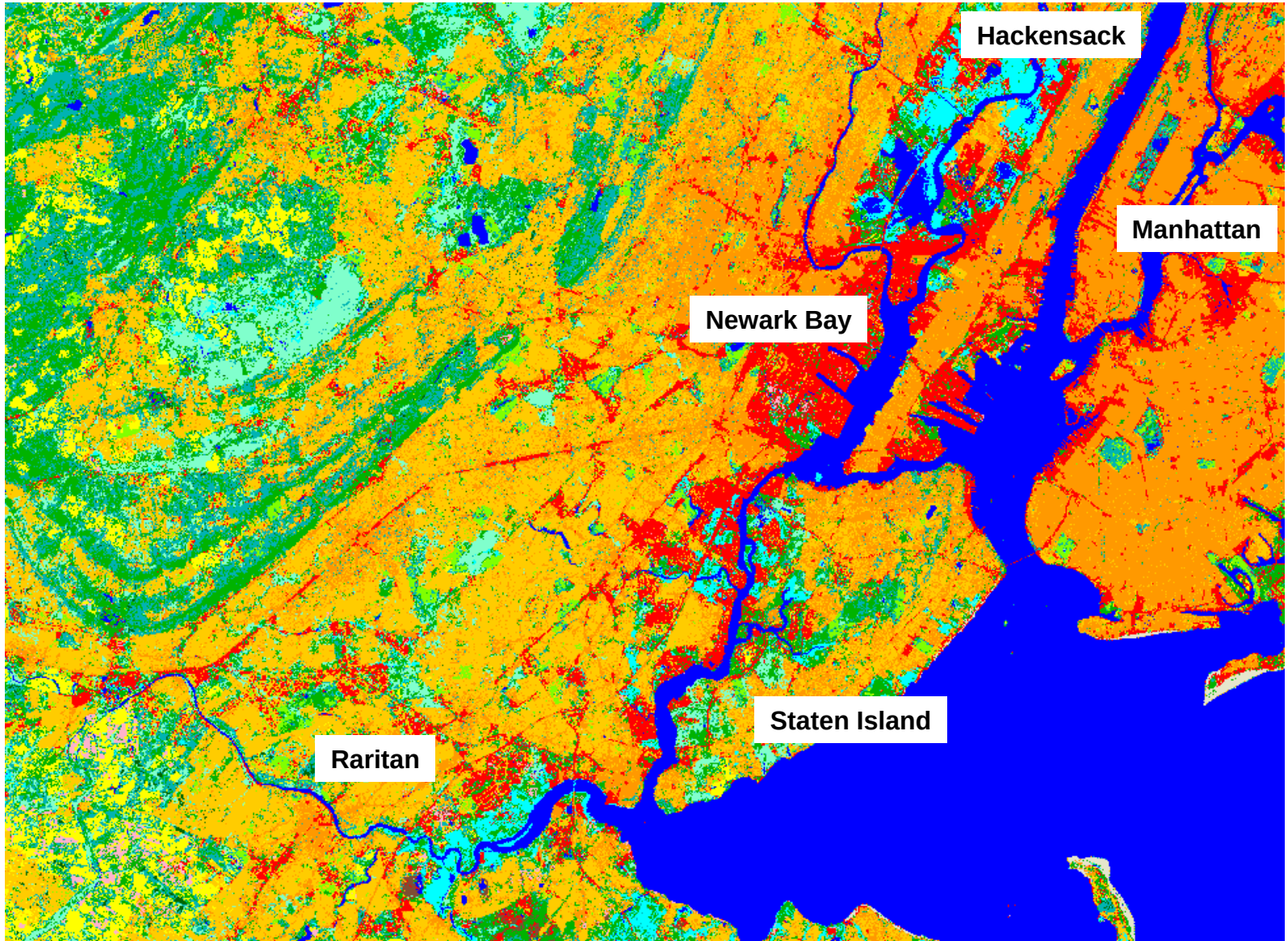


Tidal Wetland Derived CDOM Export

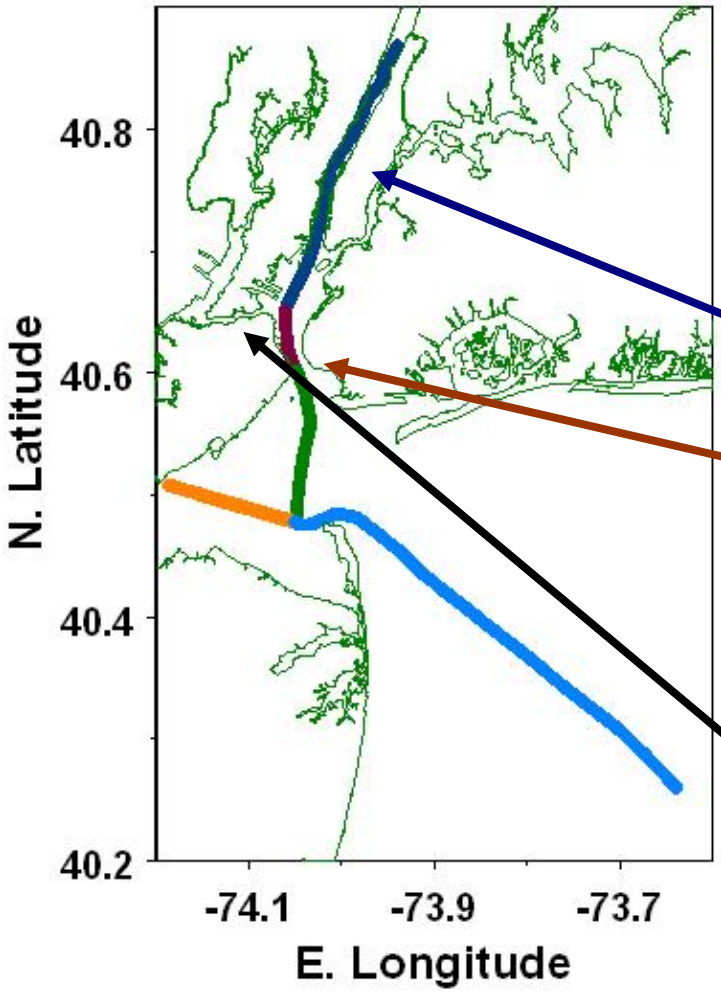
- Tidal wetlands contribute significantly to CDOM export.
  - Reflected in mixing curve where most of wetlands are in estuarine portion. (Neponset, San Francisco Bay, Hudson River, Mississippi River)
  - Fresh water tidal wetlands increase export without impacting the mixing curve. (Atchafalaya vs. Mississippi)
  - In large, complex estuarine systems, it is difficult to attribute export to specific sources. (Chesapeake Bay)

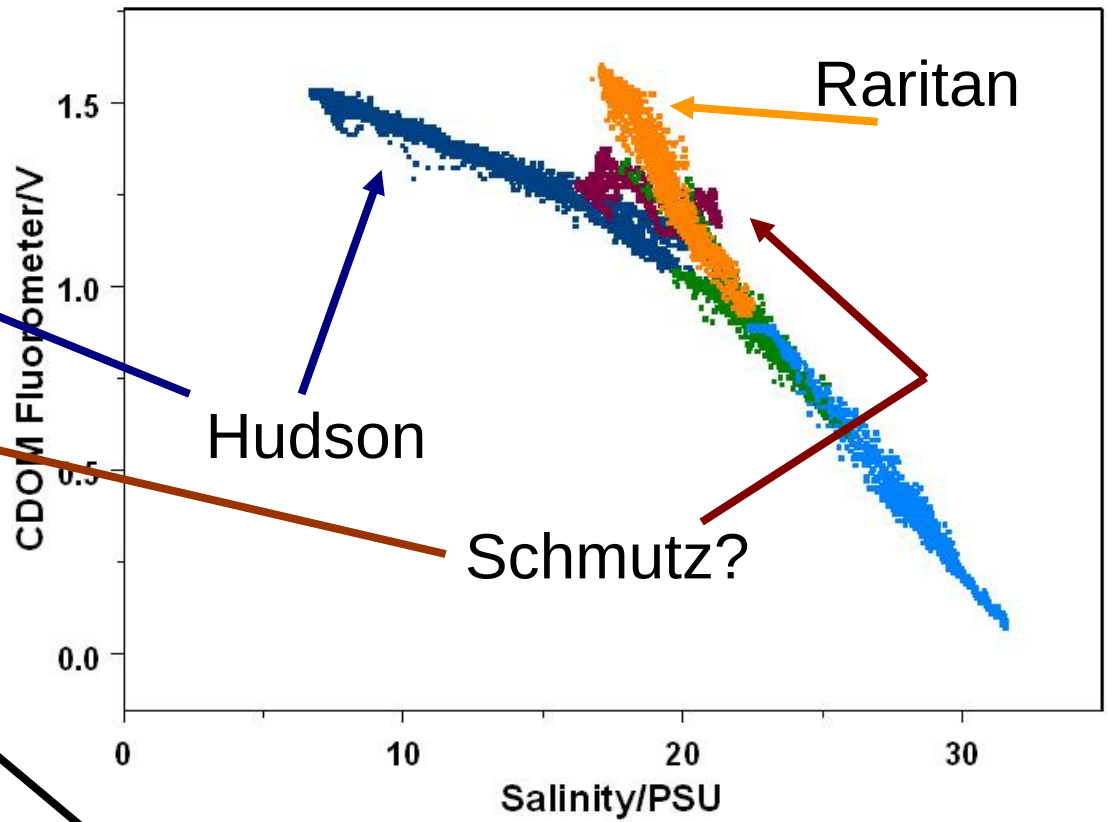


Hudson River Estuary



Hudson River Estuary
June, 2004





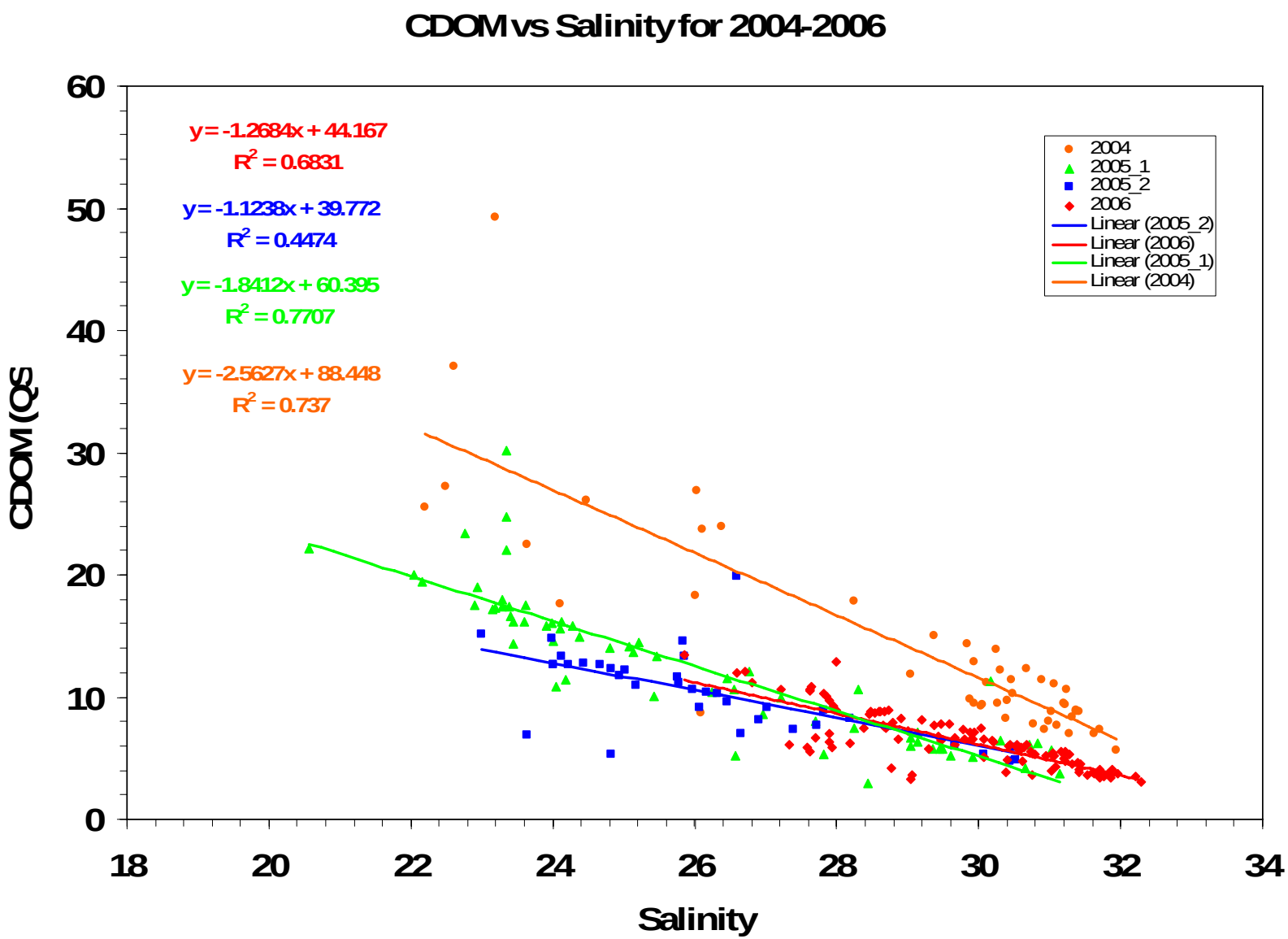
Raritan

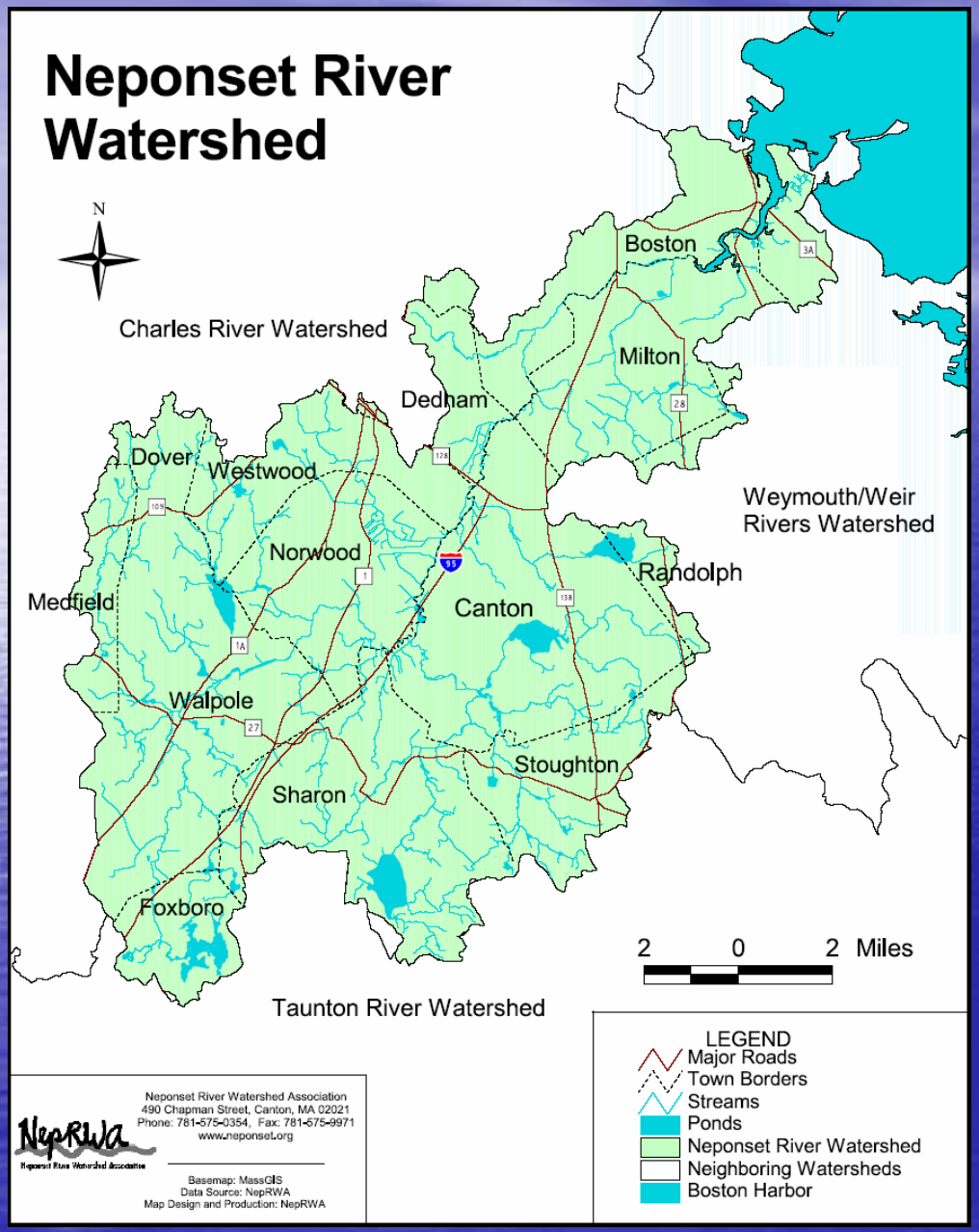
Hudson

Schmutz?

Port Richmond Sewage Outfall

2004-2006 Hudson Plume





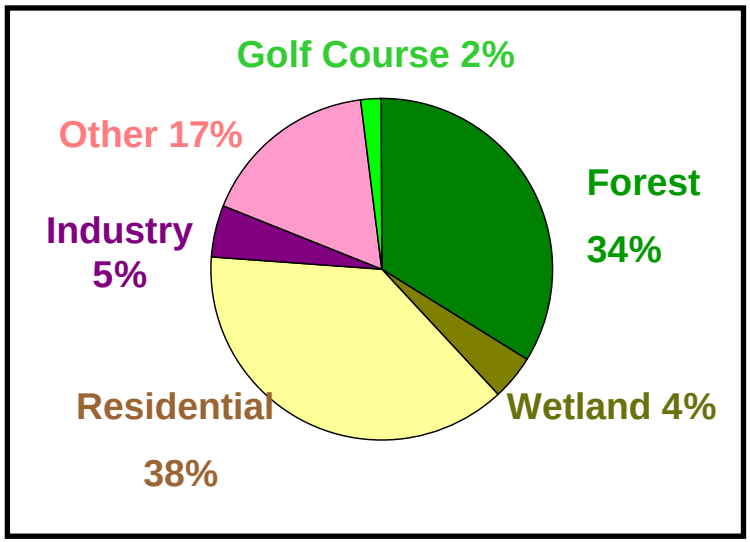
Neponset Watershed

- 250 km^2
- 14 cities and towns
- ~300,000 people
- 50 km long
- Freshwater flux is about 2 m^3s^{-1}, (<2-40 m^3s^{-1})

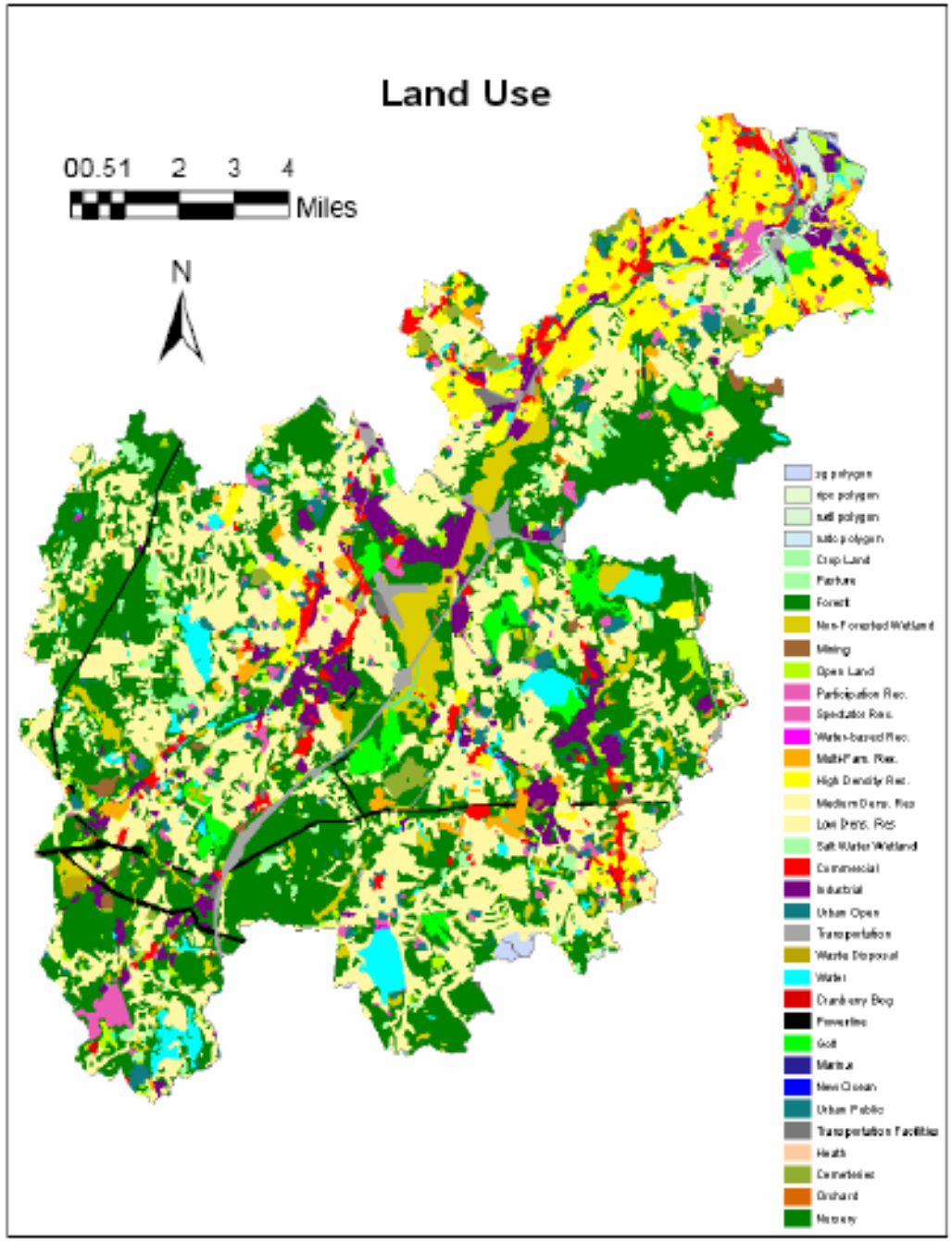
(Source: NepRWA)

Land Cover

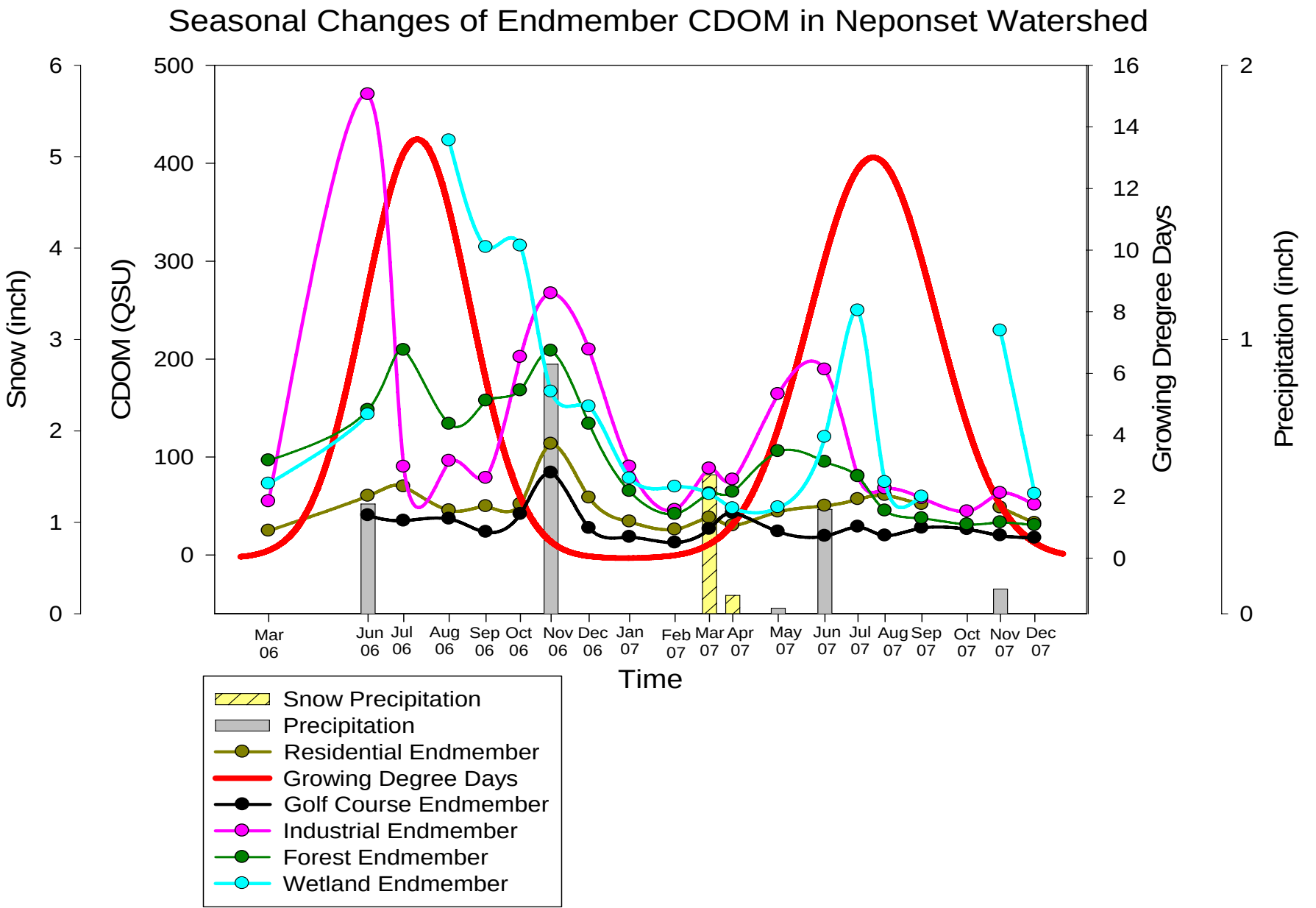
- — Forest
- — Residential
- — Wetland
- — Industry
- — Golf course



Data Source: Mass GIS



Two-year Data



Summary

- CDOM is generally conservative
  - Chesapeake, San Diego, Mississippi
- Non-linear relationships suggest in situ production
  - Wetlands-Neponset, Achafalaya, Plum Island
  - Sewage-Hudson
- Freshwater endmembers depend on watershed characteristics
  - Rainfall, season, land use
- Remote sensing and hydrodynamic modeling allows prediction of CDOM in coastal waters