



**Chlorophyll algorithms for
coastal remote sensing:**

**Rationale and perspectives from mesocosm
experiments and *in situ* observations
in productive inland waters
and Southeastern estuaries**

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FUNDING FROM: NASA, USDA, EPA, NOAA, UNIV. GEORGIA,
US-ISRAEL BINATIONAL SCIENCE FOUNDATION

OCEAN COLOR MINDSET

- **SINGING THE
BLUES & GREENS**
- **PHYSICS RULES**
- **BIG SPACES AND
BIG PIXELS**
- **SATELLITES
AND BIG BOATS**

INLAND WATERS MINDSET

- **SHADES OF GREEN,
BROWN, & MORE**
- **WATERSHEDS RULE**
- **WATCH OUT FOR
MIXED PIXELS**
- **AIRPLANES AND
SMALL BOATS**

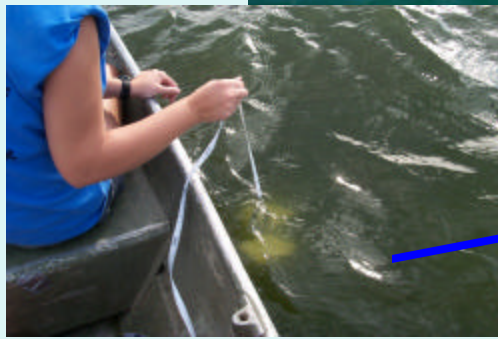
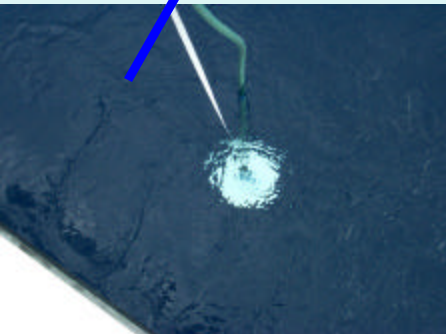
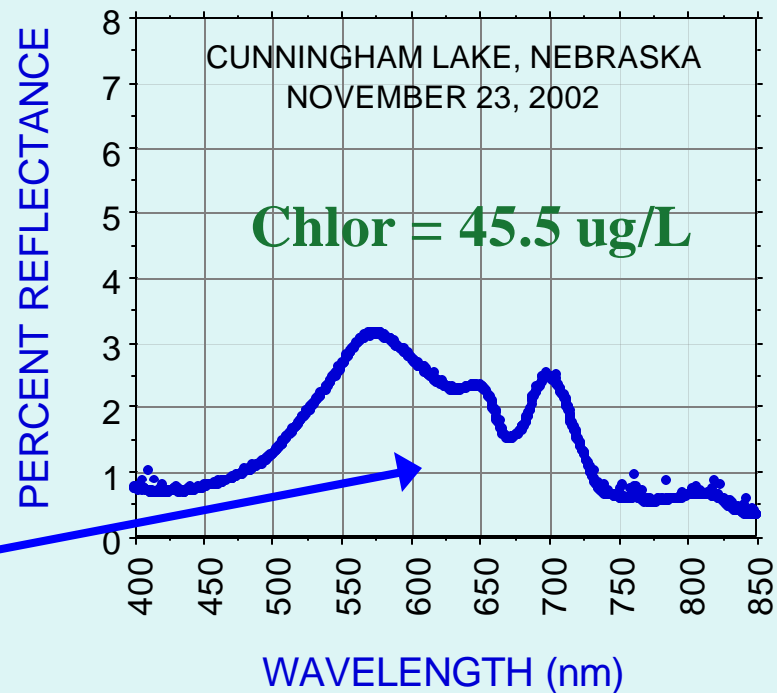
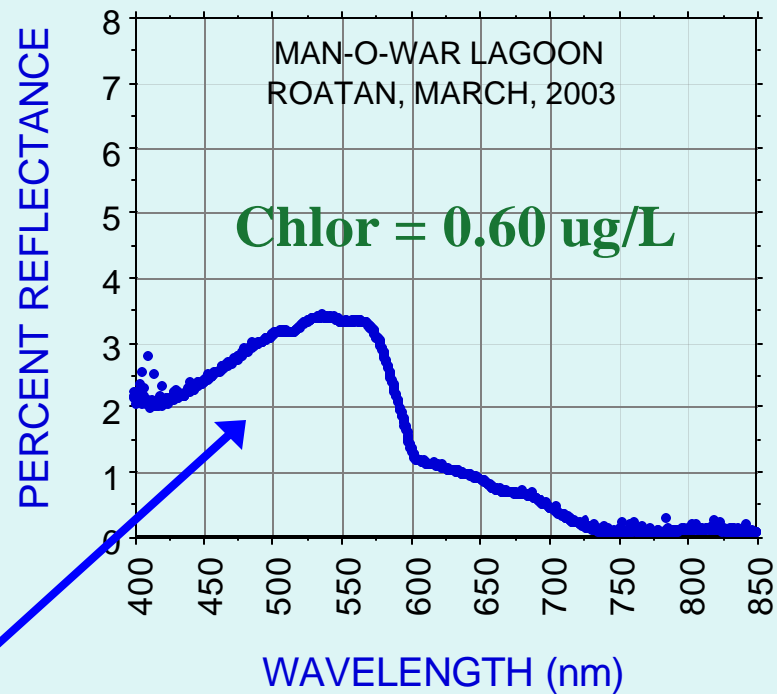
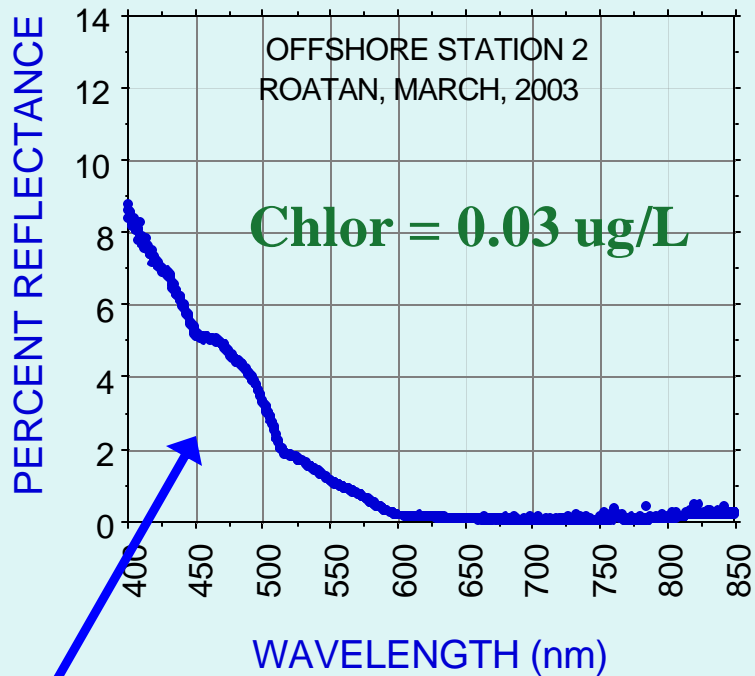
Roughly 98% of the world's oceans and coastal waters fall into the Case 1 category, and almost all bio-optical research has been directed toward these phytoplankton-dominated waters. However, near-shore and estuarine Case 2 waters are disproportionately important to human interests..... It is therefore likely that Case 2 waters will receive increasing attention in coming years.

-- Curtis Mobley, 1994. Light and Water: Radiative Transfer in Natural Waters. Academic Press, p. 97.



**AS YOU MOVE INLAND,
THINGS CAN GET
REAL DIFFERENT**

**GOOSEBERRY FALLS
NORTH SHORE OF LAKE SUPERIOR**





FIELD SPECTROSCOPY

TANK MESOCOSMS

- SPECTRON SE590
(BOOM MOUNTED)
- SPECTRALON PANEL
- PLANKTON ENRICHMENT
OR CLAY SLURRIES
- PUMPS/CIRCULATION

NATURAL SYSTEMS

- OCEAN OPTICS SE590
- FIBER OPTIC GUIDES
- SPECTRALON PANEL /
COSINE CORRECTED
SOLAR REFERENCE



USDA/ARS WATER QUALITY LABORATORY DURANT, OKLAHOMA

- TEN 80M³ TANKS
- BLACK WALLS
AND FLOOR
- ALGAL CULTURE
FACILITY

UNIV. OF NEBRASKA AGRICULTURE EXPERIMENT STATION MEAD, NEBRASKA

- SIX 10M³ TANKS
- TWO 20 M³ TANKS
- BLACK LINERS





WATER ANALYSIS

CHLOROPHYLL *a*

- FILTRATION
- GRINDING WITH 90% ACETONE
- SPECTROPHOMETRY
- ACCESSORY PIGMENTS WITH HPLC

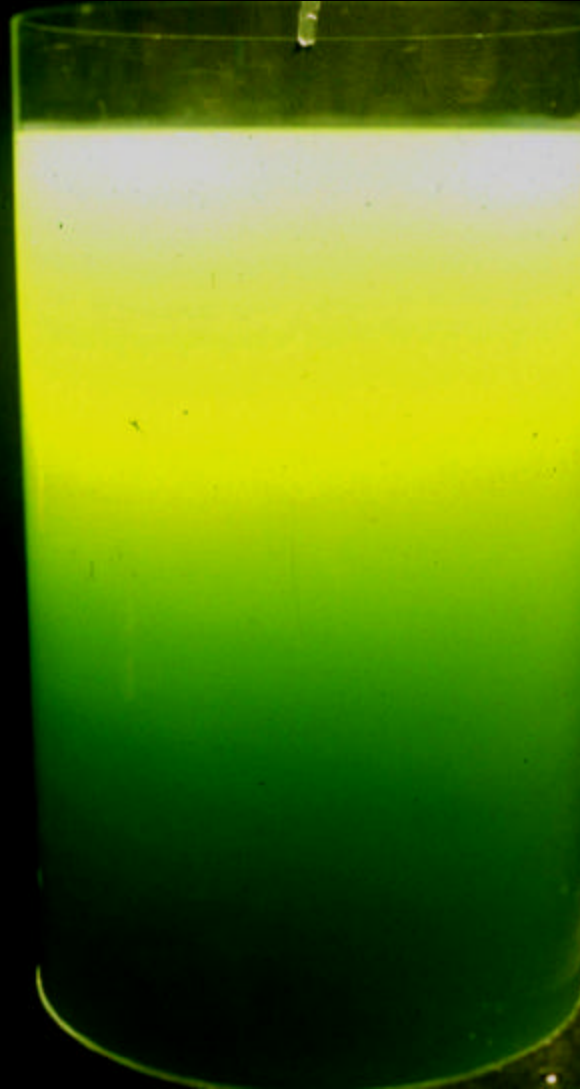
SESTON

- GRAVIMETRIC
- ASHING FOR % ORG

CDOM

- UV ABSORBANCE
- CARBON ANALYZER

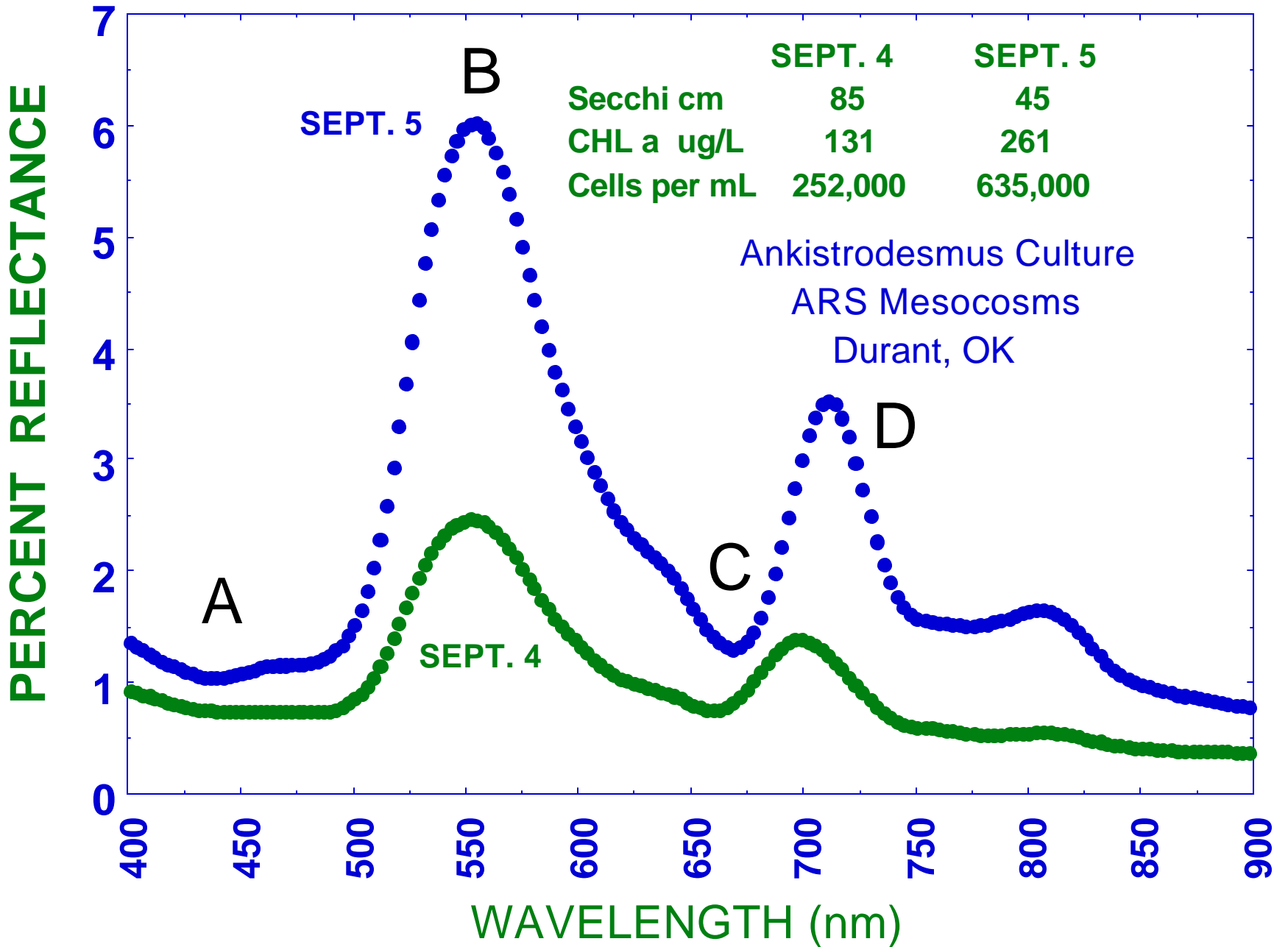
Illumination from above

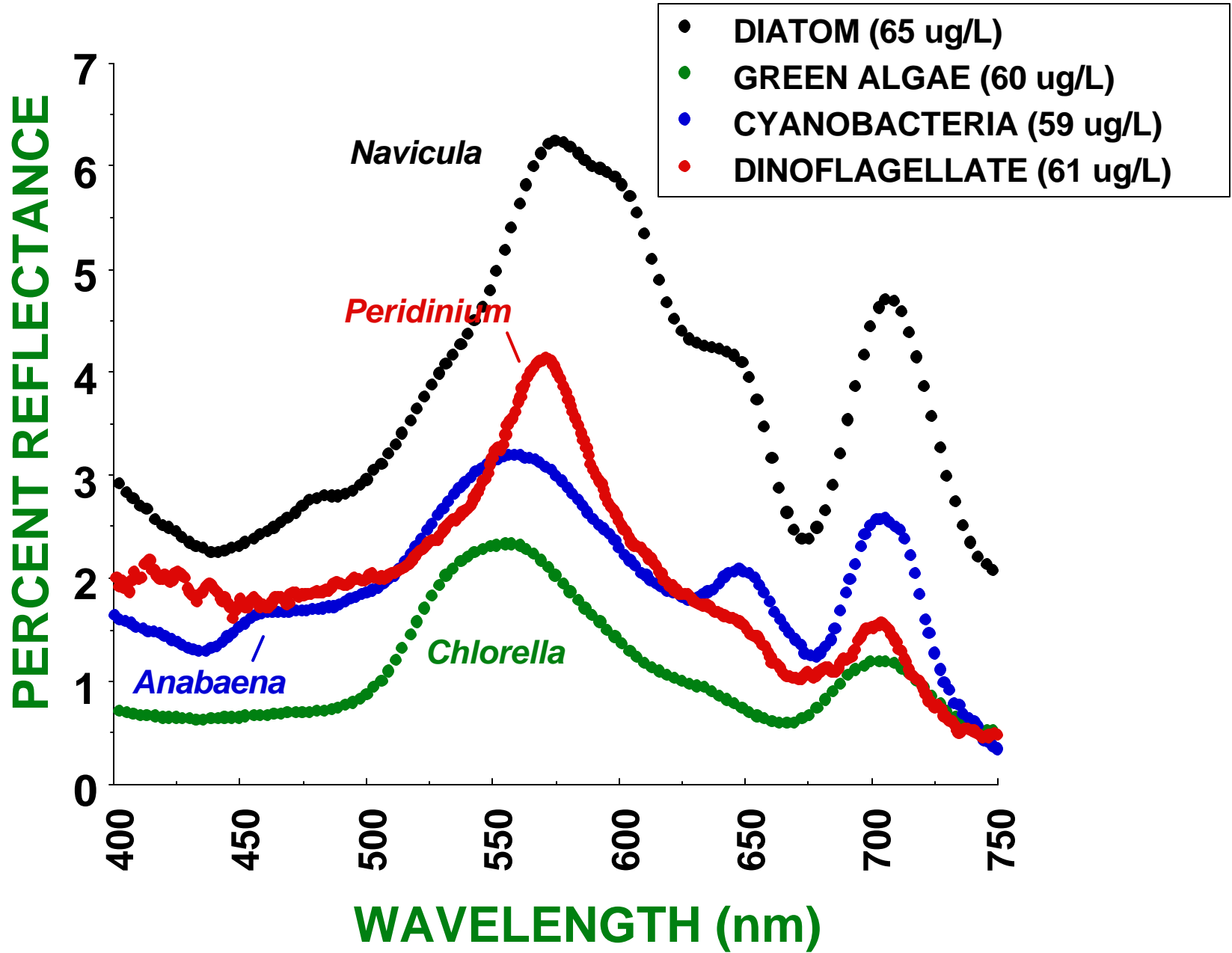


Plastic
container
with
high
algal
density
(Schalles
& Schiebe)

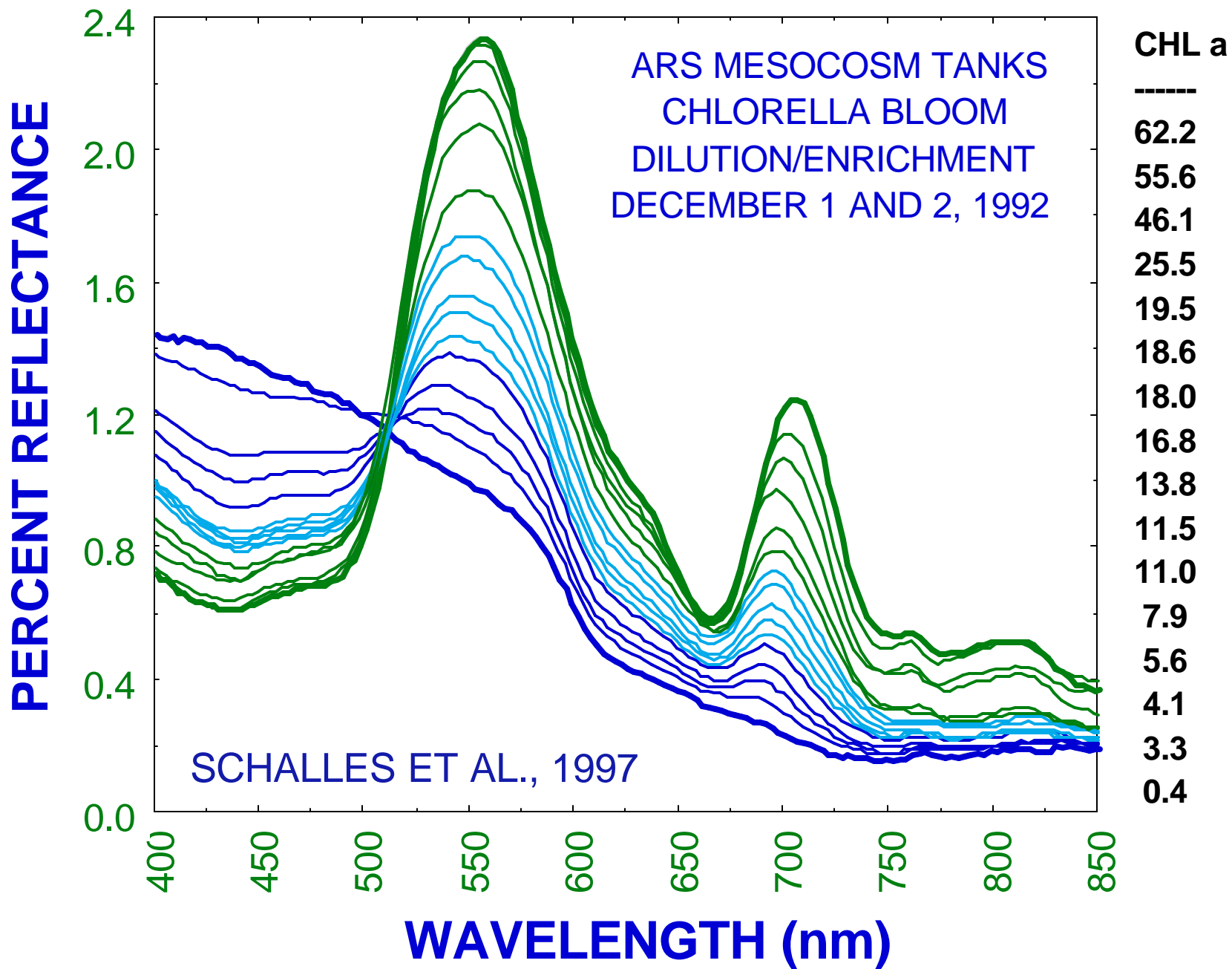


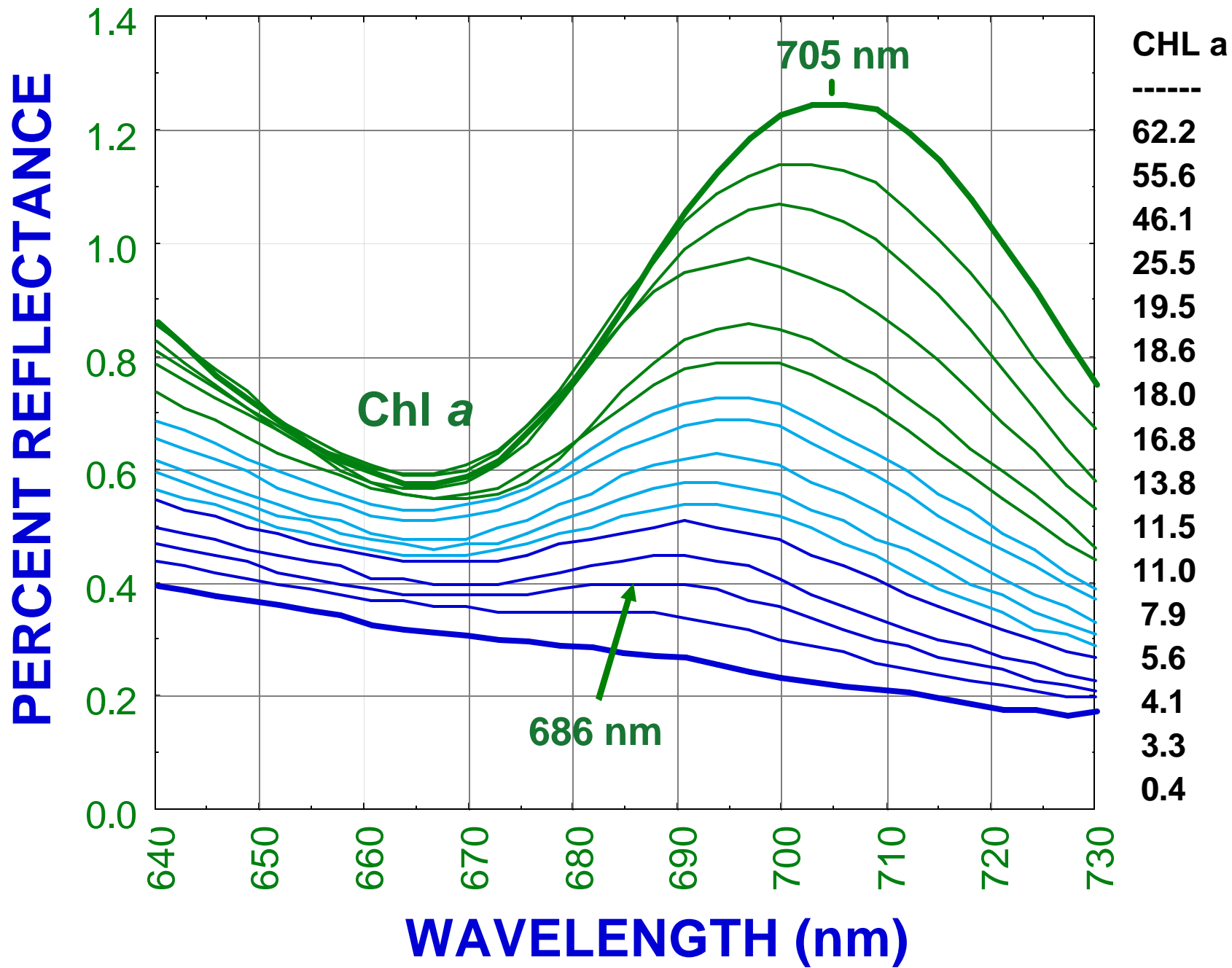
Increasing
attenuation
from
light
scattering
and
absorption





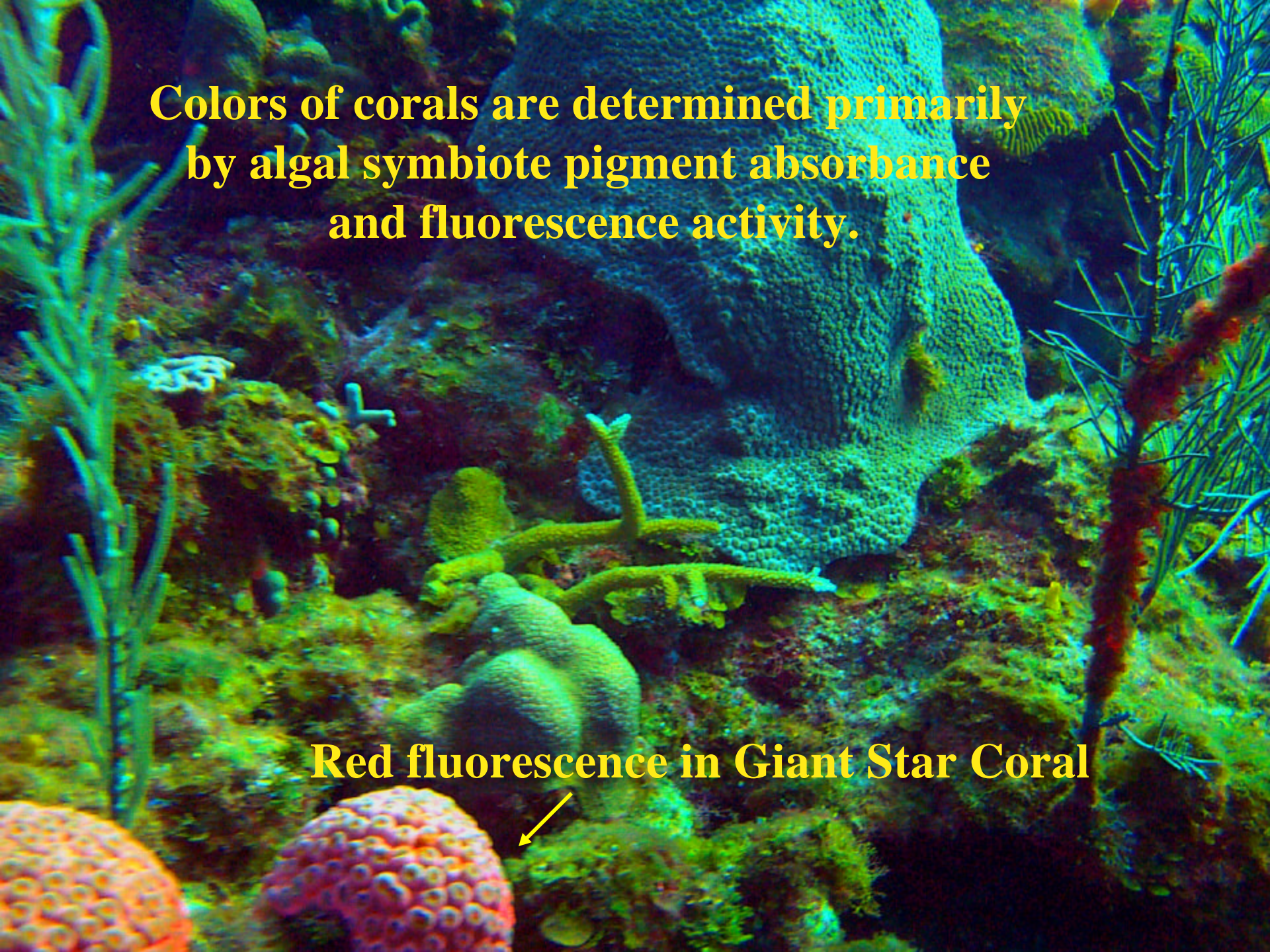




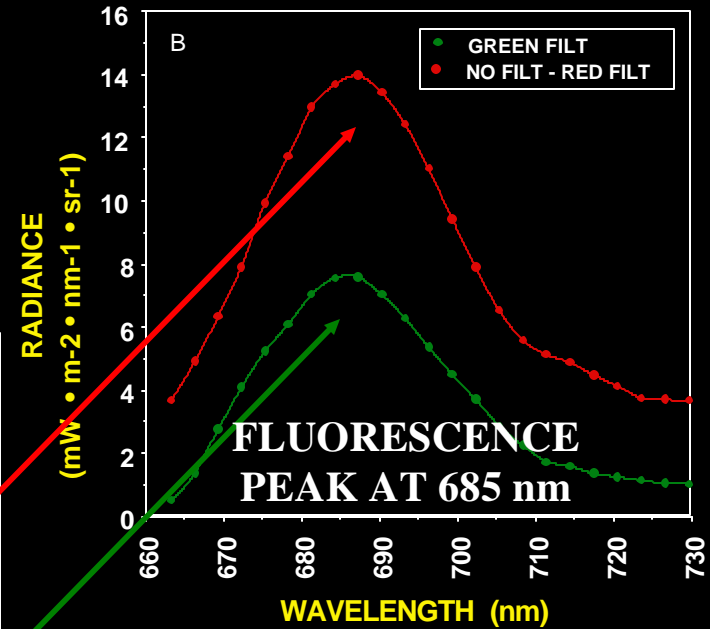
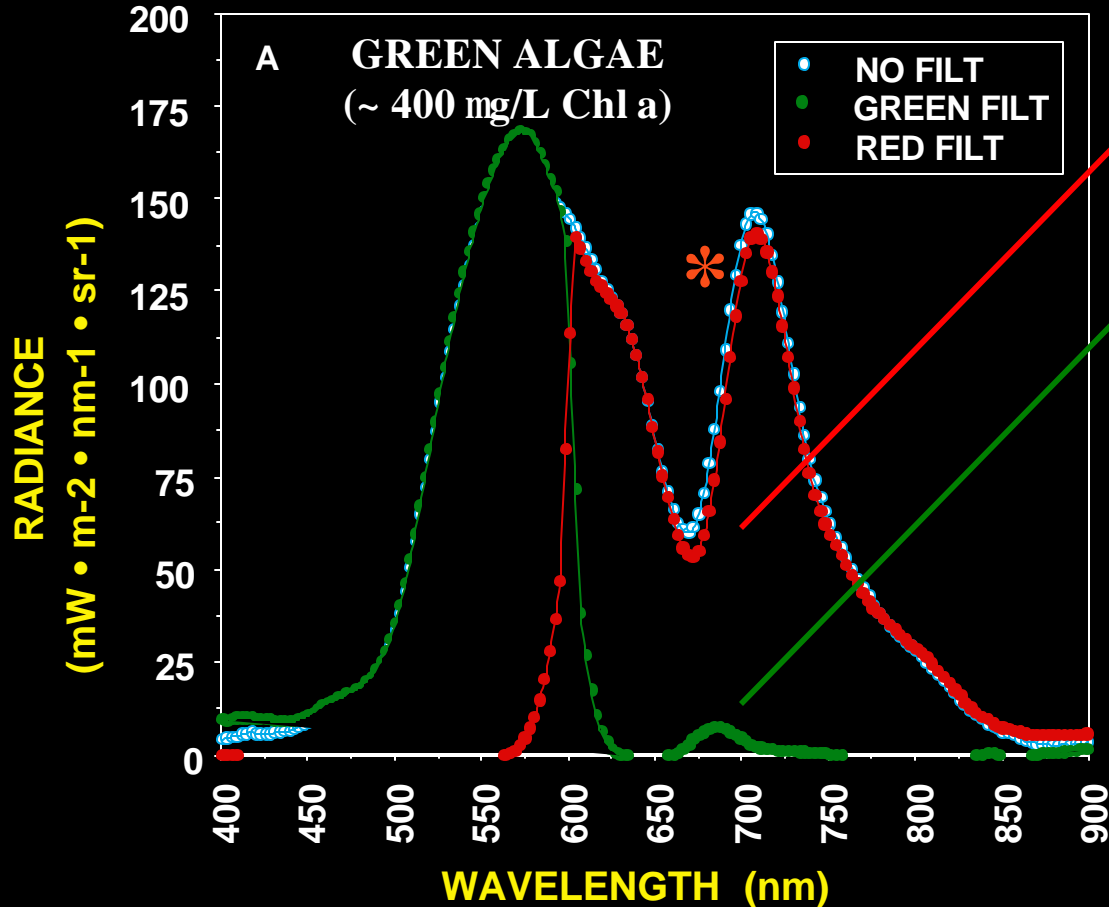


Colors of corals are determined primarily by algal symbiote pigment absorbance and fluorescence activity.

Red fluorescence in Giant Star Coral



* THE NIR PEAK (near 700 nm)
IS THIS FEATURE
FLUORESCENCE OR
SCATTERING (OR BOTH)?



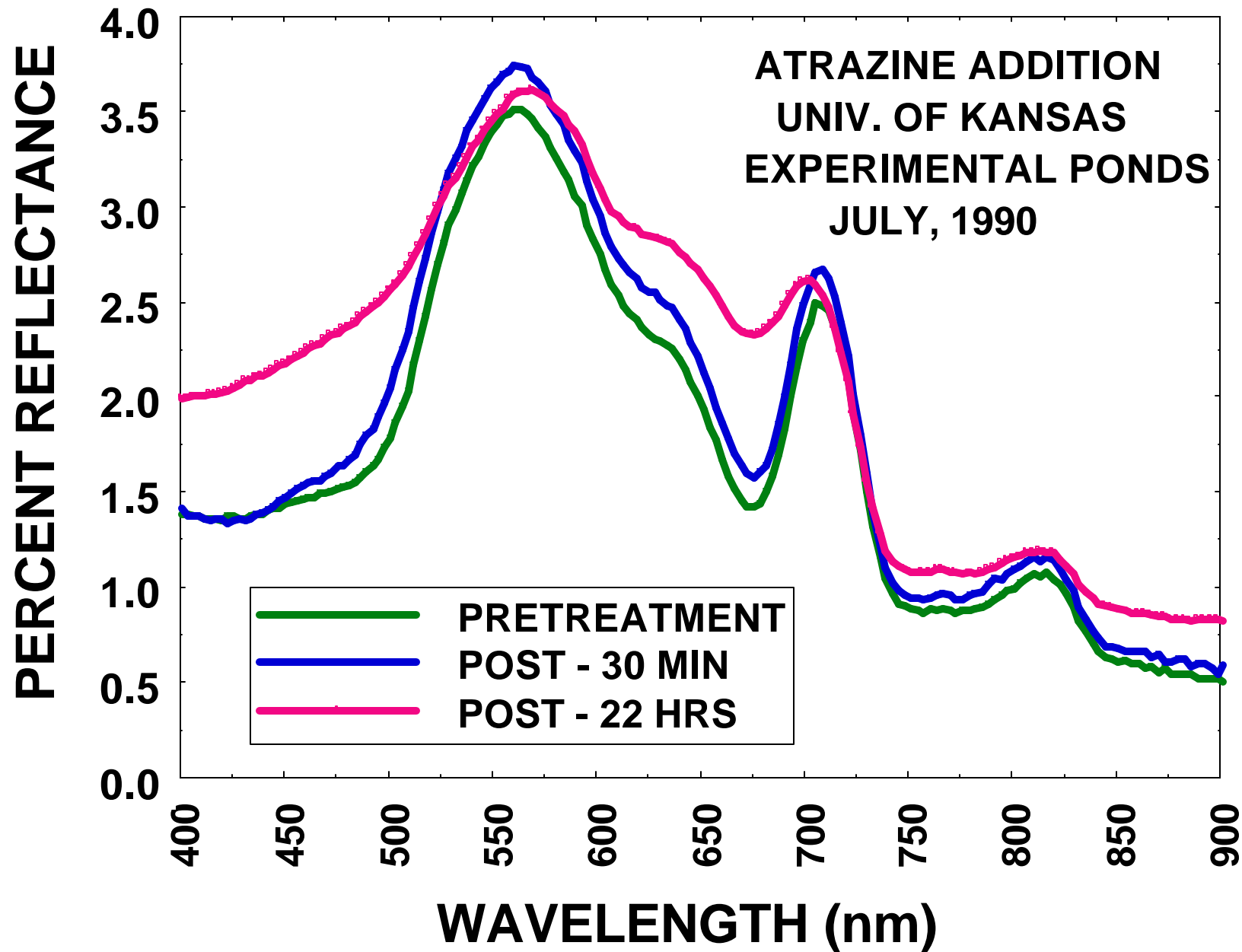
ISOLATION OF
FLUORESCENCE
WITH NARROW
PASS FILTERS:


* FLUORESCENCE
< 8% OF TOTAL
PEAK ENERGY



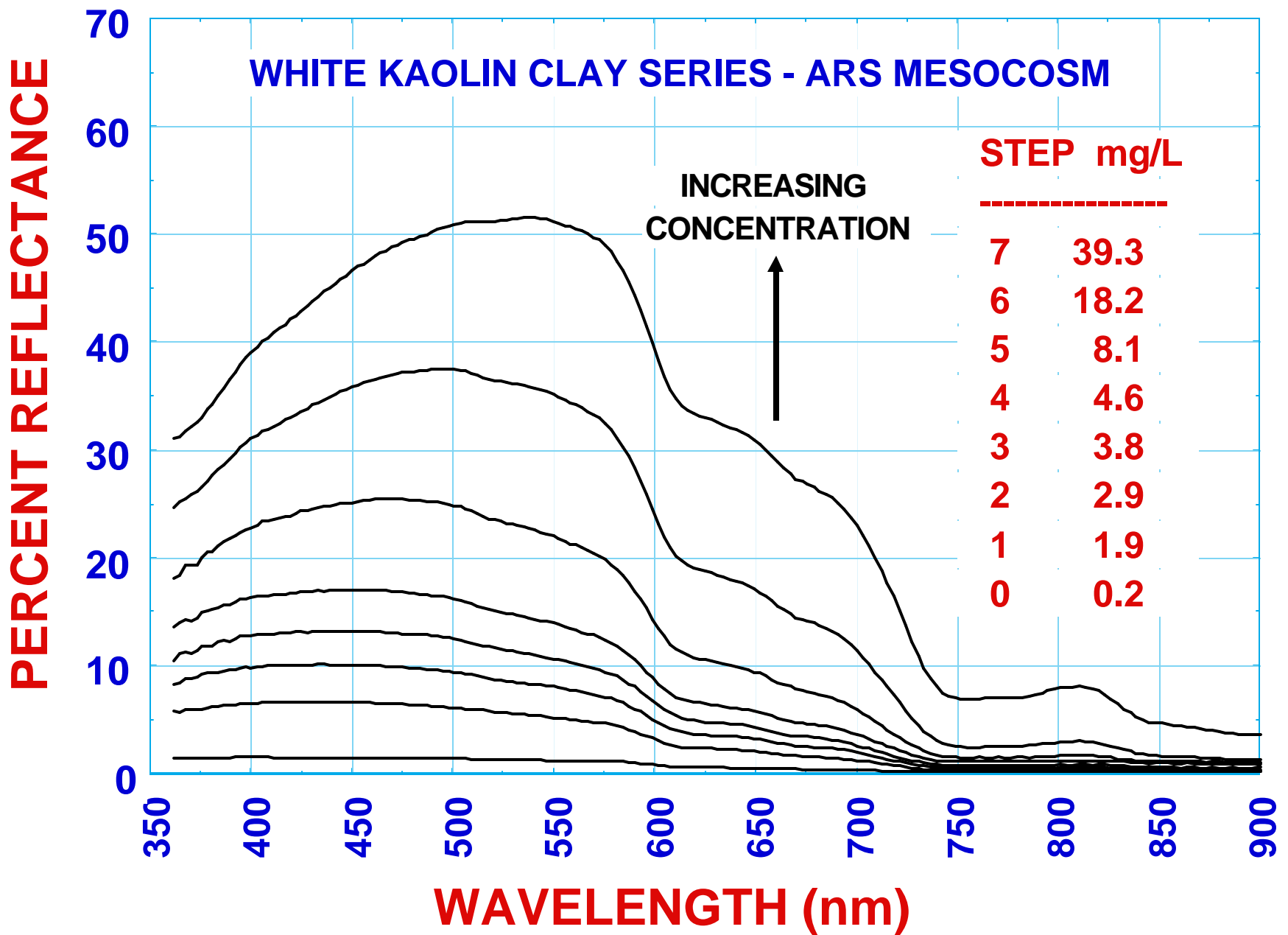
**NELSON ENVIRONMENTAL STUDIES AREA
UNIVERSITY OF KANSAS, LAWRENCE, KANSAS
PONDS FOR ECOTOXICOLOGY RESEARCH**

**ATRAZINE BLOCKS PS II ELECTRON TRANSFER IN
PHOTOSYNTHESIS, CAUSING A LARGE INCREASE IN
CHLOROPHYLL FLORESCENCE - WOULD THIS CAUSE AN
INCREASE IN THE MAGNITUDE OF THE NIR PEAK IN A
POND PHYTOPLANKTON COMMUNITY?**



A large circular tank, likely a clarifier or sedimentation tank, is shown. The water inside is a uniform light blue color, indicating turbidity. A complex metal frame structure is suspended above the tank, possibly for aeration or mixing. The tank is situated outdoors on a grassy area. In the background, another similar tank is visible, along with some industrial equipment and pipes.

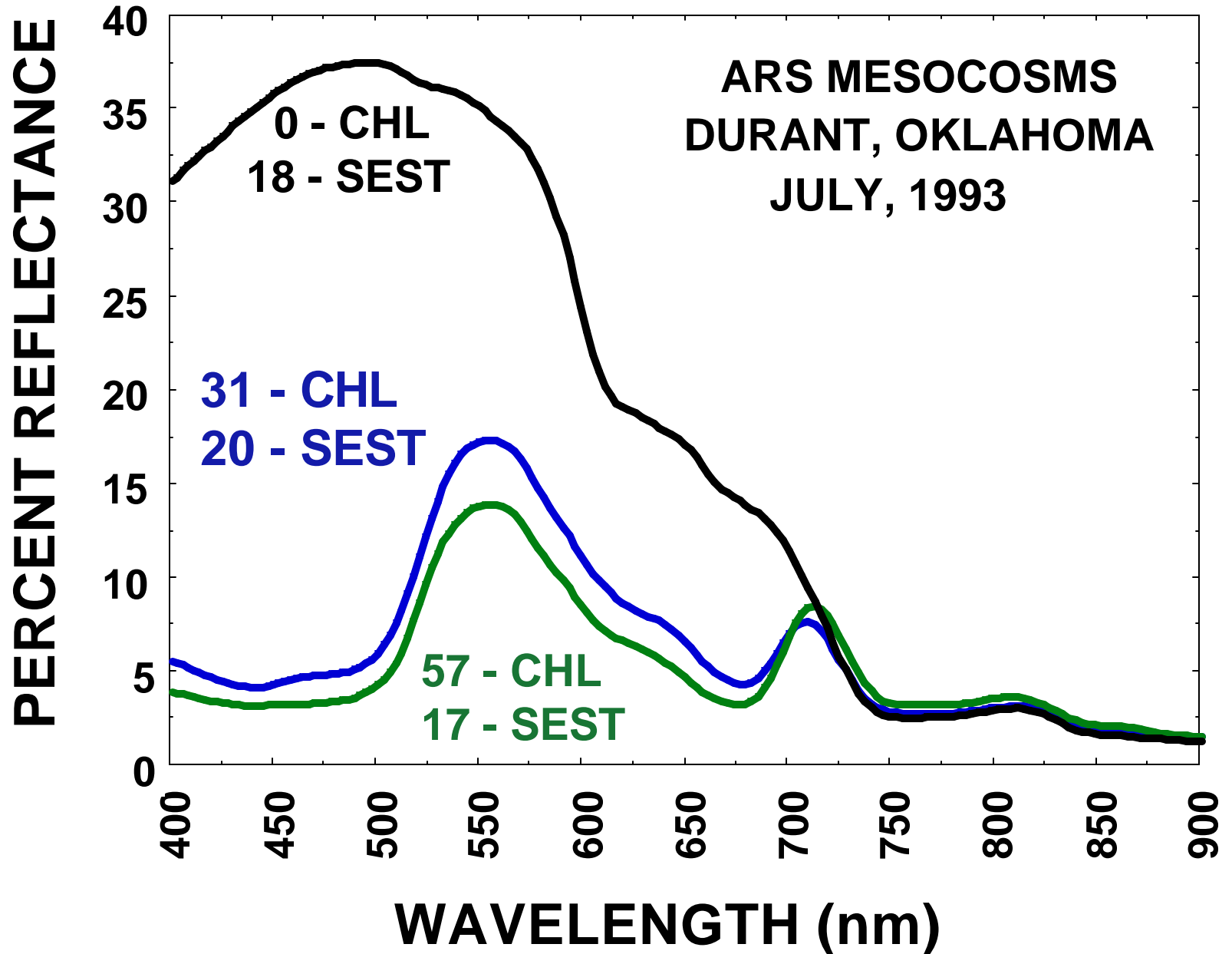
**NON-ALGAL TURBIDITY:
CLAY MANIPULATION STUDIES**



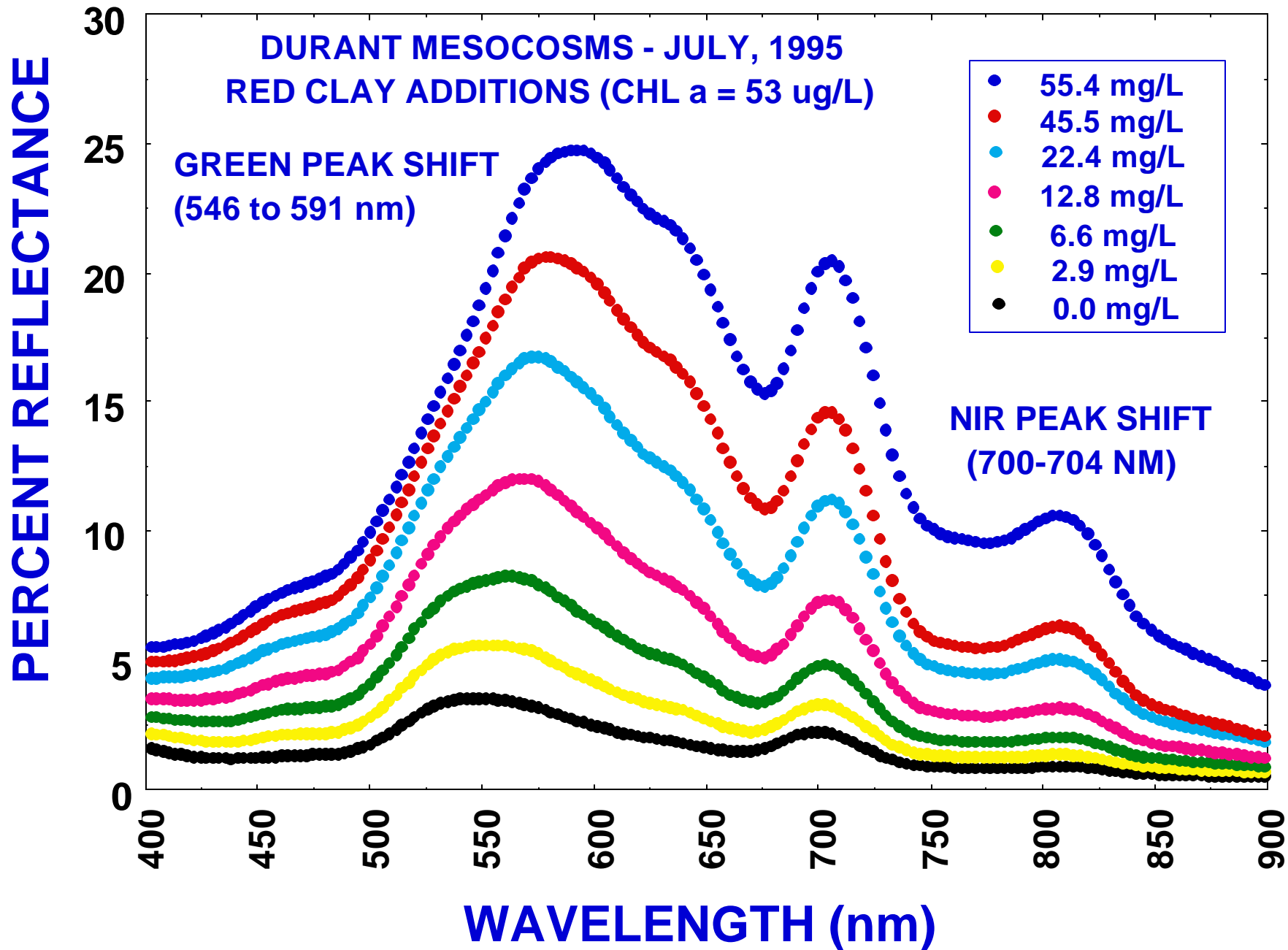


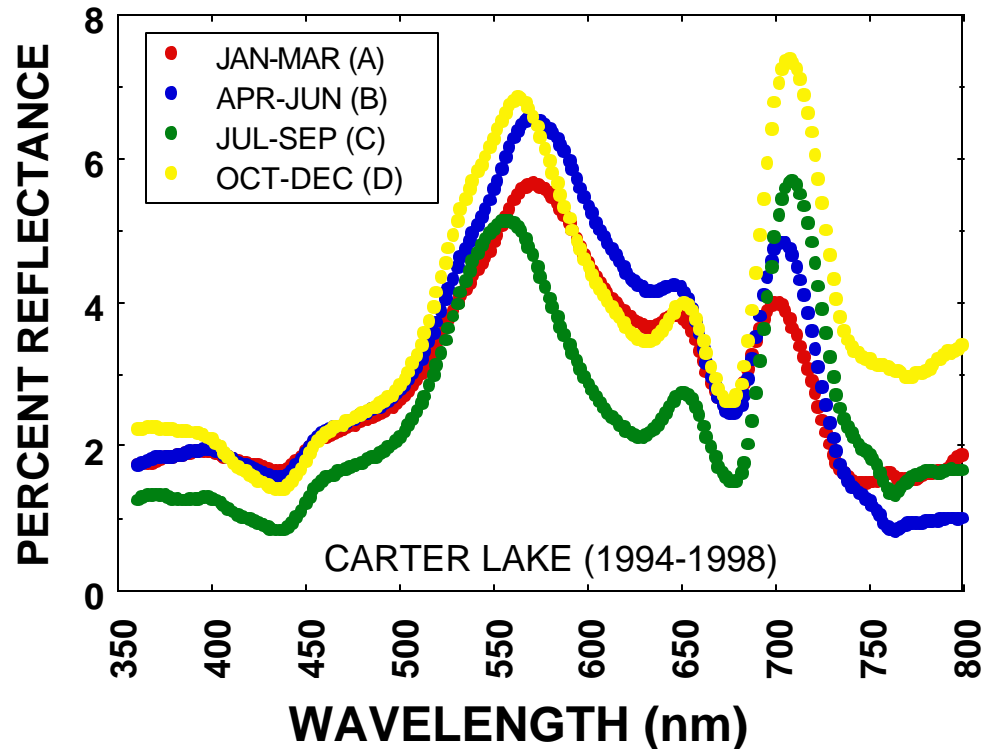
MIXED ALGAL/CLAY SUSPENSIONS

Schalles et al., 1997







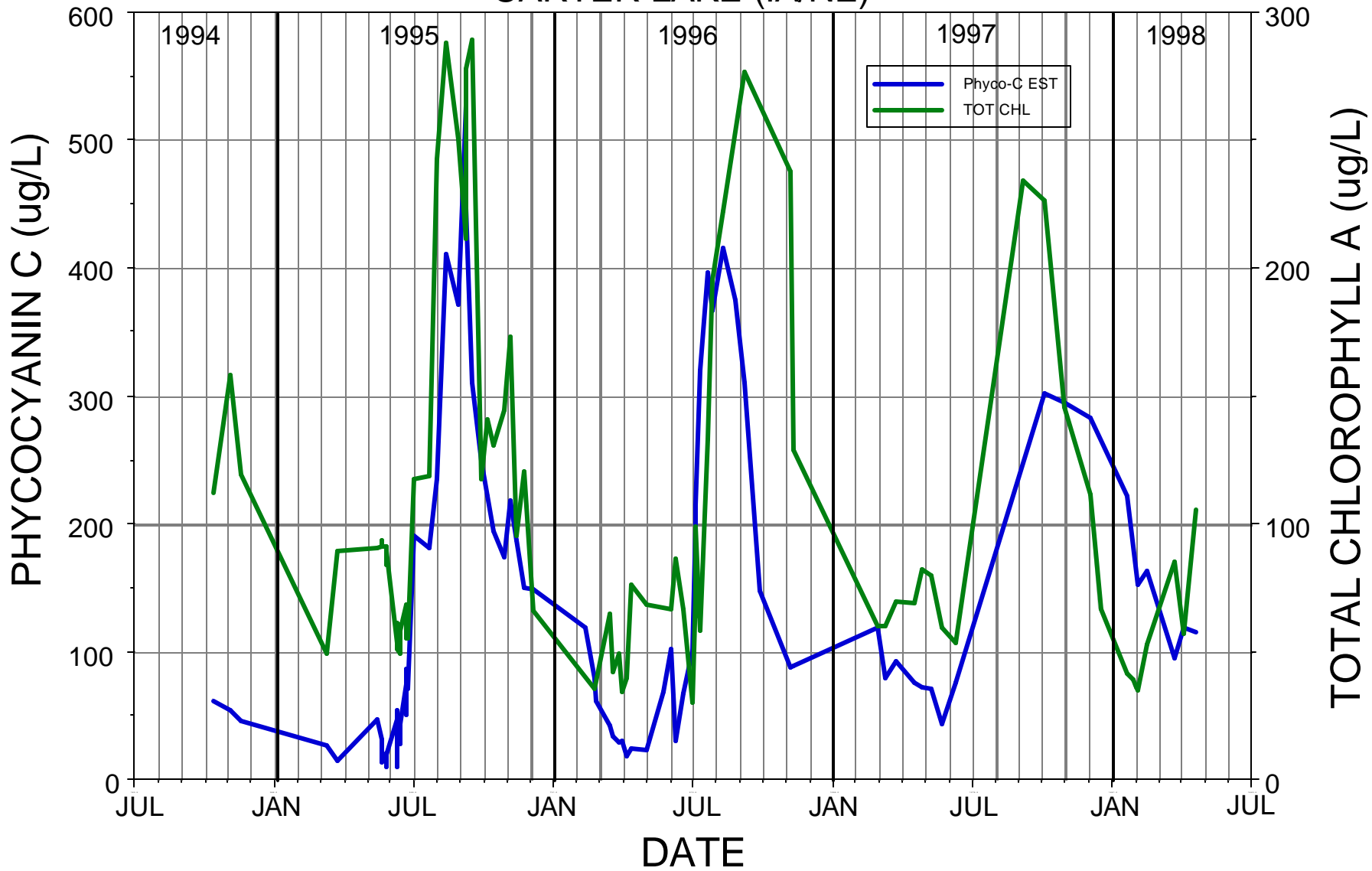


CARTER LAKE, NEBRASKA

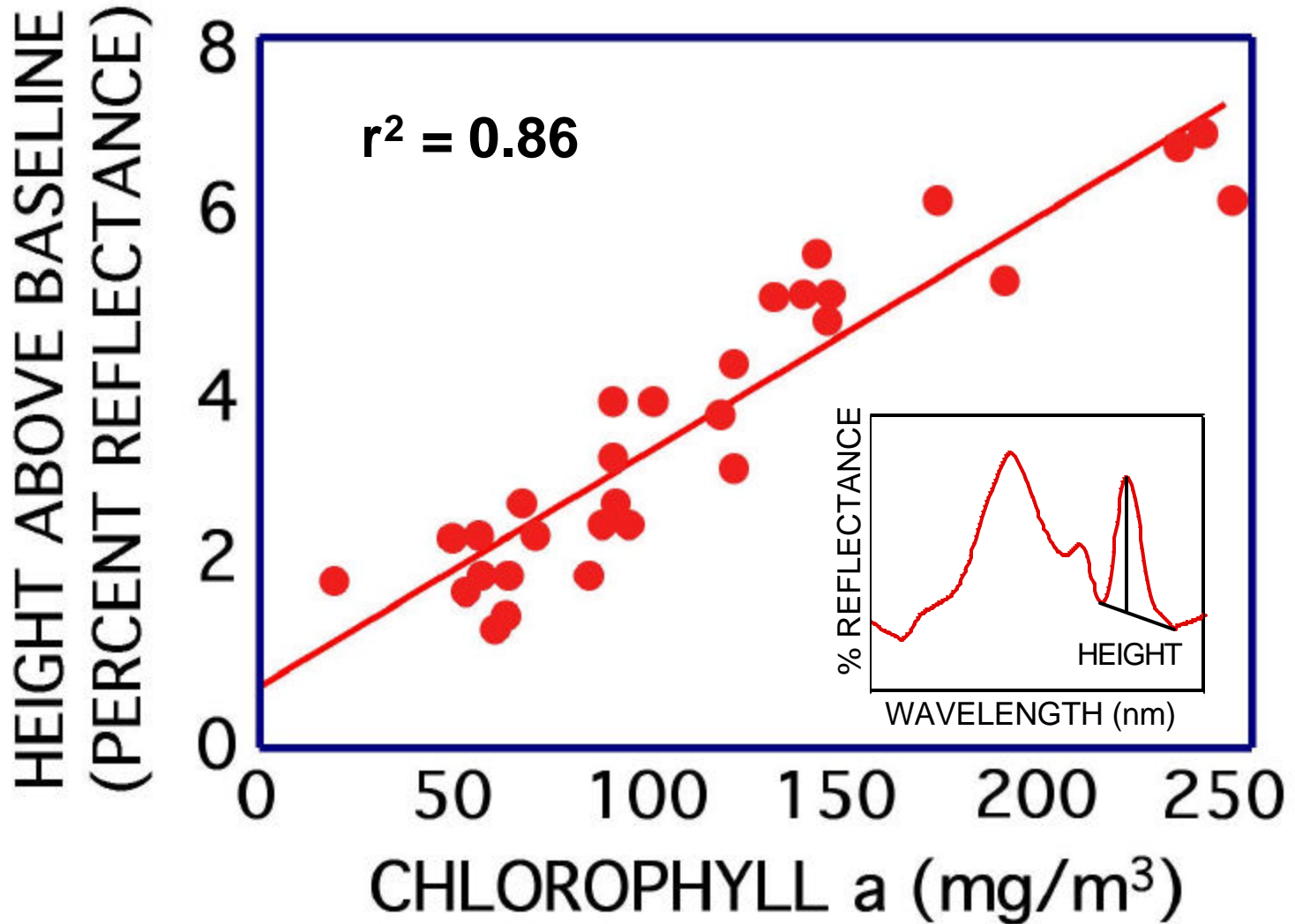
- HYPEREUTROPHIC OXBOW
- DIATOMS - SPRING
- CYANOPHYTES - SUM/FALL
- 1994-1998 STUDY



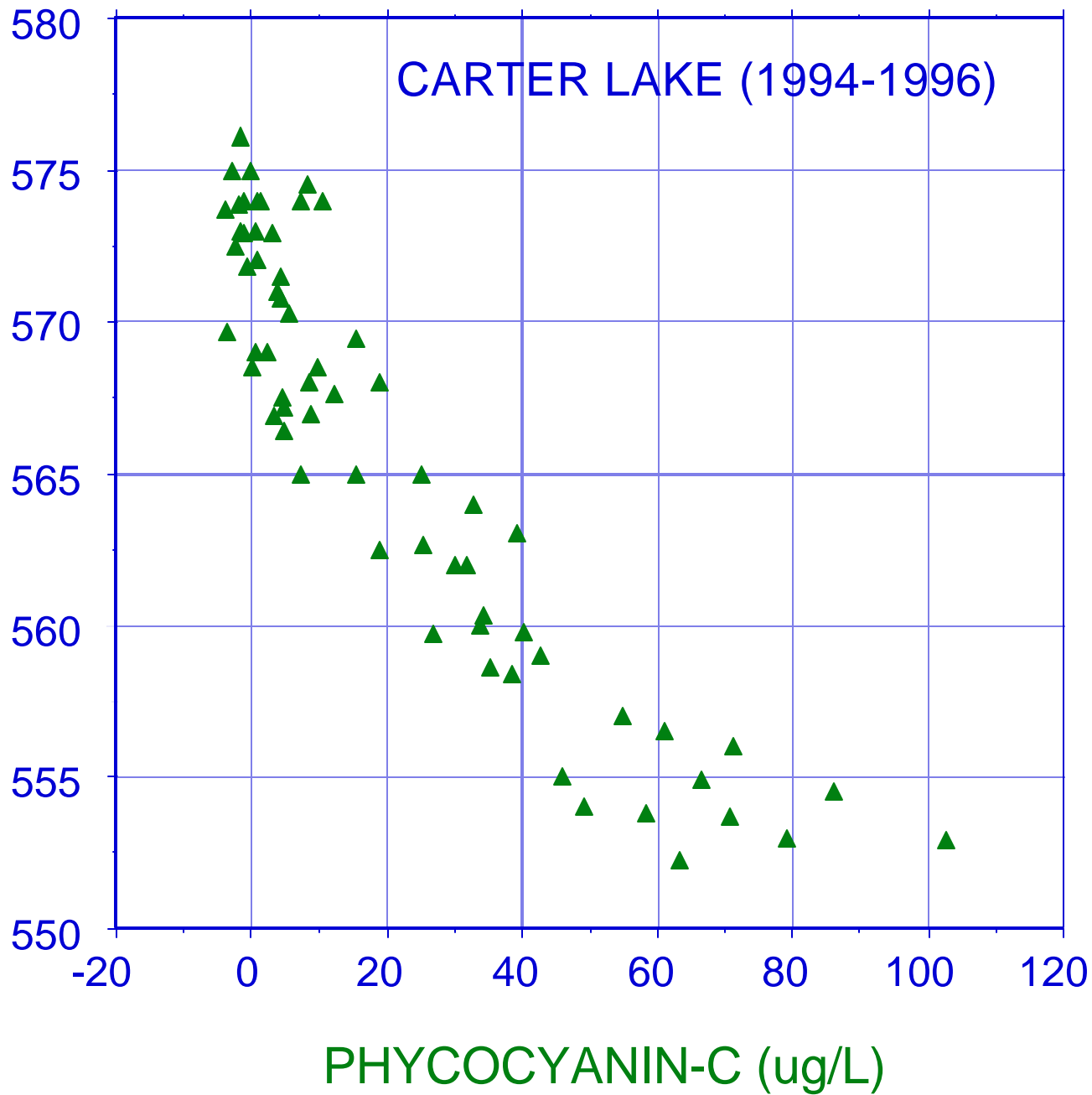
CARTER LAKE (IA/NE)



CARTER LAKE, NE - HYPEREUTROPHIC LAKE

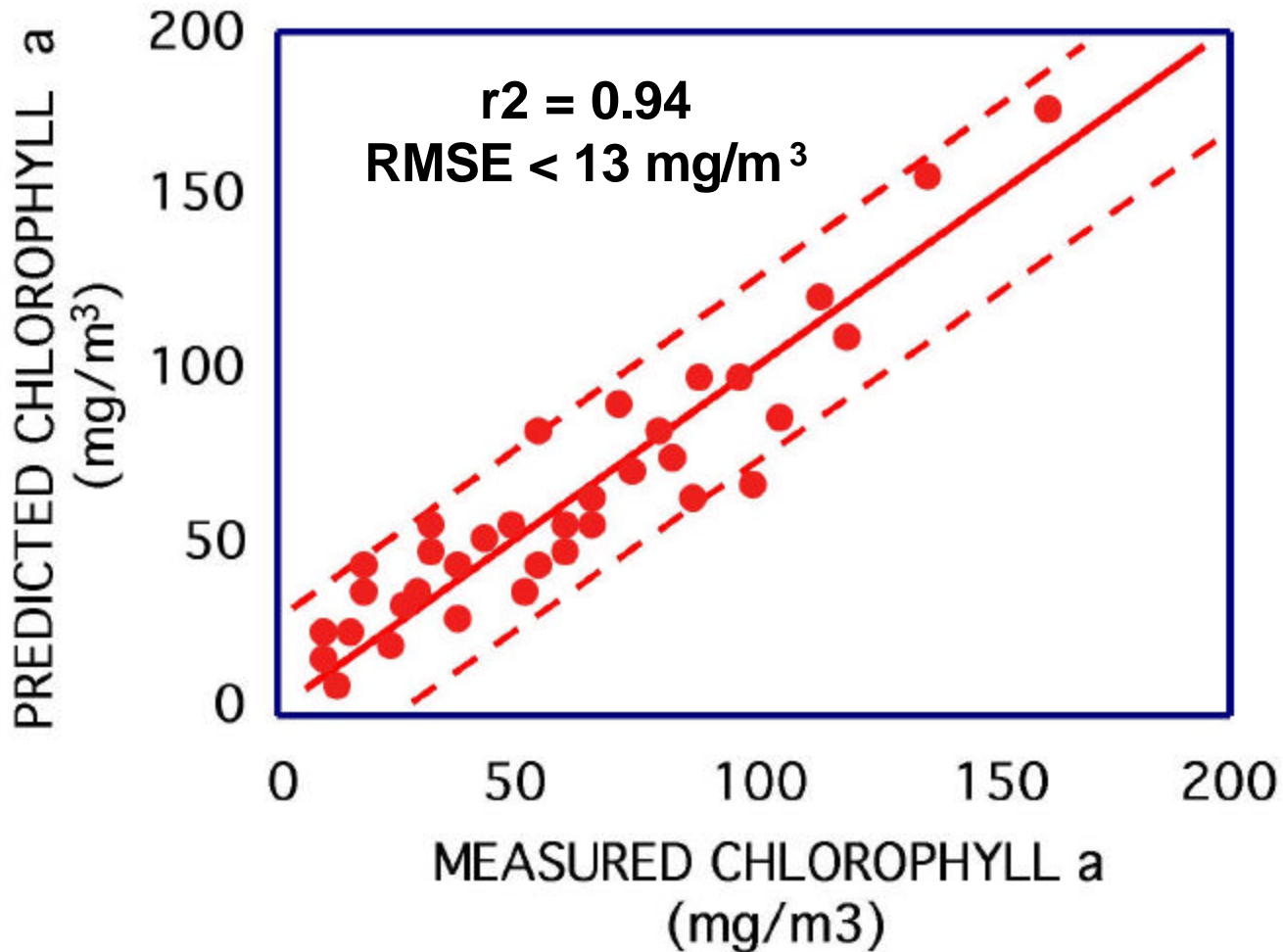


Schalles et al. 1998



NEBRASKA LAKES (DALL 'OLMO ET AL., IN PRESS)

TSS <0.1 - 214 mg/L; CDOM 440^{abs} 0.7-2.3; TRIPTON^{abs} 0.7-6



$$\text{Chl} = 56.7 + 161 * X - 28.4 * X^2 ; X = (R665 - R725) * R755$$

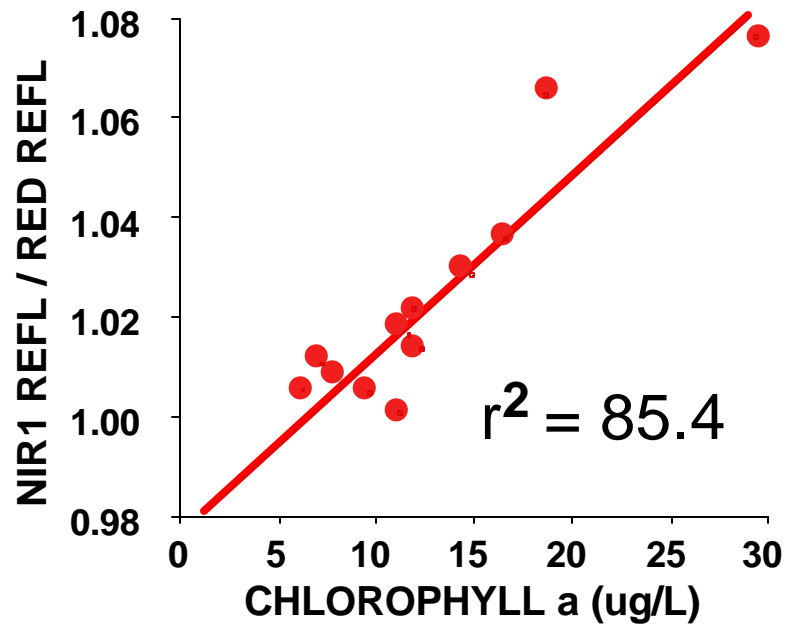
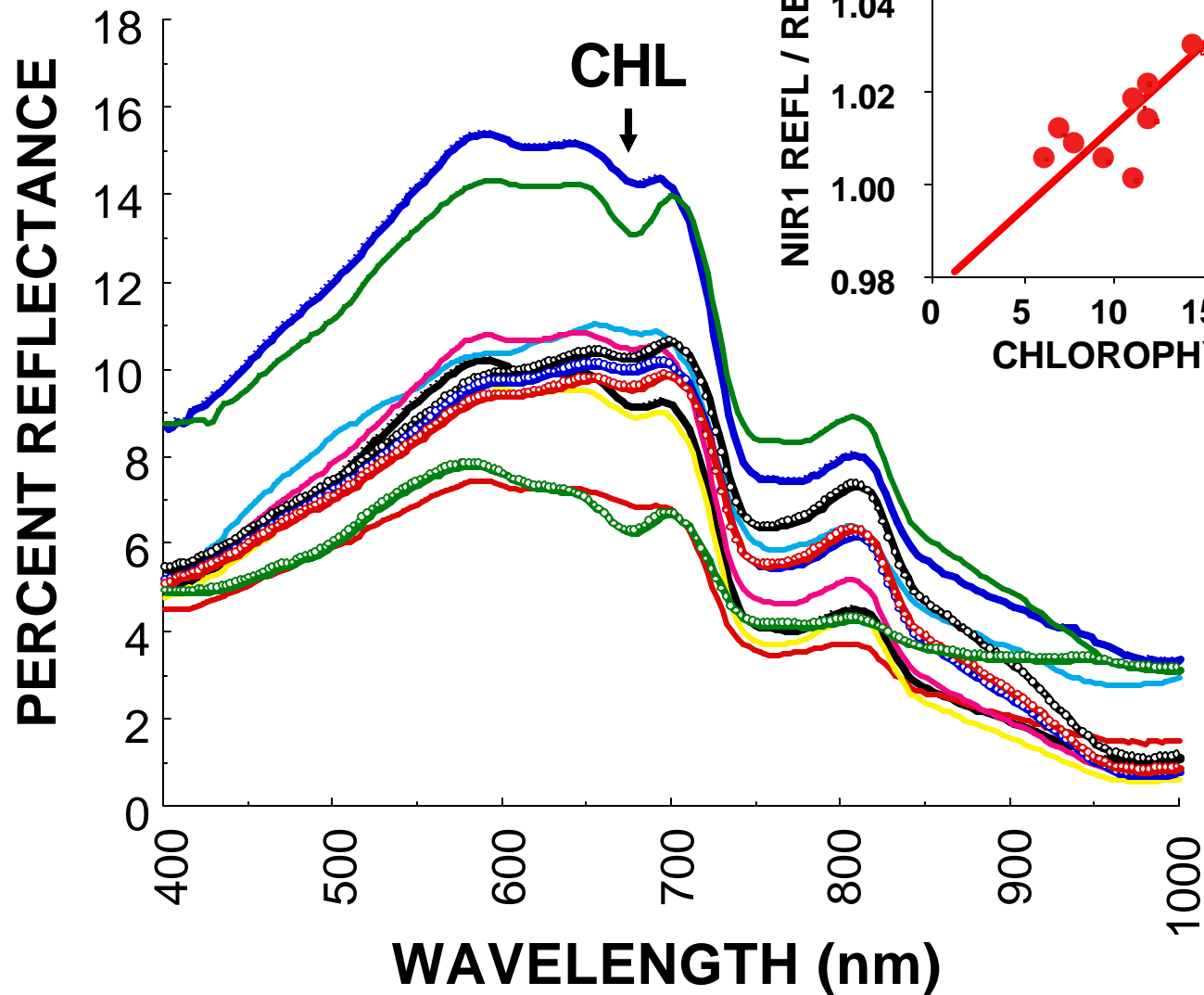


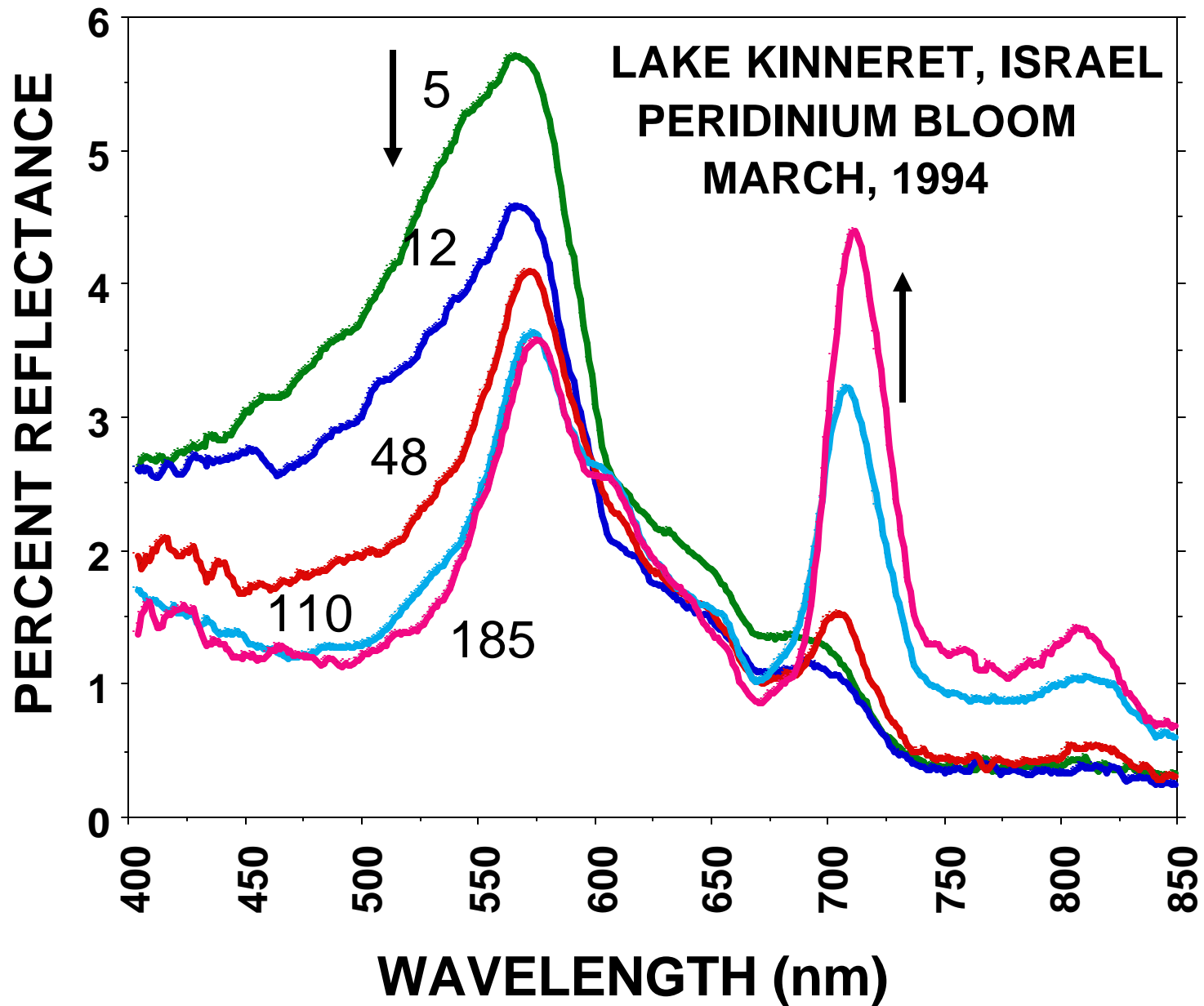
**Lake Chapala
Mexican Highlands
near Guadalajara**

Clay Turbid
Chl a: 6-33 ug/L
Seston: 16-163 ug/L

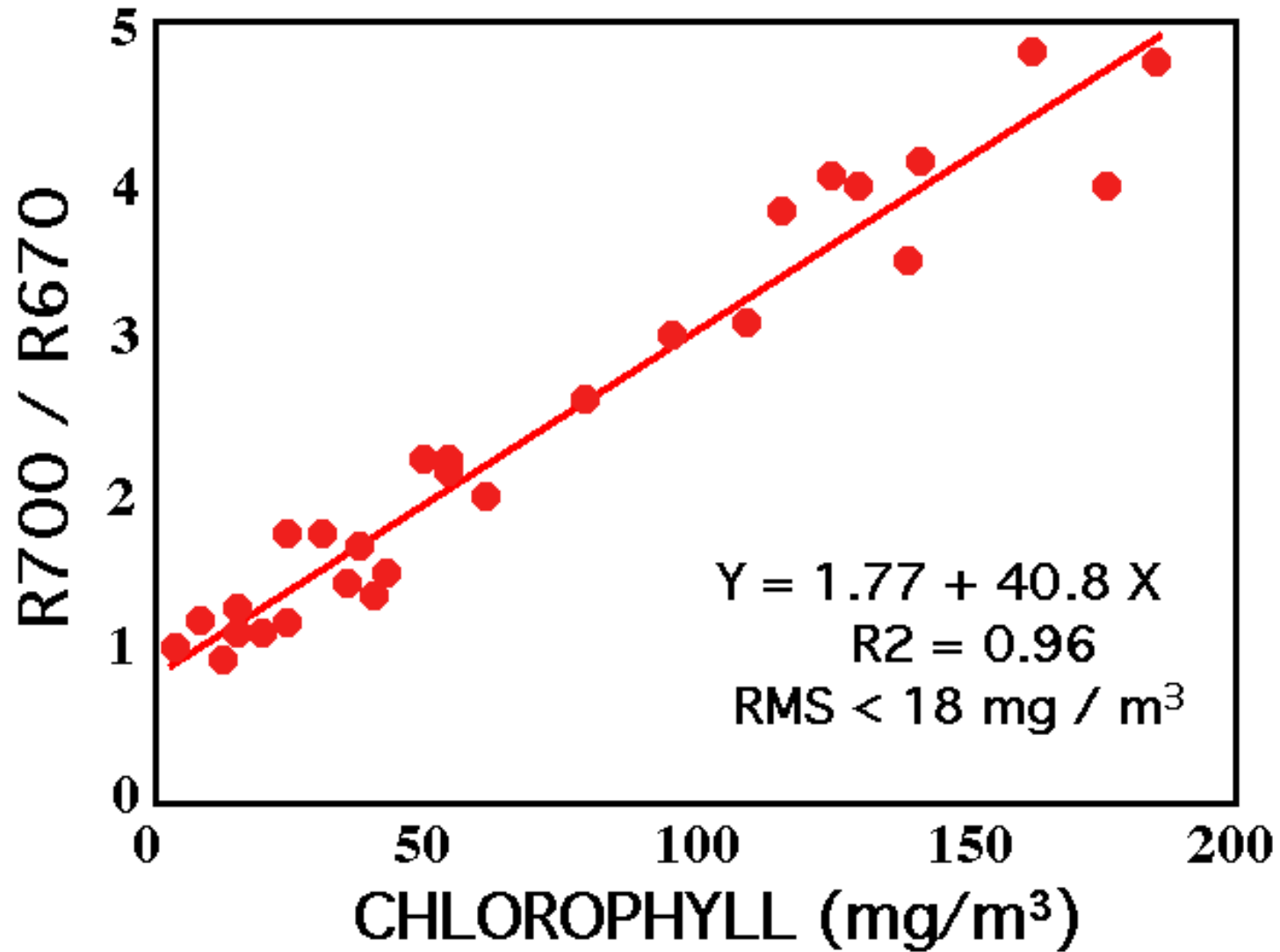


LAKE CHAPALA JALISCO, MEXICO





LAKE KINNERET - MARCH, 1993





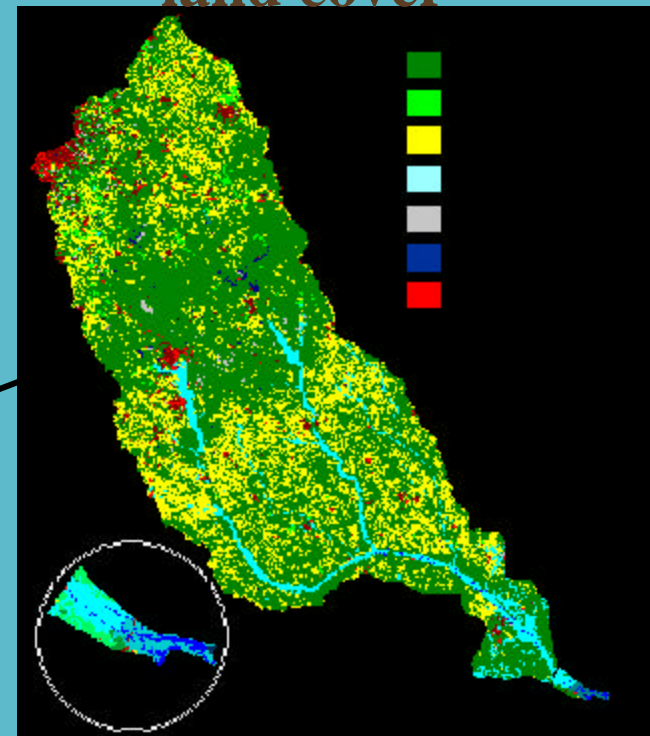
**Georgia
estuaries
and shelf
waters**

Georgia Coast: estuaries and nearshore waters

**Highly variable
Chl a: 0.4 - 63 ug/L
Seston: 0.7 - 127 mg/L**



Altamaha watershed - land cover



Rivers in this study:

- Ogeechee
- Altamaha
- Satilla
- St. Marys

UNIVERSITY OF GEORGIA'S R.V. SPARTINA

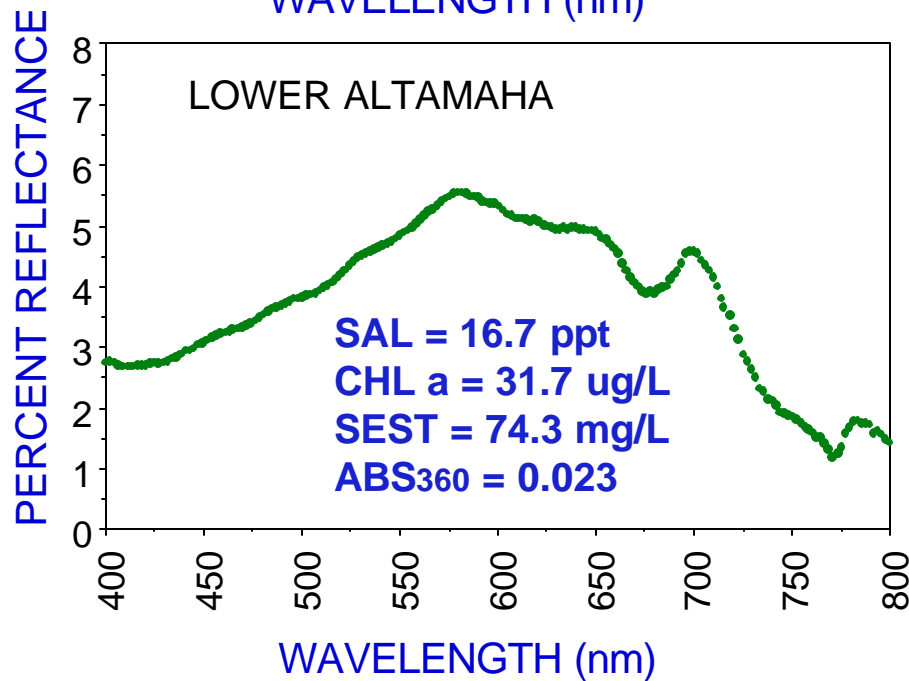
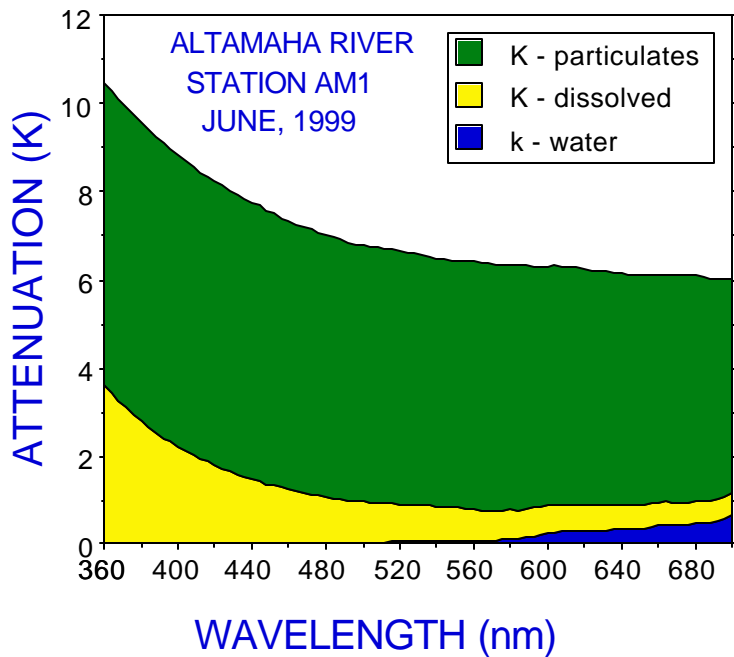
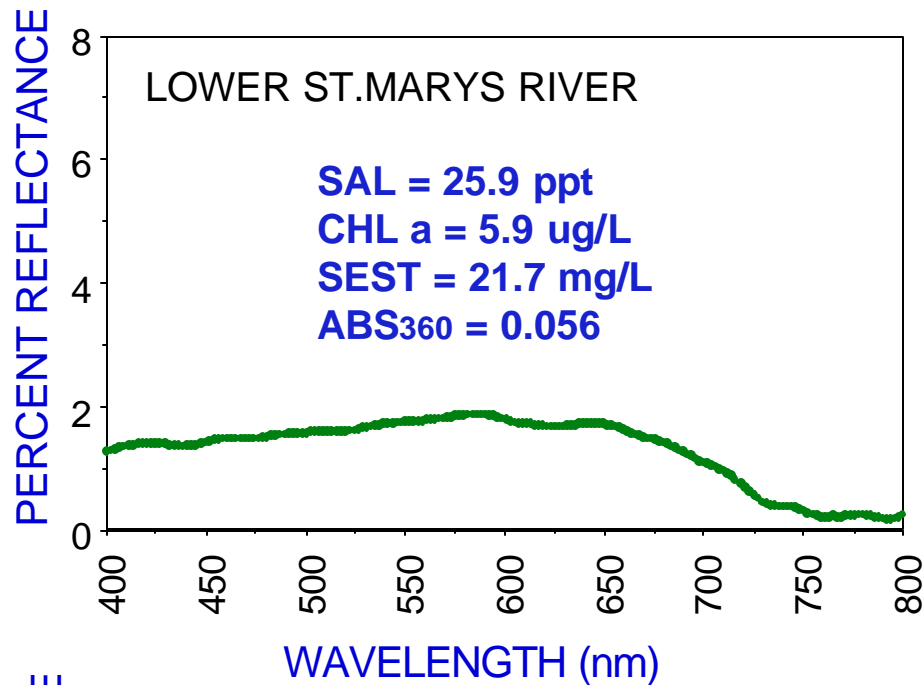
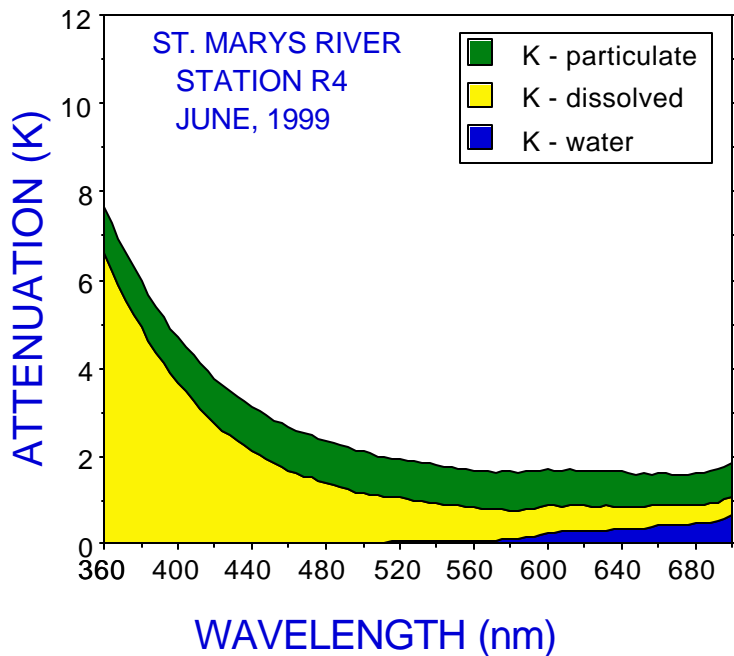




LOWER ALTAMAHA RIVER

ST. MARYS RIVER







Sapelo Sound

Sapelo Island

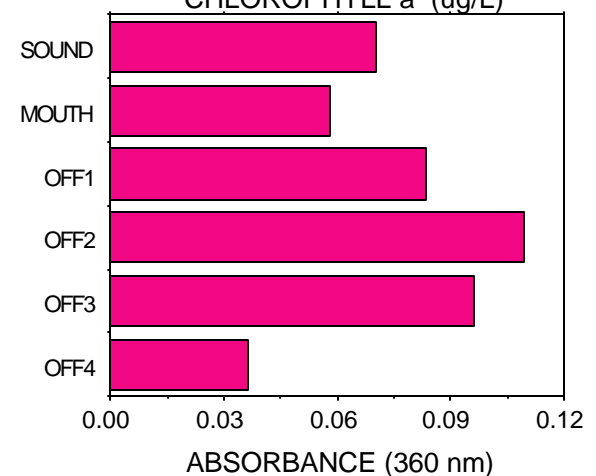
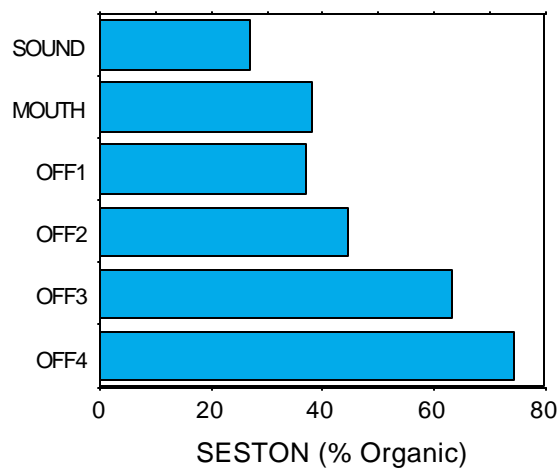
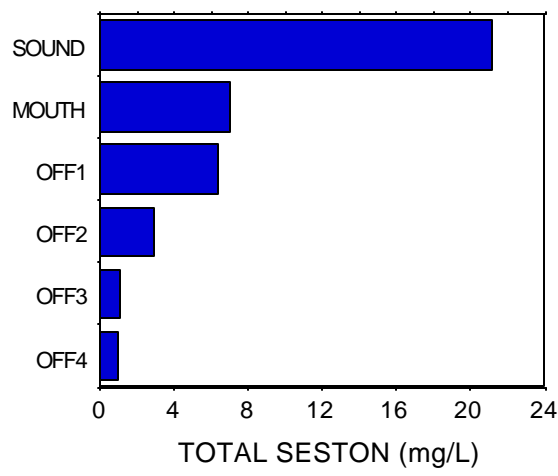
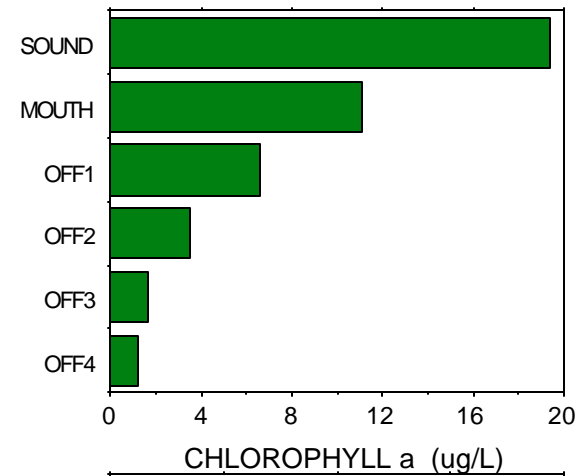
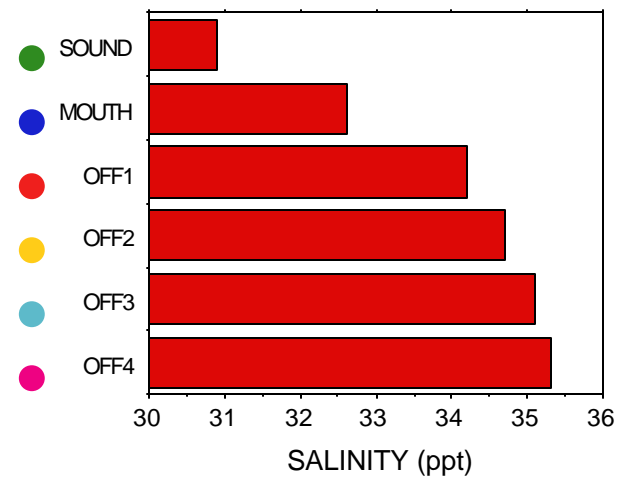
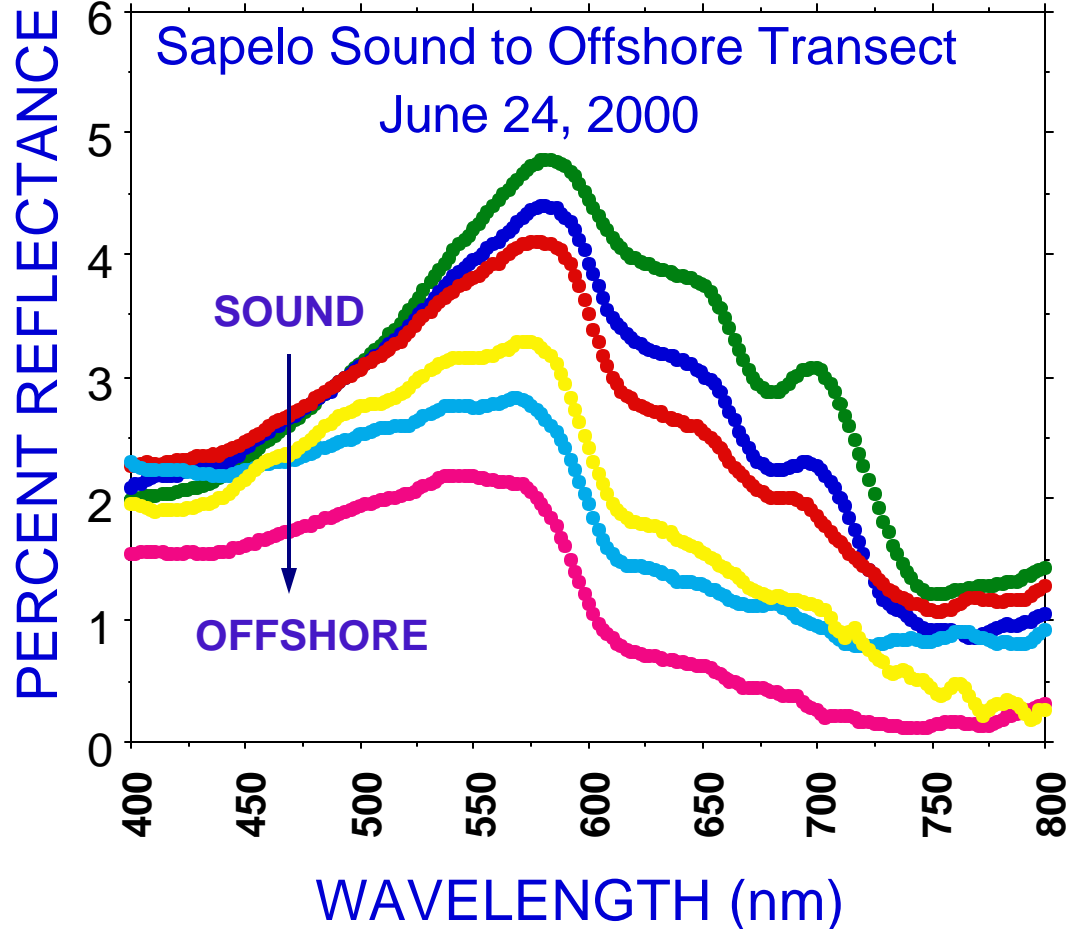
Doboy Sound

Altamaha River

OPERATIONS BASE:

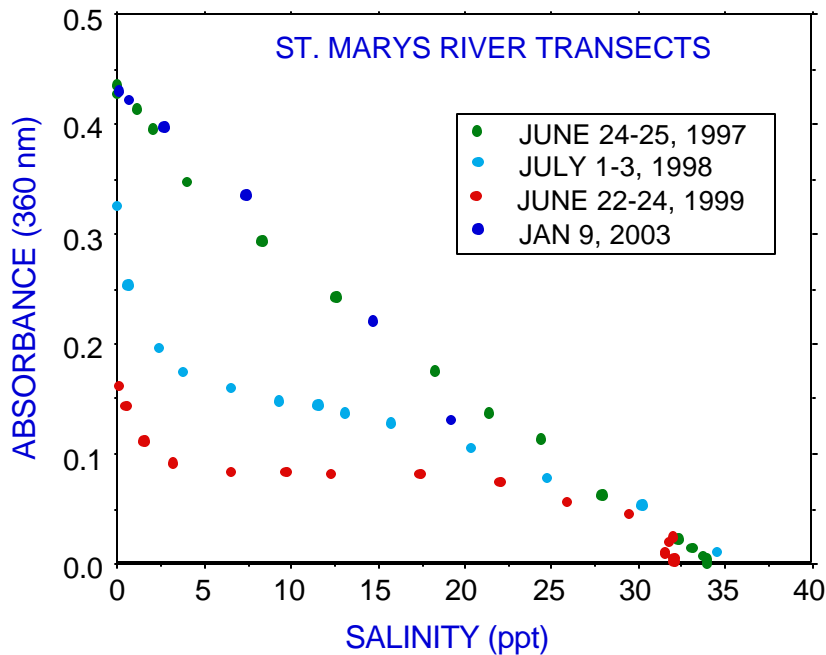
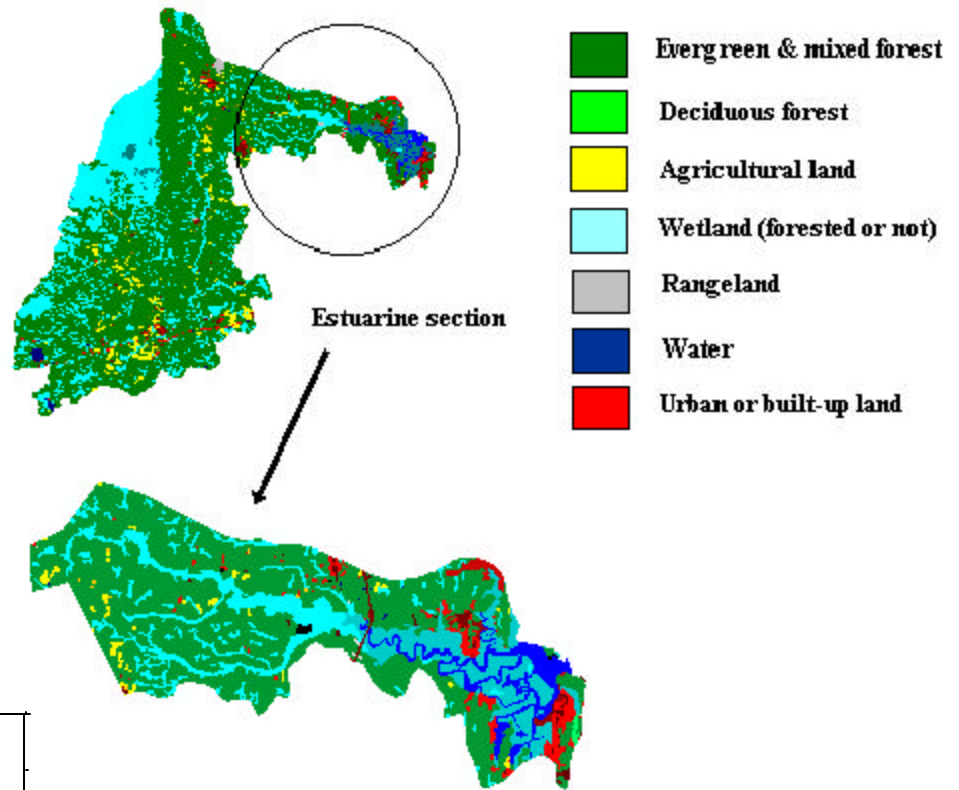
**UNIVERSITY OF GEORGIA
MARINE INSTITUTE AT
SAPELO ISLAND**

(GO DAWGS!)

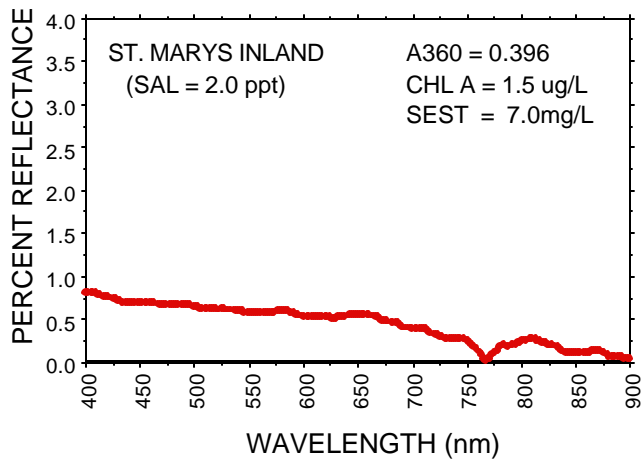


ST. MARYS RIVER (GA/FL BORDER)

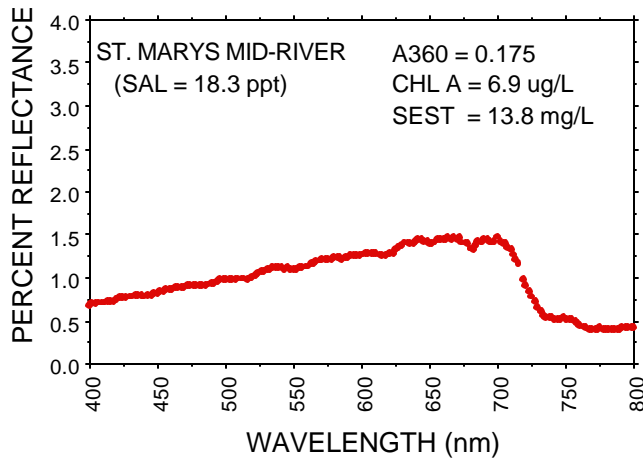
CLASSIC BLACKWATER STREAM



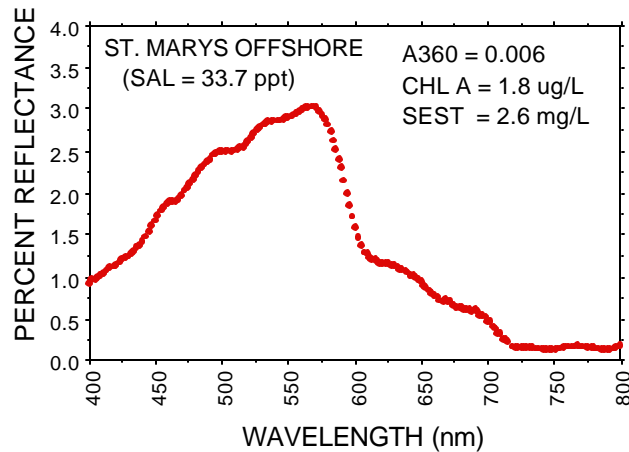
OKEFENOKEE SWAMP



CHL 1.5
CDOM 42
SESTON 7.0

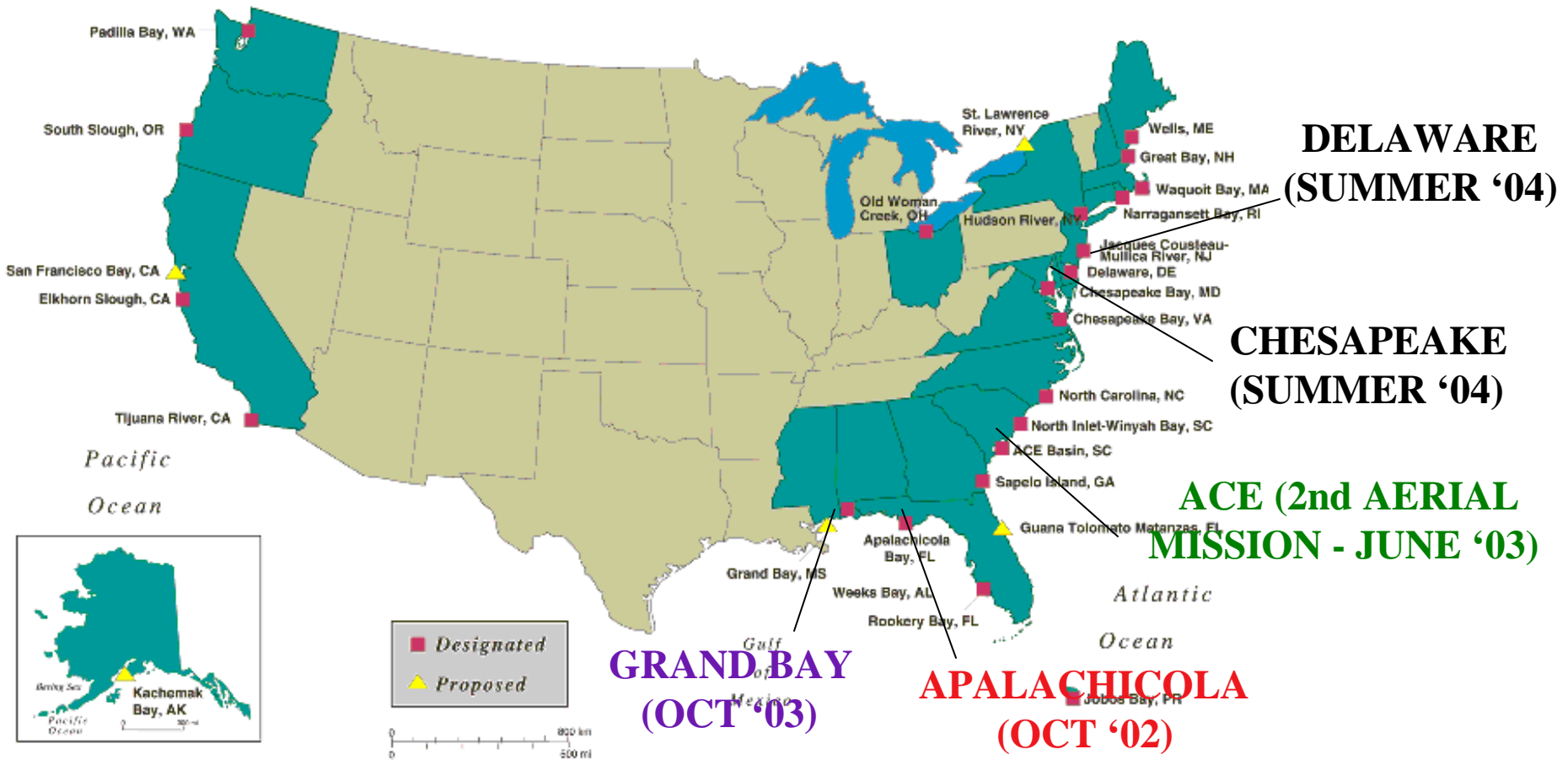


CHL 6.9
CDOM 18.6
SESTON 13.8

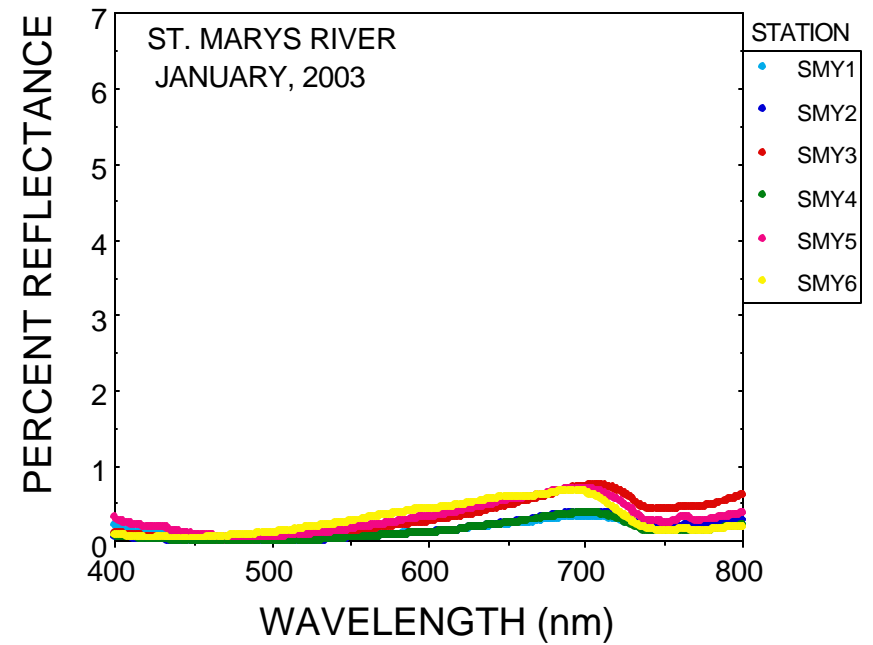
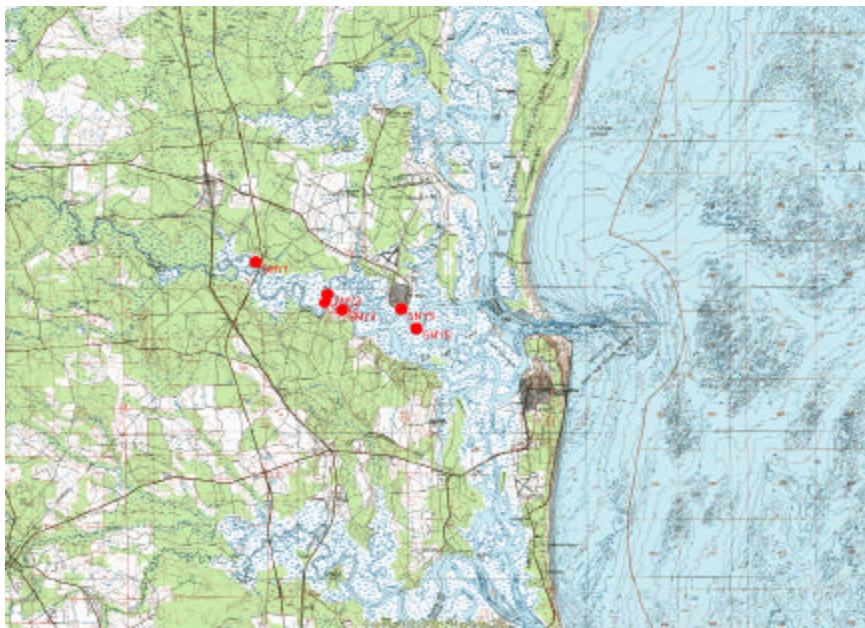
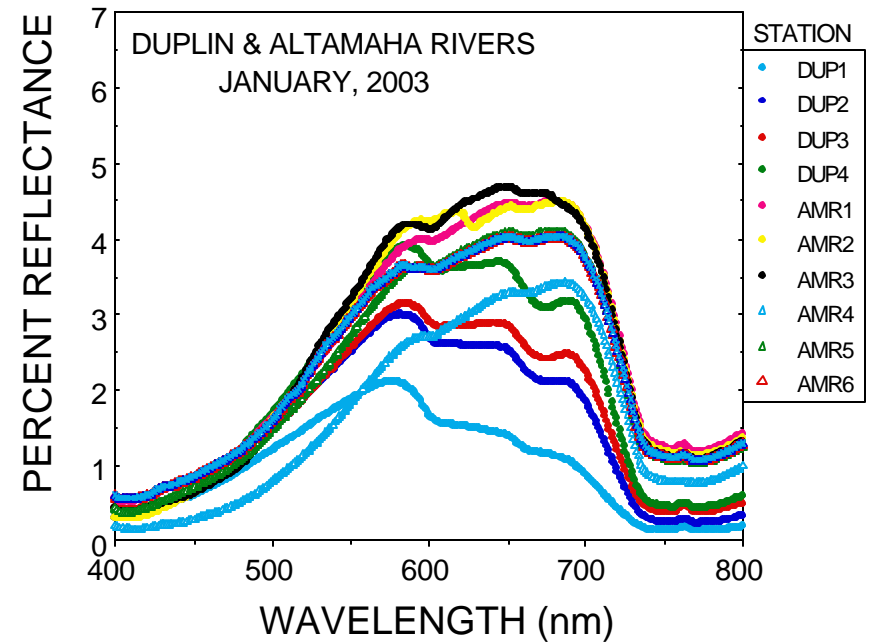


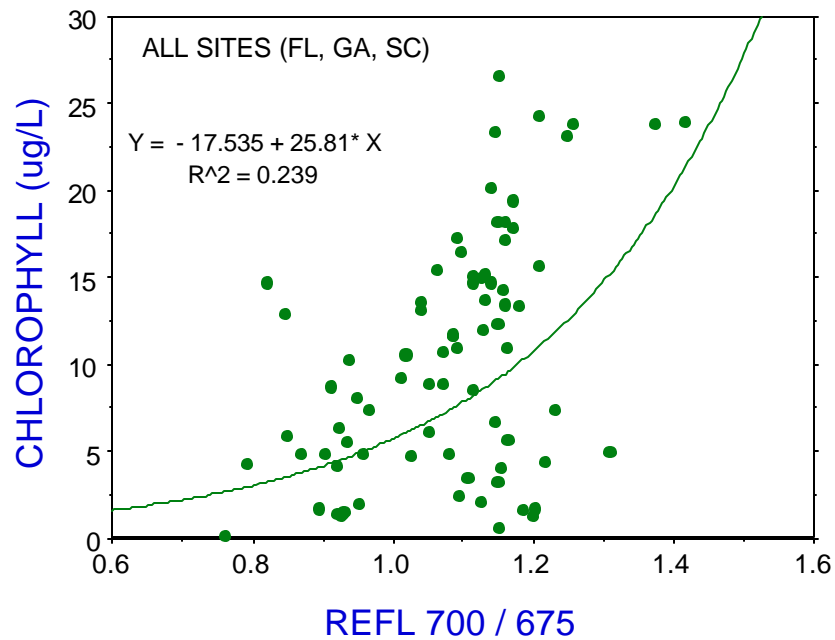
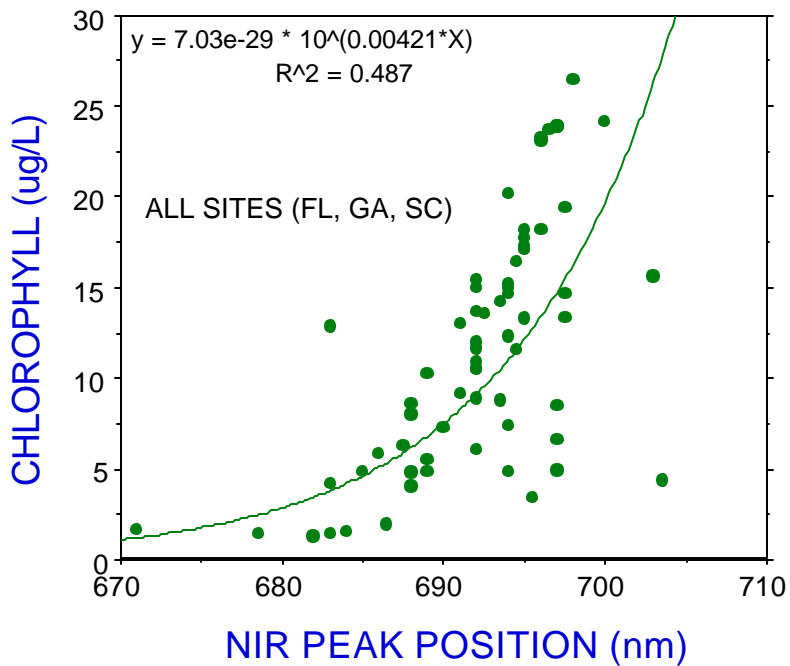
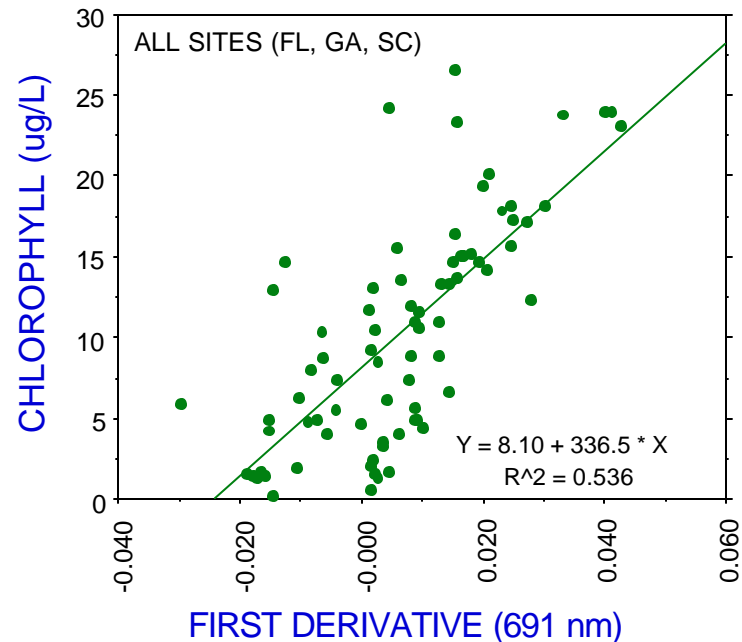
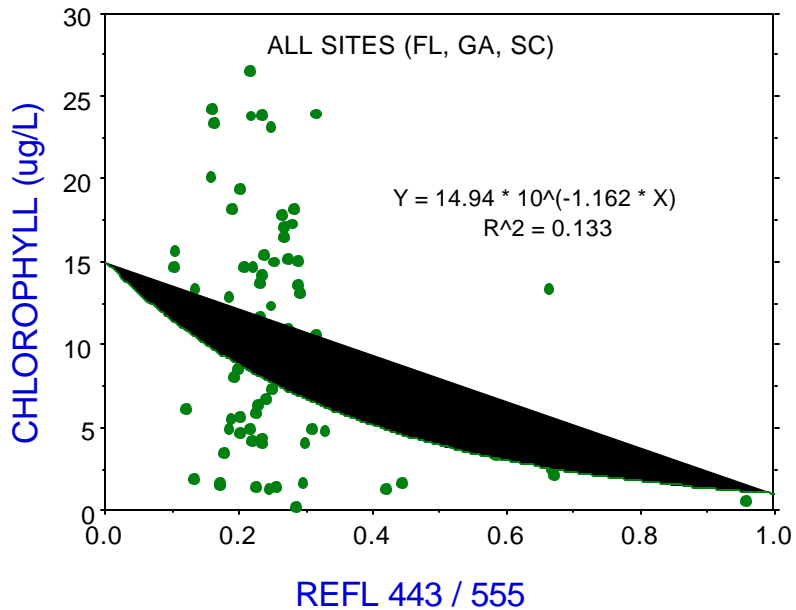
CHL 1.8
CDOM 0.4
SESTON 2.6





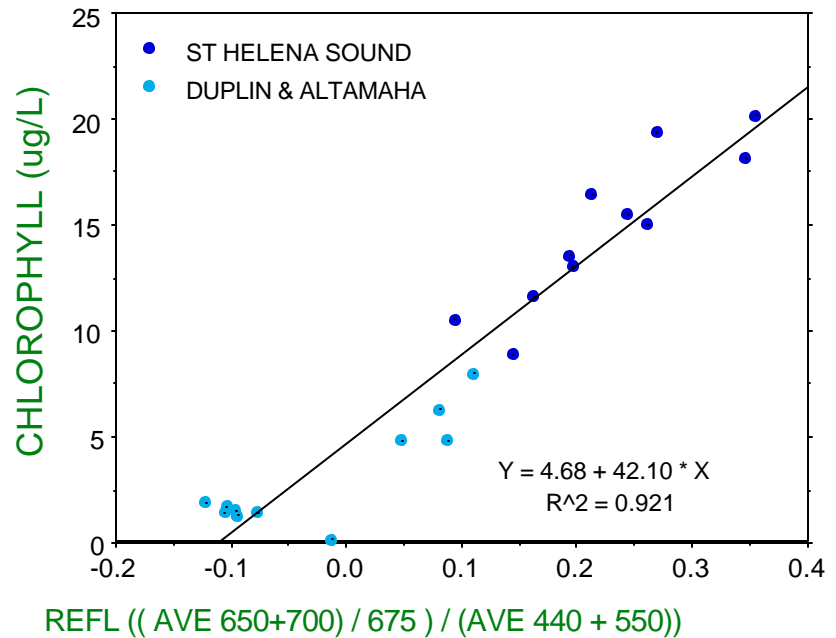
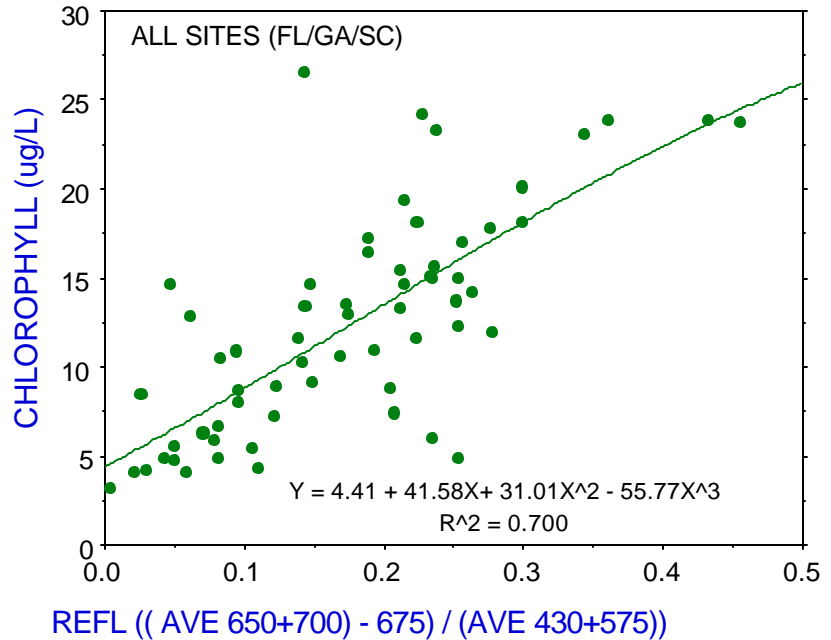
FIVE NERR SITES ARE PARTNERS WITH ECSC SCHOOLS AND ARE PARTICIPATING WITH UNIV. OF NEBRASKA/CREIGHTON UNIV. IN A JOINT REMOTE SENSING SUBPROJECT)





NEW
APPROACH -
ADJUSTING
FOR EFFECTS OF

TRIPTON
(AMPLIFYING)
VS
CDOM
(DAMPENING)





**CASE 1 WATERS
VS
CASE 2 WATERS**

**ARE WE
OVERSIMPLIFYING
THINGS?**