NITROGEN LOADING FROM A LARGE SOUTH ATLANTIC WATERSHED DRIVES A COASTAL ZONE OF ENHANCED BIOLOGICAL PRODUCTION

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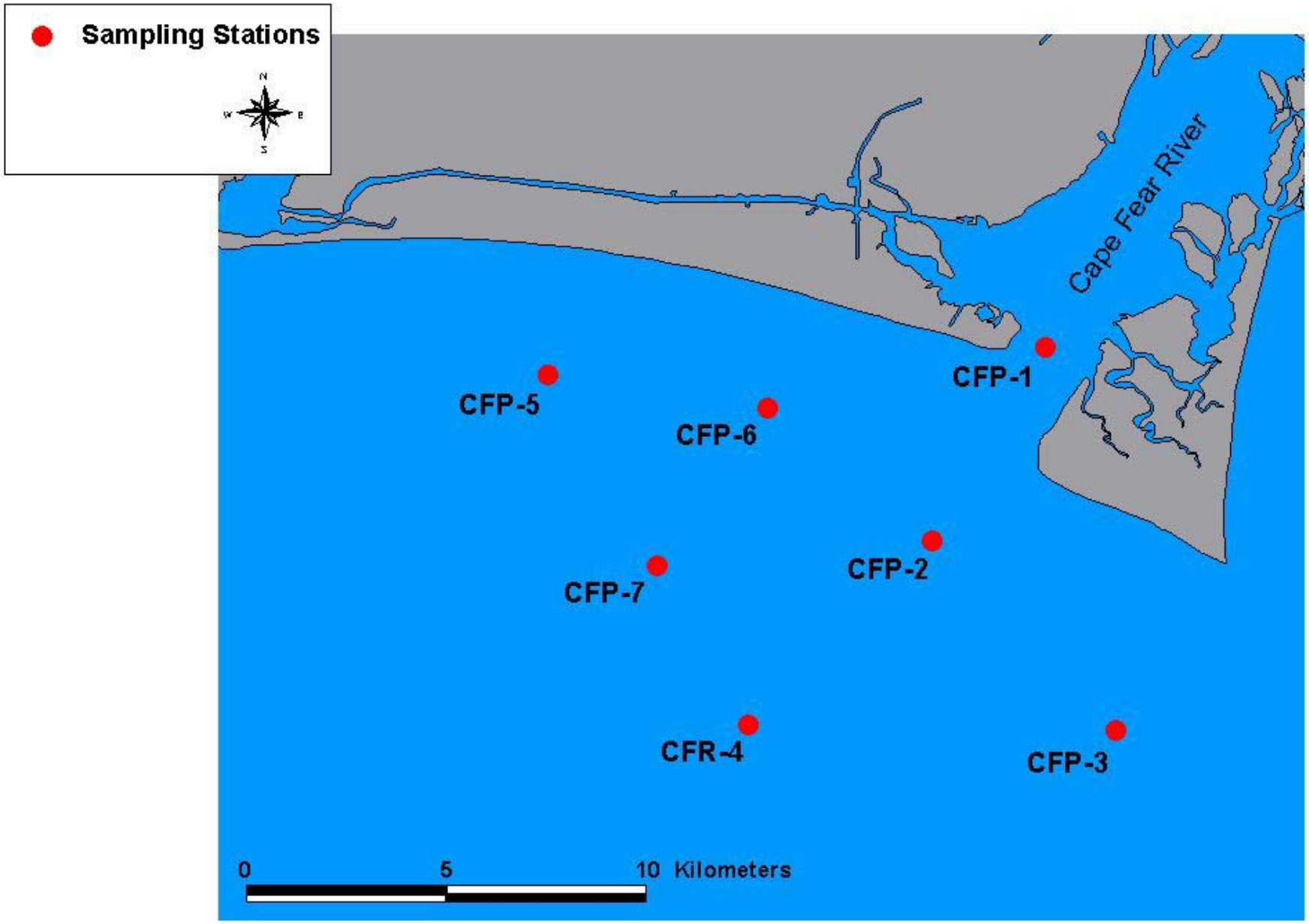
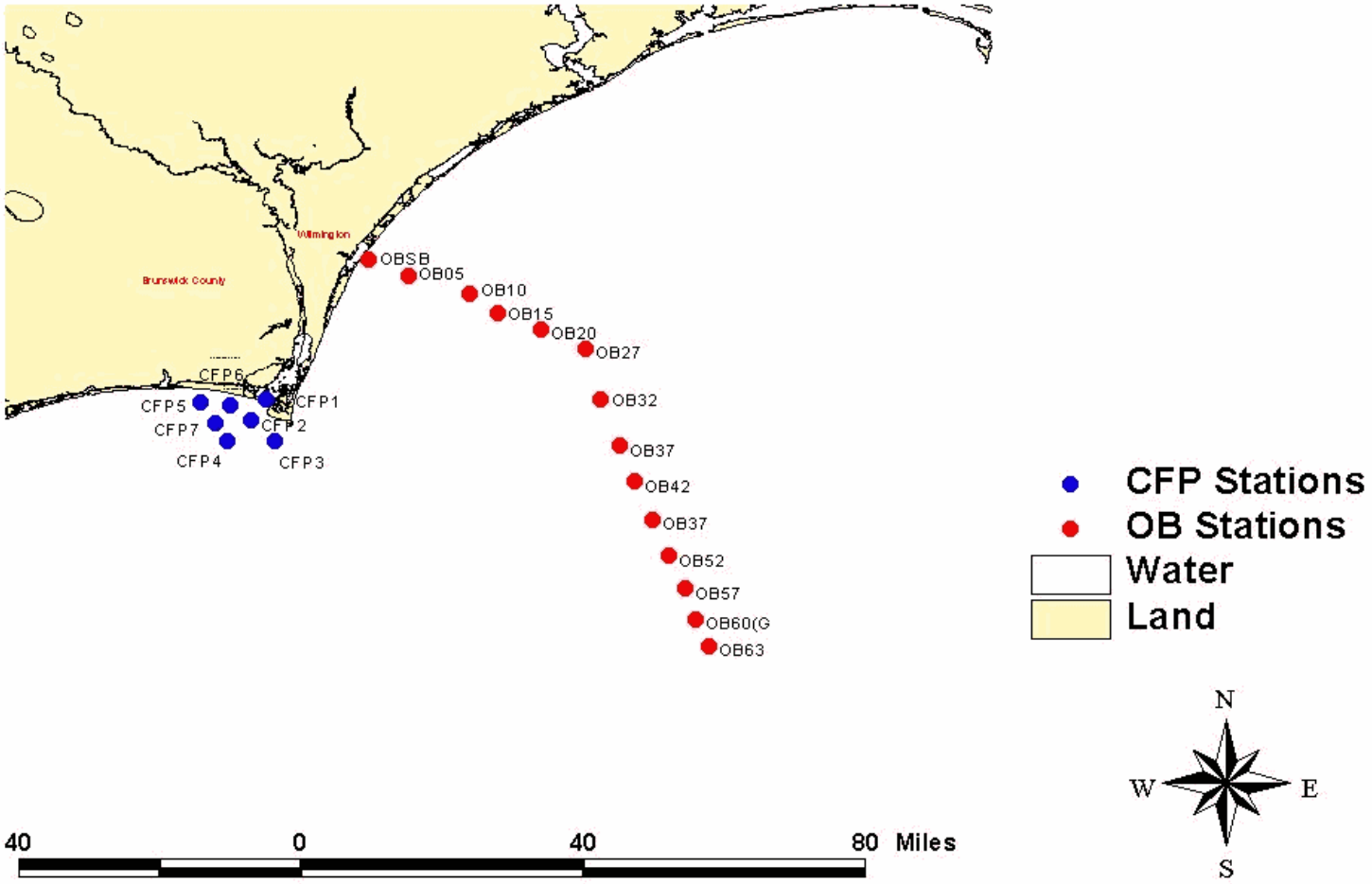
CORMP - UNC Wilmington
Coastal Ocean Research and Monitoring Program

- A nearshore and offshore program - Initiated January 2000
- Funded by NOAA
- Conduct sampling cruises to ten stations located in the lower CFR estuary and coastal ocean in and outside of the plume (Long Bay) and offshore (Onslow Bay)
- Sample DO, salinity, turbidity, solar irradiance, chlorophyll, nitrogen, phosphorus, silicate, zooplankton, benthos
- Assess seasonal patterns of water quality and benthos within the plume influence area
- Perform regression/correlation analyses to determine meteorological and hydrological influence on the plume and its chemistry

UNCW-COMP Plume Sampling Stations



UNCW/NOAA Coastal Monitoring Program



AVERAGE SURFACE PARAMETER LEVELS
LONG BAY versus ONSLOW BAY

	LB plume	LB control	OB5	OB27	OB63
Chlor *a* (µg/L)	3.1	1.9	0.42	0.10	0.12
Nitrate (µM)	1.36	0.65	0.11	0.24	0.41
Amm. (µM)	1.08	0.92	0.30	0.70	0.84
Kd / m	0.68	0.64	0.23	0.14	0.16
Depth	10 m	10 m	15 m	27 m	110 m
Distance	7 km	7 km	8 km	45 km	100 km

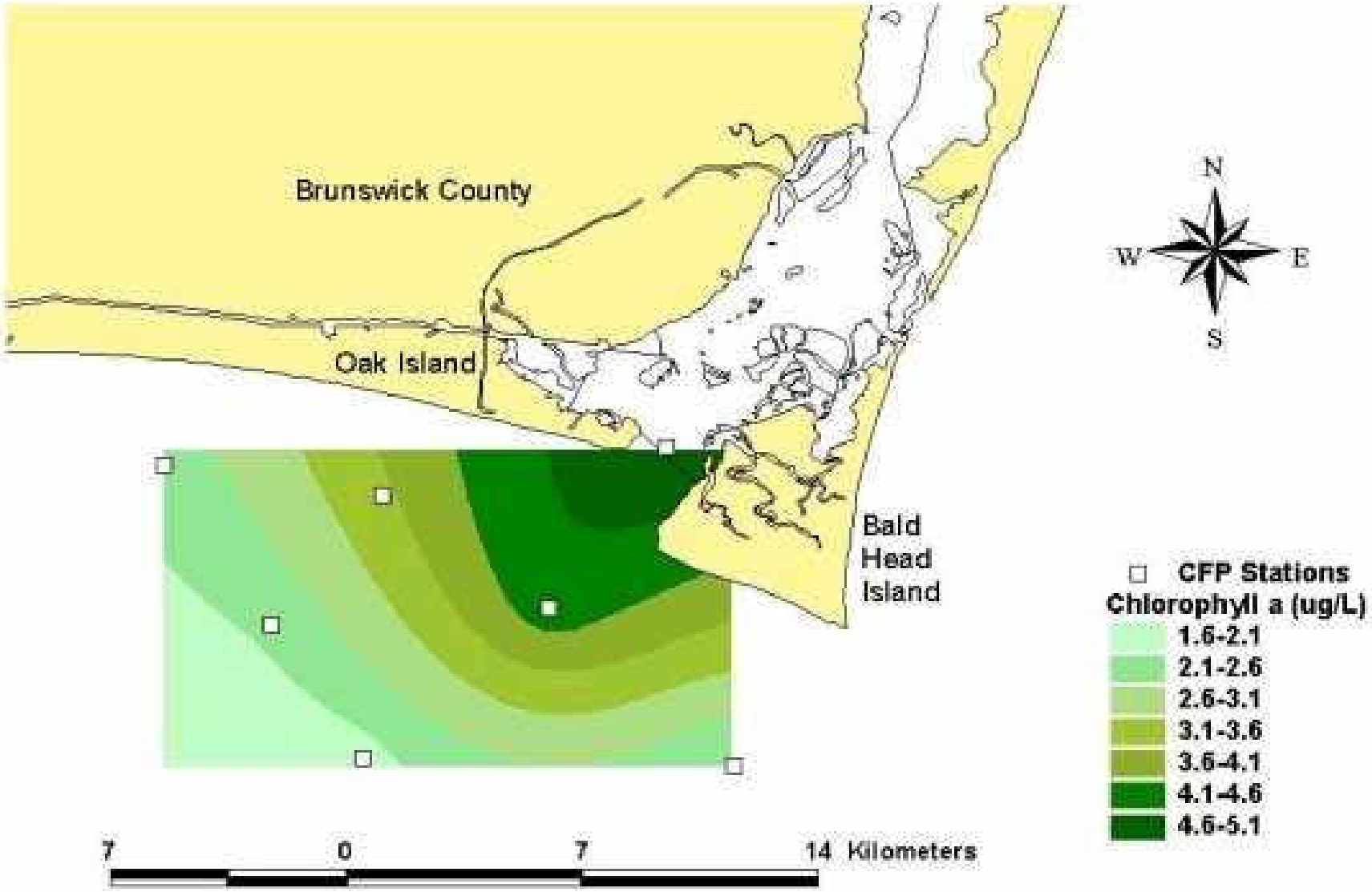
CORRELATION ANALYSES
ALL PLUME STATIONS COMBINED

- Light attenuation coefficient k_d positively correlated with turbidity, and to a lesser intent with chlorophyll *a*
- Salinity negatively correlated with all nutrients
- River flow (measured at a station 105 km upstream) is positively correlated with nitrate, TN, and Si. River flow (lagged 14 days) correlated with chlorophyll *a* - contrasts with the estuary where flow is negatively correlated to chlorophyll *a*

CORRELATION ANALYSIS
SPATIAL EFFECTS

- **OUTER STATIONS** - Positive correlation between river flow and nitrate, total nitrogen, and K_d (but these relationships non-significant for inner station CFP1 and control station CFP3)
- **TURBIDITY** – At most stations positive correlations with K_d, total P, and with chlorophyll *a* at three stations
- **CHLOROPHYLL *A*** – at CFP1, CFP3, CFP4 and CVP5 correlated with river flow (lagged)

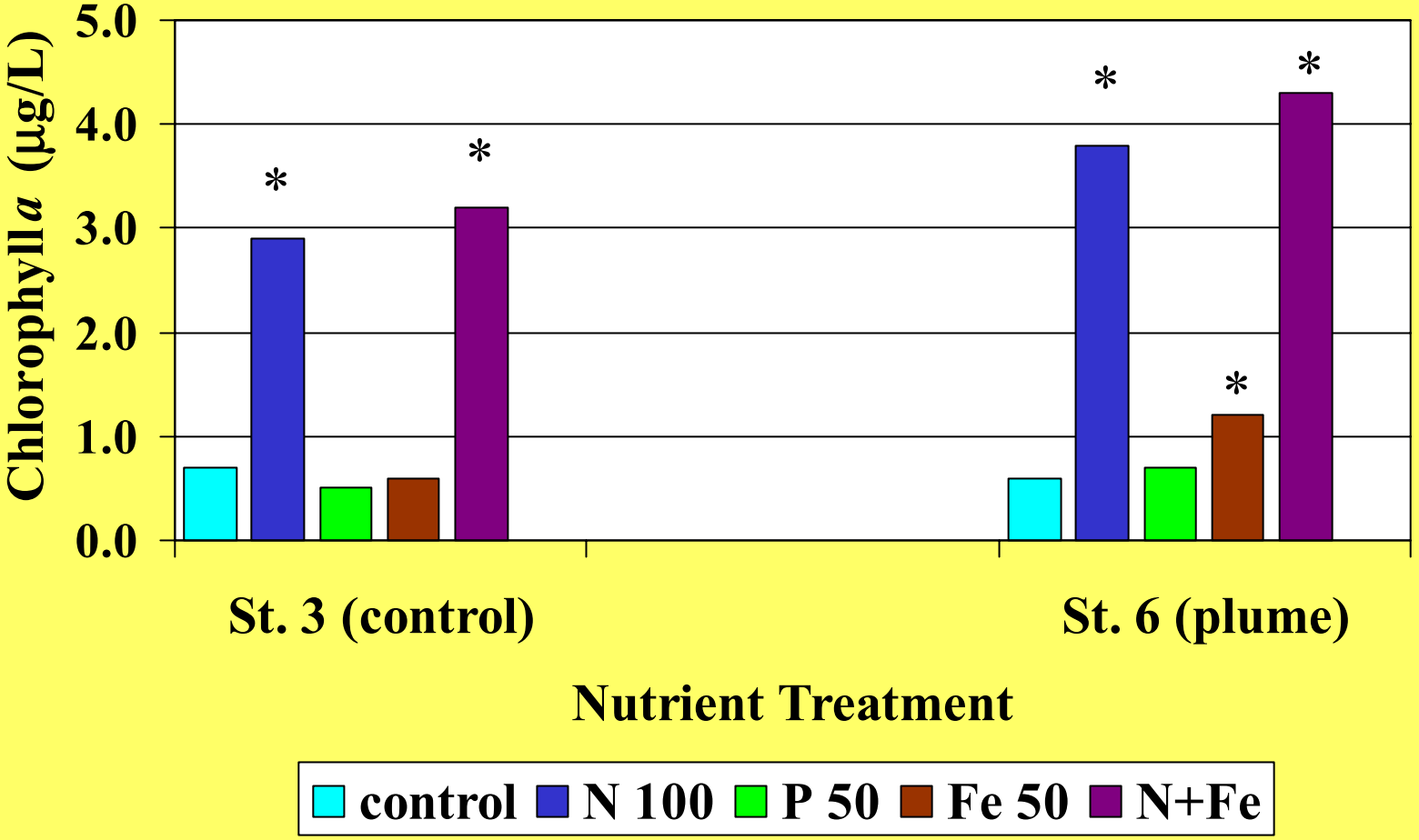
UNCW/NOAA Coastal Monitoring Program



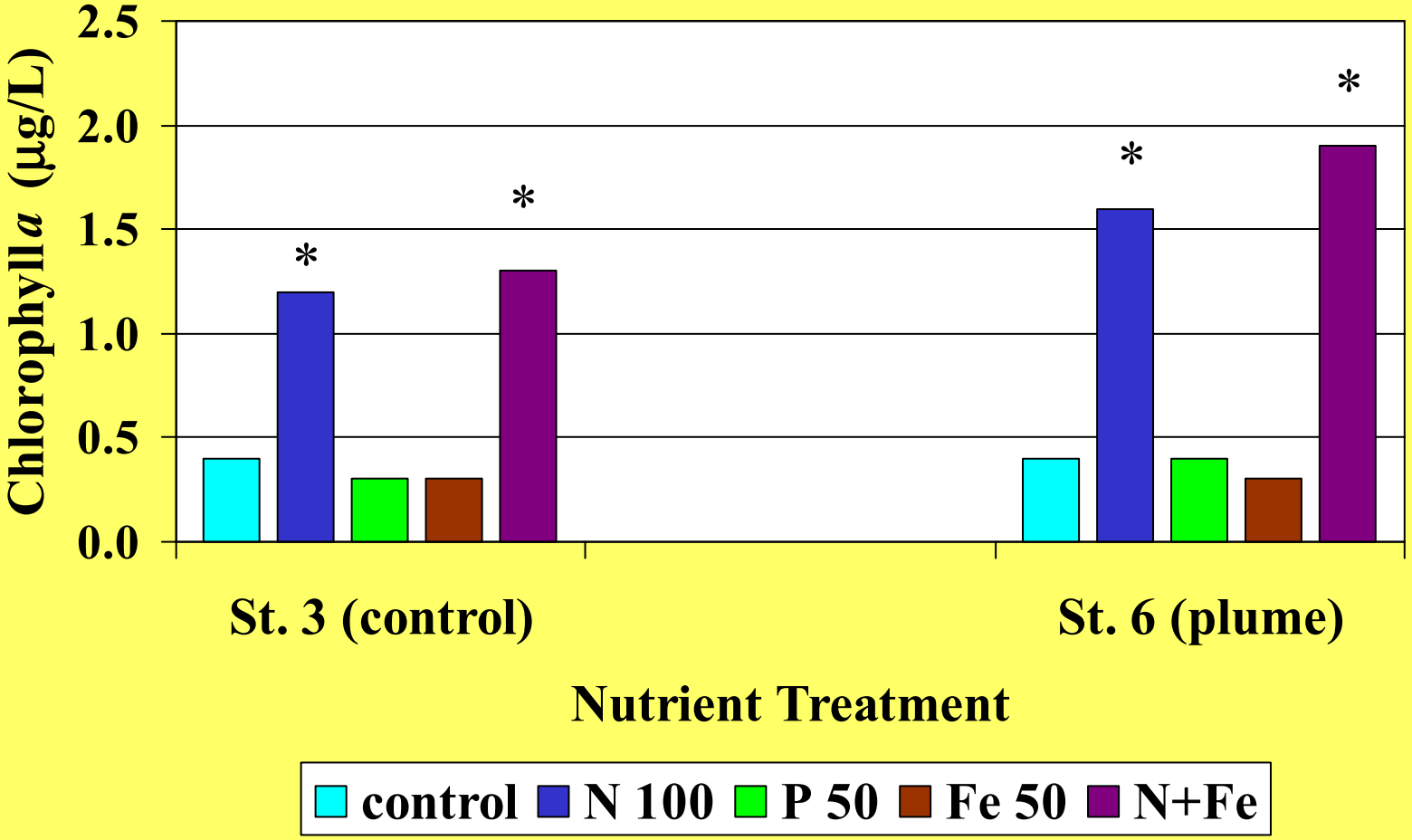
BIOASSAY METHODS

- Seawater was collected in 20-L carboys at plume-influenced (Station 6) and control (Station 3) locations
- Water was placed in triplicate 4-L cubitainers with nutrient treatments added
- Treatments were nitrate-N (100 μg/L or 7 μM), phosphate (50 μg/L or 1.6 μM), iron (50 μg/L or 1 μM) nitrate+iron, nitrate+phosphate, and control of no additions
- Incubated for 3 days in outdoor pool under 50% irradiance reduction neutral density screening
- Sampled daily for chlorophyll *a* production
- Experiments conducted in summer and fall 2002 and spring and summer 2003

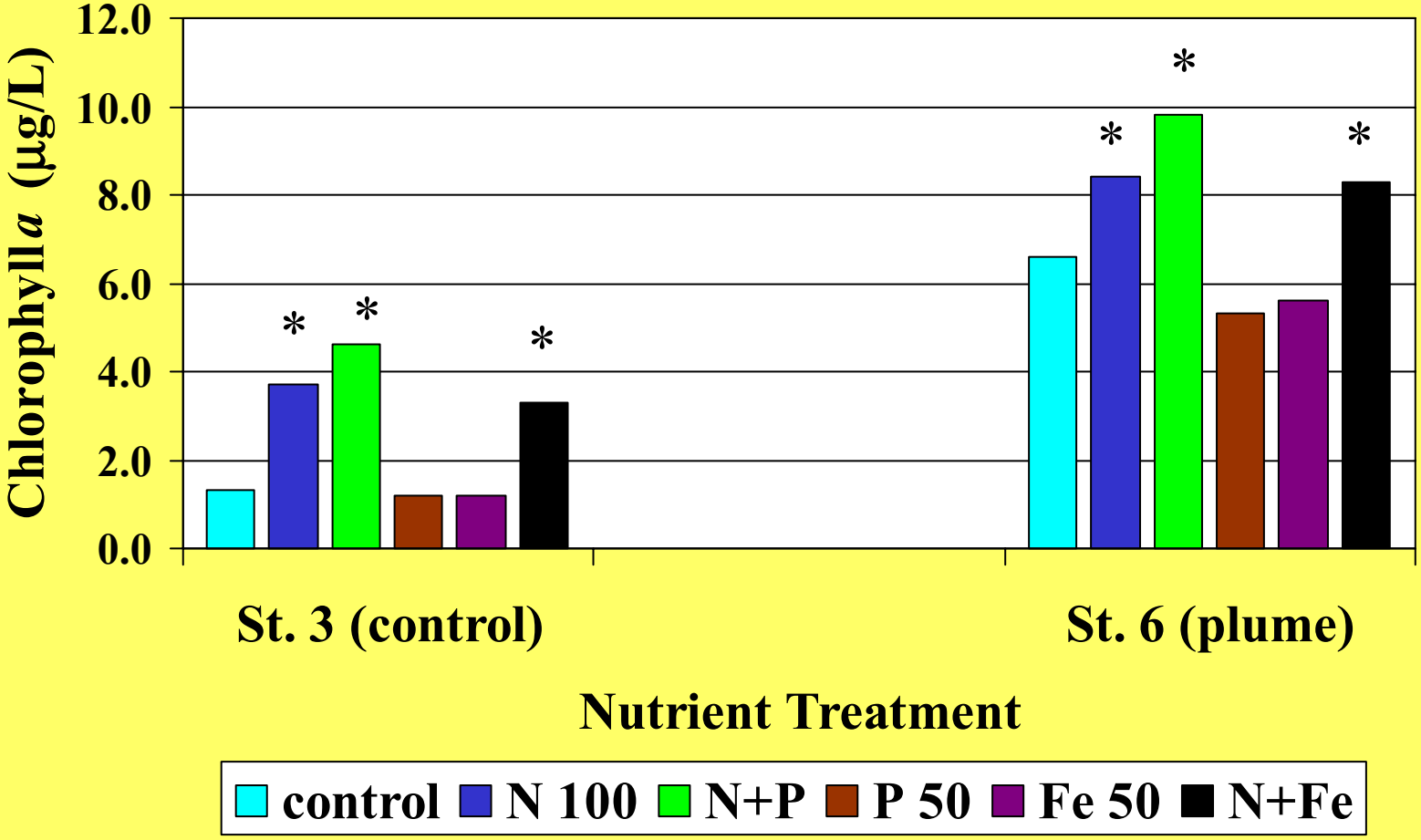
Cape Fear Plume Nutrient Limitations Experiment July 2002



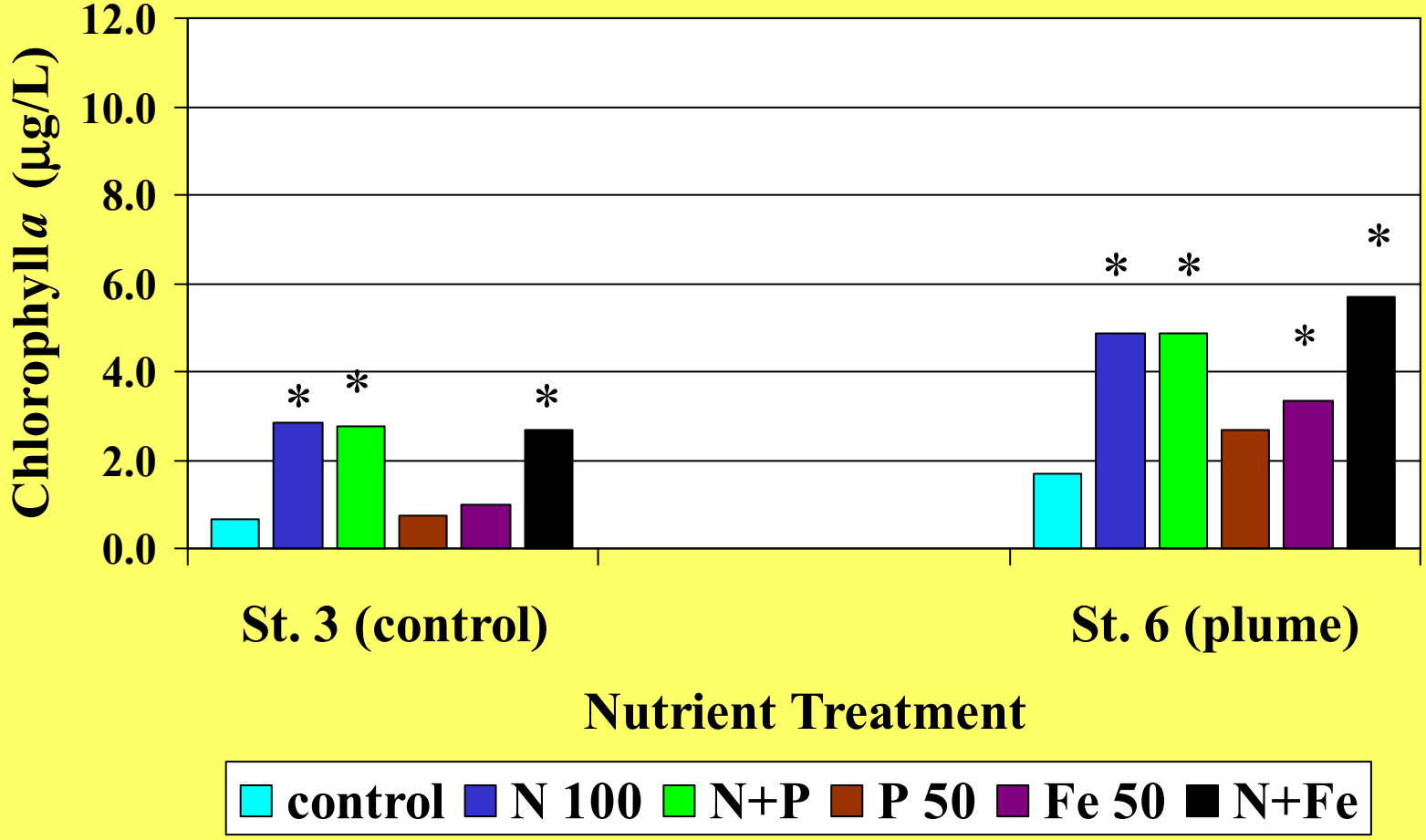
Cape Fear Plume Nutrient Limitation Experiments August 2002



Cape Fear Plume Nutrient Limitation Experiments March 2003



Cape Fear Plume Nutrient Limitation Experiments June 2003



BIOASSAY RESULTS

- During most experiments both stations showed nitrate stimulation of chlorophyll *a*
- Most experiments also showed N+Fe stimulation – at times this was > than N alone, as was N+P stimulation
- Iron alone showed significant stimulation on two occasions in the plume, although much less than nitrate stimulation (2 of 12 bioassays, 2002-2003)
- Chlorophyll *a* yield in the plume water was always greater than chlorophyll *a* yield in control station water

IMPLICATIONS

- **Chlorophyll *a* yield in modest (100 μg/L or 7 μM) nitrate treatments ranged up to 7X control, demonstrating potential of short-term enrichment of the food chain base following a nitrogen pulse**
- **Cape Fear Estuary has a median flushing time of 7 days, and only 5-9% of annual N load is removed within the estuary (Ensign and Mallin in press); vast majority enters coastal ocean (6.5 kg N/day)**
- **Nitrogen at outer plume stations significantly correlated with river flow**
- **Watershed rainfall and river flow may exert significant control over the plume as a plankton-rich area, through nitrate delivery**

Benthic Faunal Sampling

- Benthic Infauna:
  - Sampled at 5 stations (corresponding to water quality stations) in plume region ranging from areas seldom influenced to predominantly river dominated
  - Comparative data available from 2 offshore stations plus long-term historical sampling in nearshore coastal shelf
  - Also ongoing data available from lower and mid estuarine stations (Lower Cape Fear River Program)
  - Sampled seasonally over years using standard grab sampling
- Nekton
  - Trawl comparisons of blue crab use of plume versus lower estuary as spawning areas
  - Trawl and epibenthic sled studies of juvenile crab and epibenthos use of plume, adjacent coastal ocean, and lower estuarine regions
  - Larval surveys

Plume Area Benthos

- **Epibenthos**
  - **Plume region is an area of high juvenile blue crab abundances (both *Callinectes sapidus* and *Callinectes similis*)**
  - **Spawning area for *C. sapidus* and *C. similis*, with especially high abundances of *C. similis***
- **Infauna**
  - **Highly variable community structure in innermost stations, reflecting variations in riverine effects**
  - **Mid stations dominated by a mix of taxa that are common in the lower estuary and taxa common offshore**
  - **Plume stations characterized by higher per individual biomass than coastal ocean stations**

The Cape Fear River Plume and the Food Web

- The plume normally maintains higher chlorophyll *a* concentrations than nearby non-plume areas, and far higher levels than nearby coastal ocean areas with no river influence (Onslow Bay)
- Experiments suggest that pulses of flow-driven nitrate can rapidly increase chlorophyll abundance by several-fold
- Abundances of certain epifauna are greater in the plume, while infaunal biomass / individual is greater in the plume's influence – likely reflecting increased food availability
- The Cape Fear River plume may serve as a localized region to both attract grazers and predators and increase their chances of survival