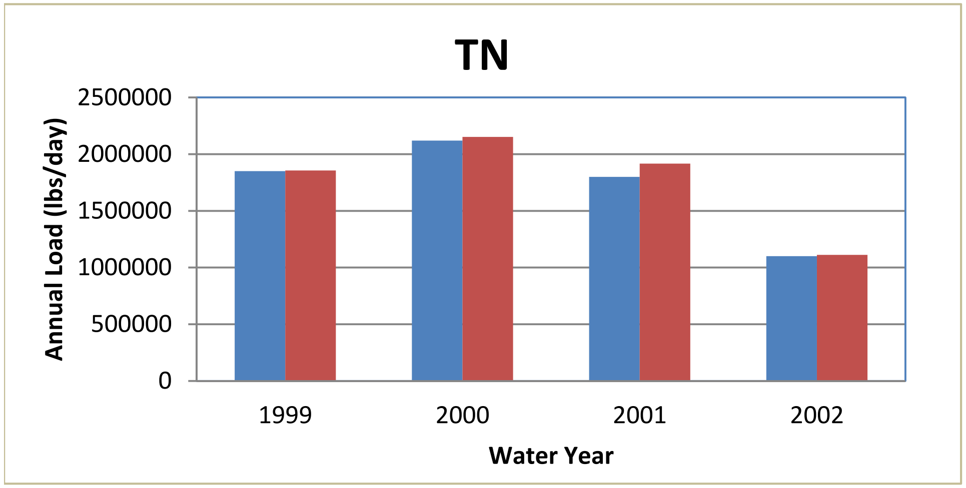
# SWEM MEG Presentation

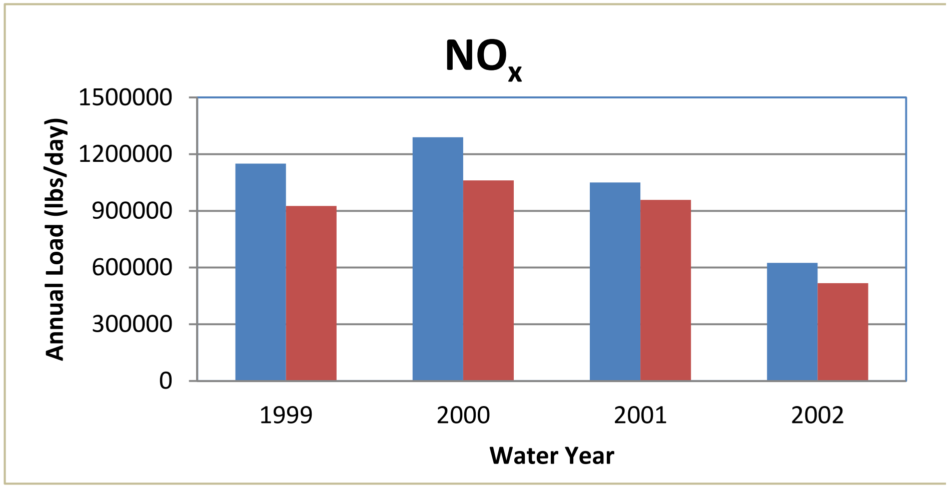
July 11, 2013

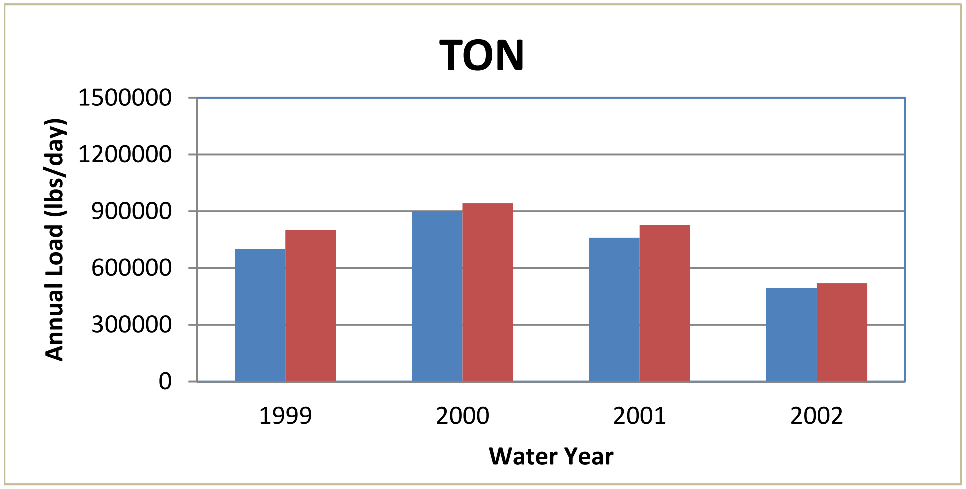
# Presentation Overview

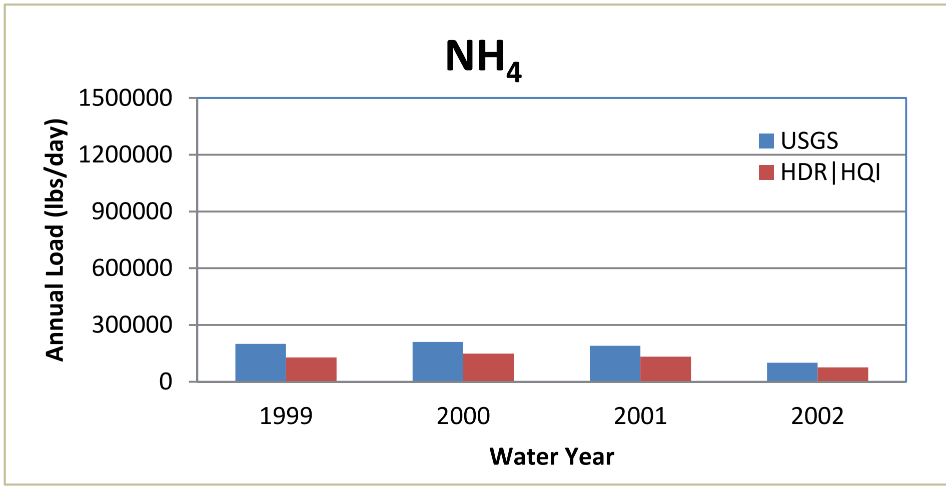
- Response to Comments
  - ✓ load comparisons
  - ✓ table of model coefficients
  - ✓ addition of primary production, respiration, and nutrient flux data
- Re-calibration status
  - ✓ water years: 89, 99-2002
- Next Steps
  - ✓ additional productivity, respiration data
  - ✓ loading comparisons
  - ✓ high resolution LIS grid

# Load Comparisons:
## Quinnipiac R. (Wallingford, CT)



# Model Coefficients:

```
C
C     SYSTEMS                                                       UNITS
C
C     -------                                                       -----
C        1 - SALINITY (SAL)                                           PPT
C
C     PHYTOPLANKTON
C        2 - WINTER DIATOMS (PHYT1)                                MG C/L
C        3 - SUMMER ASSEMBLAGE (PHYT2)                             MG C/L
C        4 - FALL ASSEMBLAGE (PHYT3)                               MG C/L
C
C     PHOSPHORUS
C        5 - REFRACTORY PARTICULATE ORGANIC (RPOP)                 MG P/L
C        6 - LABILE PARTICULATE ORGANIC (LPOP)                     MG P/L
C        7 - REFRACTORY DISSOLVED ORGANIC (RDOP)                   MG P/L
C        8 - LABILE DISSOLVED ORGANIC (LDOP)                       MG P/L
C        9 - TOTAL DISSOLVED INORGANIC (PO4T)                      MG P/L
C
C     NITROGEN
C       10 - REFRACTORY PARTICULATE ORGANIC (RPON)                 MG N/L
C       11 - LABILE PARTICULATE ORGANIC (LPON)                     MG N/L
C       12 - REFRACTORY DISSOLVED ORGANIC (RDON)                   MG N/L
C       13 - LABILE DISSOLVED ORGANIC (LDON)                       MG N/L
C       14 - TOTAL AMMONIA (NH4T)                                  MG N/L
C       15 - NITRITE + NITRATE (NO23)                              MG N/L
C
C     SILICA
C       16 - BIOGENIC - UNAVAILABLE (BSI)                         MG SI/L
C       17 - TOTAL INORGANIC (SIT)                                MG SI/L
```

# Model Coefficients:

```
C***********************************************************************
C
C     CONSTANTS
C     ---------
C                  NAMES AND DESCRIPTIONS OF CONSTANTS
C
C*****        OPTIONS OR SWITCHES TO CONTROL COMPUTATIONS IN "EUTRO" TUNER    VALUE
C   NO   NAME      DESCRIPTION                                          UNITS
C   --   ----    -------------------------------------------------------
C    1   AGMOPT  ALGAL GROWTH MODEL OPTION
C                = 0 USE STANDARD OR TRADITIONAL ALGAL GROWTH KINETICS
C                = 1 USE JASSY-PLATT FORMULATION                              1
C                = 2 USE LAWS-CHALUP FORMULATION
C    2   ACTALG  NUMBER OF ACTIVE ALGAL GROUPS TO SIMULATE
C                = 1 JUST ONE GROUP WILL BE SIMULATED USING SYSTEM 2
C                = 2 TWO GROUPS WILL BE SIMULATED USING SYSTEMS 2 AND 3       2
C                = 3 THREE GROUPS WILL BE SIMULATED (SYSTEMS 2 THRU 4)
C    3   KAOPT   REAERATION FORMULATION OPTION
C                = 0 USE SPATIALLY CONSTANT KL  (KA = KL/DEPTH)               1
C                = 1 USE SPATIALLY VARIABLE KL
C                = 2 USE WIND SHEAR FORMULATION
C    4   KEOPT   EXTINCTION COEFFICIENT OPTION
C                = 0 KE IS A CONSTANT (SPATIALLY AND TEMPORALLY
C                    INVARIANT
C                = 1 KE IS A SPATIALLY VARIABLE BUT CONSTANT IN TIME
C                    (USING 2-D PARAMETER ARRAY)
C                = 2 KE IS SPATIALLY INVARIANT BUT VARIES IN TIME
C                    (USING TIME-VARIABLE FUNCTION)
C                = 3 KE IS SPATIALLY VARIABLE AND CAN VARY IN TIME,
C                    (USING 2-D PARAMETER ARRAY AND ONE TIME-VARIABLE
C                     FUNCTION)
C                = 4 KE IS SPATIALLY AND TEMPORALLY VARIABLE                  4
C                    (REQUIRES SEPARATE INPUT FILE)
C    5   TGROPT  ALGAL GROWTH TEMPERATURE OPTION
C                = 0 USE ARRENHIUS TEMPERATURE CORRECTION FOR ALGAL GROWTH
C                = 1 USE TEMPERATURE OPTIMUM FORMULATION FOR ALGAL GROWTH     1
C
```

```
C   IF <AGMOPT> = 0 OR 1 THEN THE USER HAS CHOSEN TO USE THE STANDARD OR
C        TRADITIONAL EUTROPHICATION MODEL AND THE FOLLOWING CONSTANTS
C       (9 Thru 104) ARE SET ASIDE TO SPECIFY THE ALGAL COEFFICIENTS
C   Algal Group 1
C    9   TOPT1   OPTIMAL GROWTH TEMPERATURE FOR DIATOMS            DEG C      8.
C   10   K1BETA1 TEMPERATURE CORRECTION EFFECT ON GROWTH     (DEG C)**-2      0.004
C                RATE BELOW TOPT1
C   11   K1BETA2 TEMPERATURE CORRECTION EFFECT ON GROWTH     (DEG C)**-2      0.004
C                RATE ABOVE TOPT1
C   IF <AGMOPT> = 0 THEN
C   12   K1C     SATURATED PHYTOPLANKTON GROWTH RATE                  /DAY
C                (AT TEMPERATURE = TOPT1)
C   OR IF <AGMOPT> = 1 THEN
C   12   PBMAX1  MAXIMUM PHOTOSYNTHETIC RATE             MG C/MG CHL-DAY     60.
C   13   K1T     TEMPERATURE COEFFICIENT
C   IF <AGMOPT> = 0 THEN
C   14   IS1     SATURATING ALGAL LIGHT INTENSITY                   LY/DAY
C   OR IF <AGMOPT> = 1 THEN
C   14   ALPHA1  INITAL SLOPE OF PRODUCTION VS. IRRADIANCE
C                                      MG C/MG CHL-EINSTEINS M**-2      7.
C   15   KMN1    HALF SATURATION CONSTANT FOR NITROGEN              MG N/L      0.010
C   16   KMP1    HALF SATURATION CONSTANT FOR PHOSPHOROUS           MG P/L      0.001
C   17   KMS1    HALF SATURATION CONSTANT FOR SILICA               MG SI/L      0.010
C   18   K1RB    BASAL/RESTING RESPIRATION RATE -or-                  /DAY
C                ENDOGENOUS RESPIRATION RATE AT 20 DEG C              /DAY      0.085
C   19   K1RT    TEMPERATURE COEFFICIENT                                        1.068
C   20   K1RG    GROWTH-RATE-DEPENDENT RESPIRATION COEFFICIENT                  0.0
C   21   K1GRZC  DEATH RATE DUE TO GRAZING                            /DAY      0.120
C   22   K1GRZT  TEMPERATURE COEFFICIENT                                        1.10
C   23   CCHL1   CARBON TO CHLOROPHYLL RATIO                  MG C/MG CHLA     40.0
C   24   CRBP11  CARBON TO PHOSPHORUS RATIO - NON-P LIMITED     MG C/MG P      50.0
C   25   CRBP12  CARBON TO PHOSPHORUS RATIO - P LIMITED         MG C/MG P      90.0
C   26   CRBP13  COEFFICIENT DETERMINING RANGE OF P LIMITATION    L/MG P     500.
C   27   CRBN11  CARBON TO NITROGEN RATIO - NON-N LIMITED       MG C/MG N       5.4
C   28   CRBN12  CARBON TO NITROGEN RATIO - N LIMITED           MG C/MG N      10.0
C   29   CRBN13  COEFFICIENT DETERMINING RANGE OF N LIMITATION    L/MG N      25.
C   30   CRBS11  CARBON TO SILICA RATIO - NON-SI LIMITED       MG C/MG SI       3.30
C   31   CRBS12  CARBON TO SILICA RATIO - SI LIMITED           MG C/MG SI       9.0
C   32   CRBS13  COEFFICIENT DETERMINING RANGE OF SI LIMITATION  L/MG SI      40.
C   33   XKC1    CHLOROPHYLL SELF-SHADING EXTINCTION           M2/MG CHLA       0.017
C                COEFFICIENT FOR ALGAL GROUP 1
```

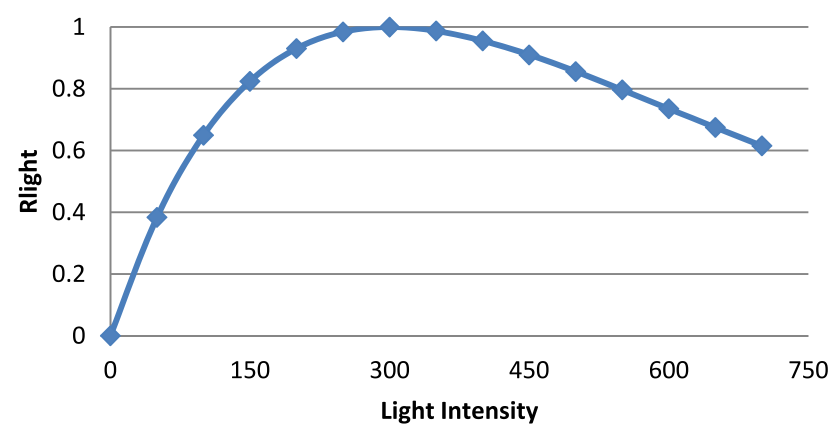
```
C                  RECYCLE FRACTIONS
C  106   FRPOP   REFRACTORY PARTICULATE ORGANIC PHOSPHOROUS                 0.10
C  107   FLPOP   LABILE PARTICULATE ORGANIC PHOSPHOROUS                     0.25
C  108   FRDOP   REFRACTORY DISSOLVED ORGANIC PHOSPHOROUS                   0.10
C  109   FLDOP   LABILE DISSOLVED ORGANIC PHOSPHOROUS                       0.10
C  110   FPO4    DISSOLVED INORGANIC PHOSPHOROUS                            0.45
C  111   FRPON   REFRACTORY PARTICULATE ORGANIC NITROGEN                    0.10
C  112   FLPON   LABILE PARTICULATE ORGANIC NITROGEN                        0.30
C  113   FRDON   REFRACTORY DISSOLVED ORGANIC NITROGEN                      0.125
C  114   FLDON   LABILE DISSOLVED ORGANIC NITROGEN                          0.125
C  115   FNH4    AMMONIA                                                    0.35
C  116   FRPOC   REFRACTORY PARTICULATE ORGANIC CARBON                      0.50
C  117   FLPOC   LABILE PARTICULATE ORGANIC CARBON                          0.40
C  118   FRDOC   REFRACTORY DISSOLVED ORGANIC CARBON                        0.10
C  119   FLDOC   LABILE DISSOLVED ORGANIC CARBON                            0.45
C
C           PHOSPHORUS HYDROLYSIS/MINERALIZATION RATES AT 20 DEG C
C  120   K57C    HYDROLYSIS RATE OF RPOP TO RDOP                   /DAY     0.010
C  121   K57T    TEMPERATURE COEFFICIENT                                    1.080
C  122   K68C    HYDROLYSIS RATE OF LPOP TO LDOP                   /DAY     0.085
C  123   K68T    TEMPERATURE COEFFICIENT                                    1.080
C  124   K79C    MINERALIZATION RATE OF RDOP TO PO4                /DAY     0.025
C  125   K79T    TEMPERATURE COEFFICIENT                                    1.080
C  126   K89C    MINERALIZATION RATE OF LDOP TO PO4                /DAY     0.100
C  127   K89T    TEMPERATURE COEFFICIENT                                    1.080
C
C            NITROGEN HYDROLYSIS/MINERALIZATION RATES AT 20 DEG C
C  128   K1012C  HYDROLYSIS RATE OF RPON TO RDON                   /DAY     0.008
C  129   K1012T  TEMPERATURE COEFFICIENT                                    1.080
C  130   K1113C  HYDROLYSIS RATE OF LPON TO LDON                   /DAY     0.050
C  131   K1113T  TEMPERATURE COEFFICIENT                                    1.080
C  132   K1214C  MINERALIZATION RATE of RDON TO NH4                /DAY     0.008
C  133   K1214T  TEMPERATURE COEFFICIENT                                    1.080
C  134   K1314C  MINERALIZATION RATE OF LDON TO NH4                /DAY     0.085
C  135   K1314T  TEMPERATURE COEFFICIENT                                    1.080
C                 NITRIFICATION/DENITIFICATION RATES
C  136   K1415C  NITRIFICATION RATE AT 20 DEG C                    /DAY     0.100
C  137   K1415T  TEMPERATURE COEFFICIENT                                    1.080
C  138   KNIT    HALF SATURATION CONSTANT FOR NITRIF-           MG O2/L     1.0
C                ICATION OXYGEN LIMITATION
```

# Algal Growth Formulations:

- RCA has evolved over time to reflect new information on algal growth dynamics as reported in the literature
- Initial light formulation based on Steele (1965)

$$F(I) = \frac{I}{I_s} \exp\left[ -\frac{I}{I_s} + 1 \right]$$

where I is the incident solar radiation and $I_s$ is the saturatinglight intensity



# Algal Growth Formulations:

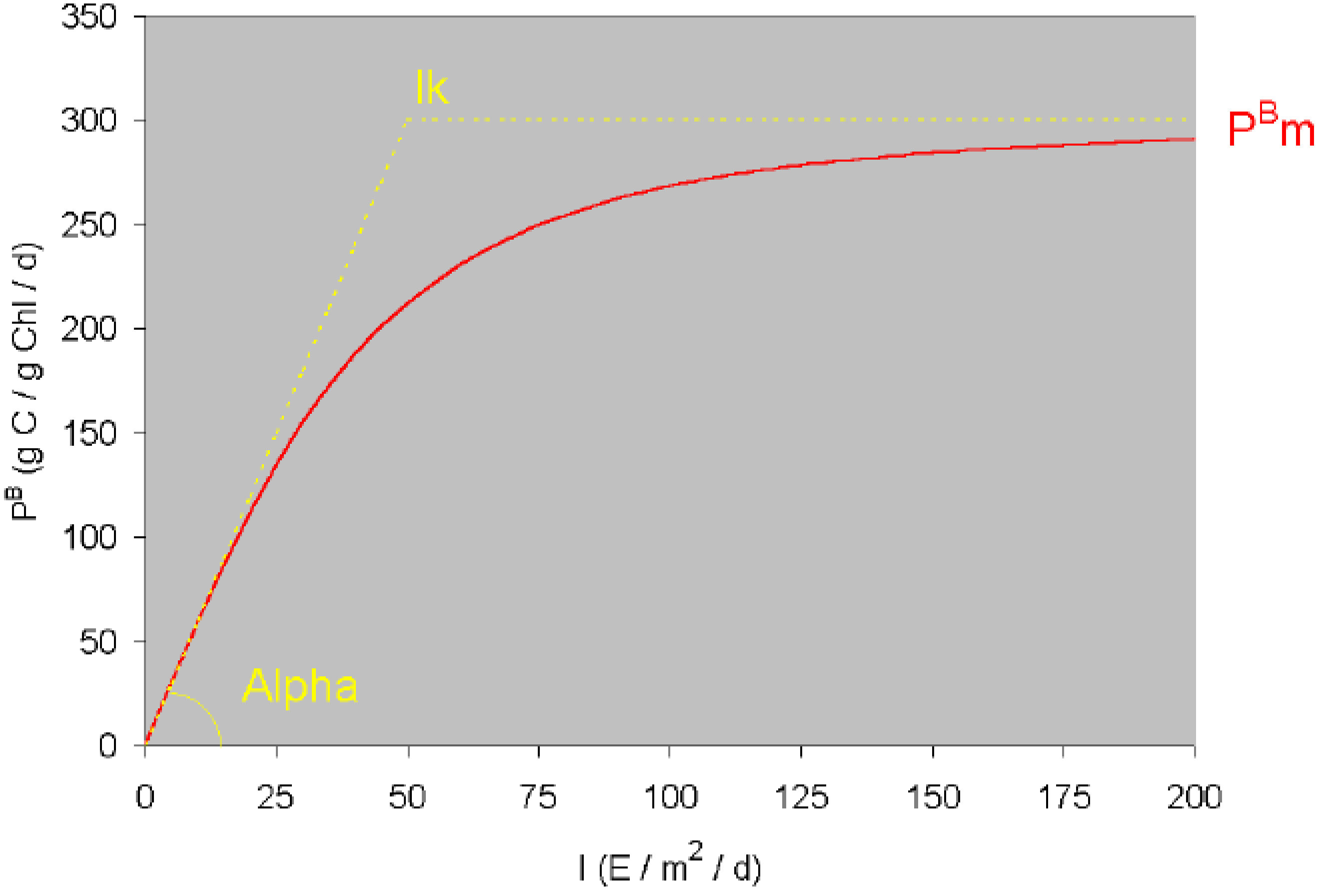
- Recently modified RCA to include the Jassby-Platt (1976) formulation

$$P^B = P^B m \frac{I}{\sqrt{I^2 + Ik^2}}$$

in which:
$P^B$ = photosynthetic rate (g C $g^{-1}$ Chl $d^{-1}$)
$P^B m$ = maximum photosynthetic rate (g C $g^{-1}$ Chl $d^{-1}$)
I = irradiance (E $m^{-2}$ $d^{-1}$)

$$Ik = \frac{P^B m}{\alpha}$$

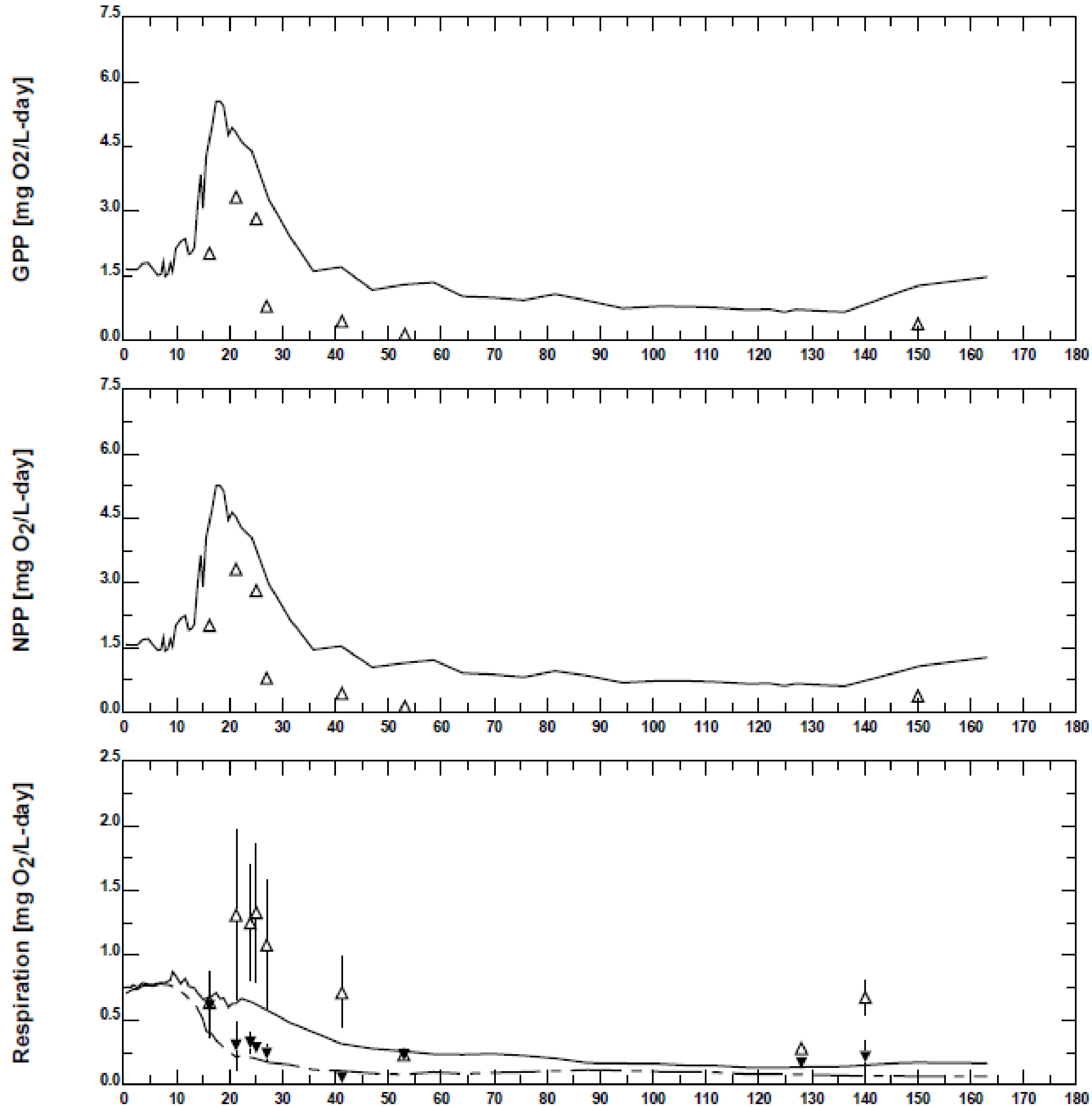
in which:
$\alpha$ = initial slope of production vs. irradiance relationship (g C $g^{-1}$ Chl $(E\ m^{-2})^{-1}$)



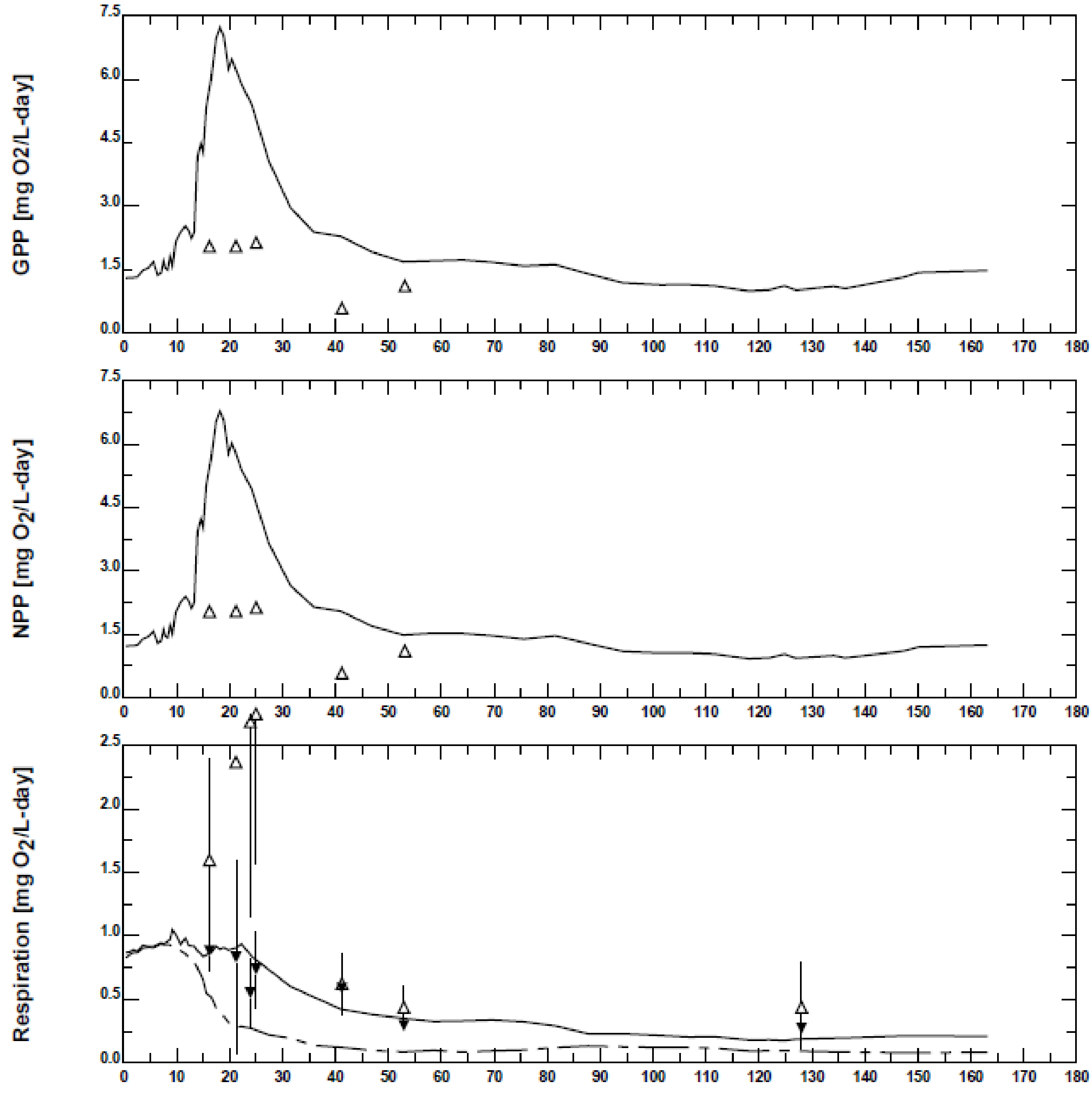
350
300
250
200
150
100
50
0
Ik
P^B m
Alpha
0
25
50
75
100
125
150
175
200
P^B (g C / g Chl / d)
I (E / m^2 / d)

**WY 1989 Calibration:**
**Production / Respiration**
**June 1989**

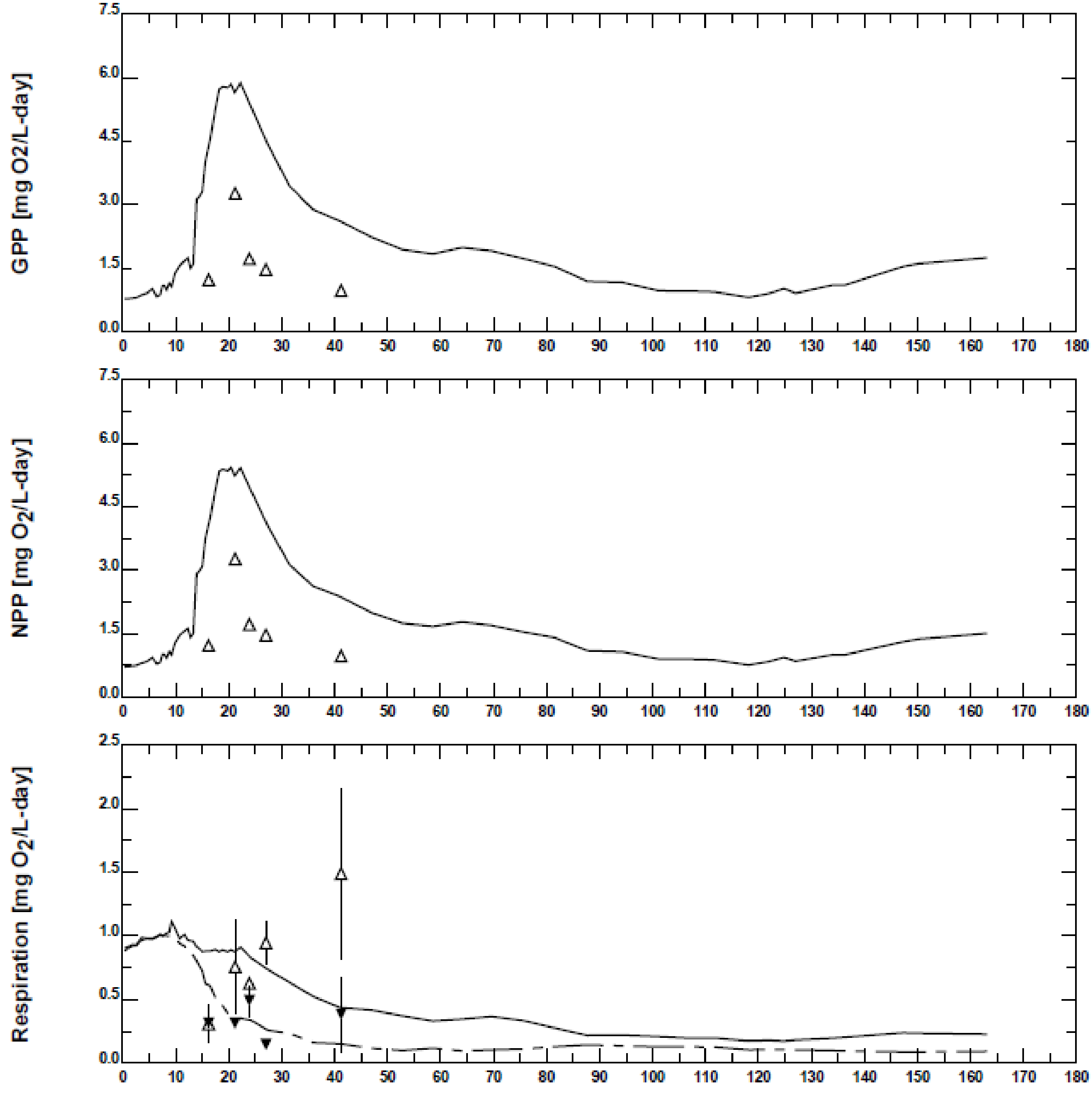
**Welsh and Eller (1991)**
**Light/dark bottles at**
**Various depths**
**1988: 8-hr incubations**
**(0.5, 5, and 10 m below surface and 1 and 10 m above bottom**
**1989: 24-hr composite of 3 sequential arrays (sunrise to solar noon, solar noon to sunset, sunset to sunrise)**
**(0.5, 2, 4, 6, and 8 m below surface and 1 and 5 m above bottom)**



## WY 1989 Calibration: Production / Respiration July 1989



# WY 1989 Calibration: Production / Respiration August 1989



**Production / Respiration 2002/2003**

**Δ D.O. over 3-4 hr incubations and then fit to a BZI model**

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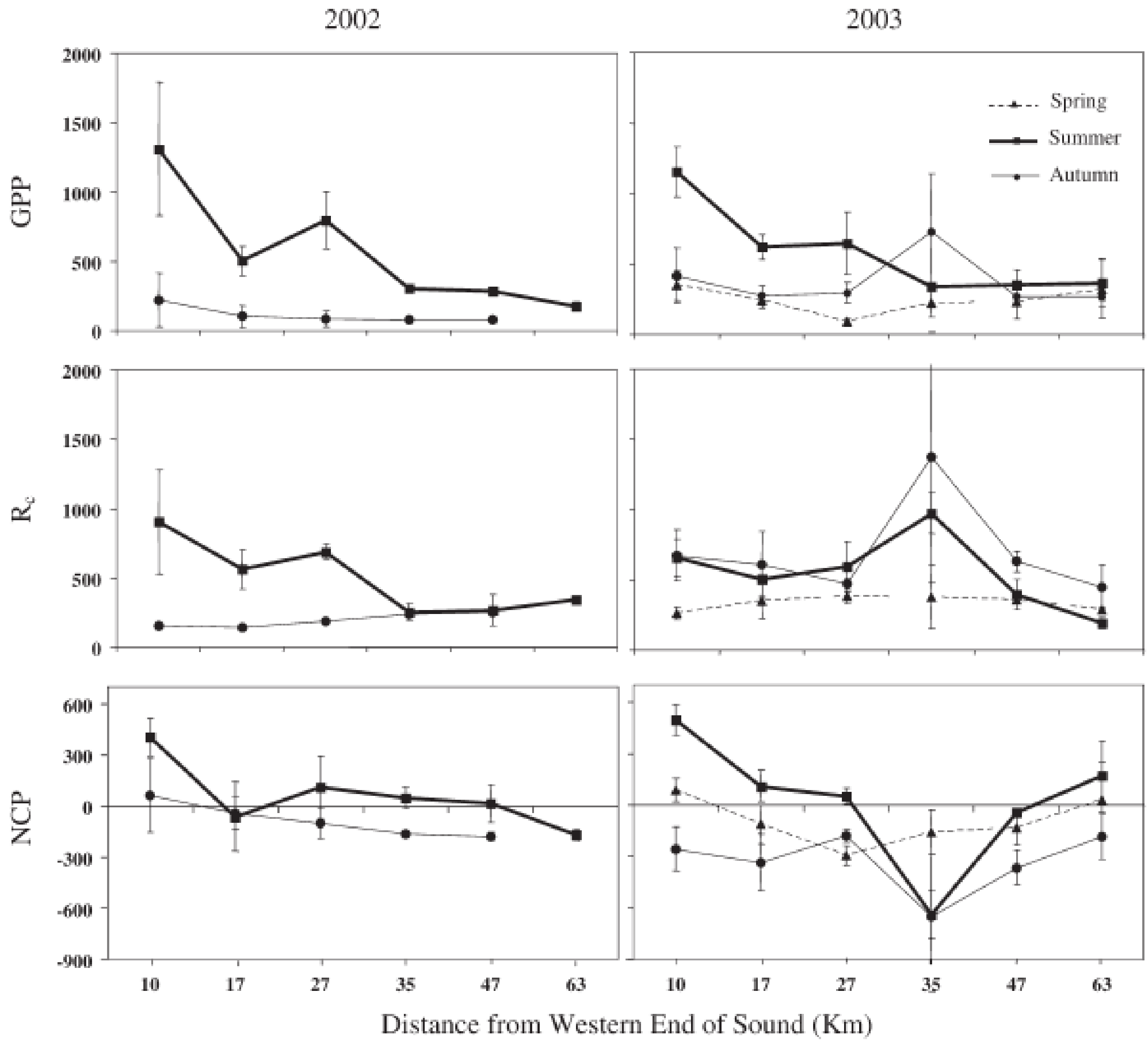
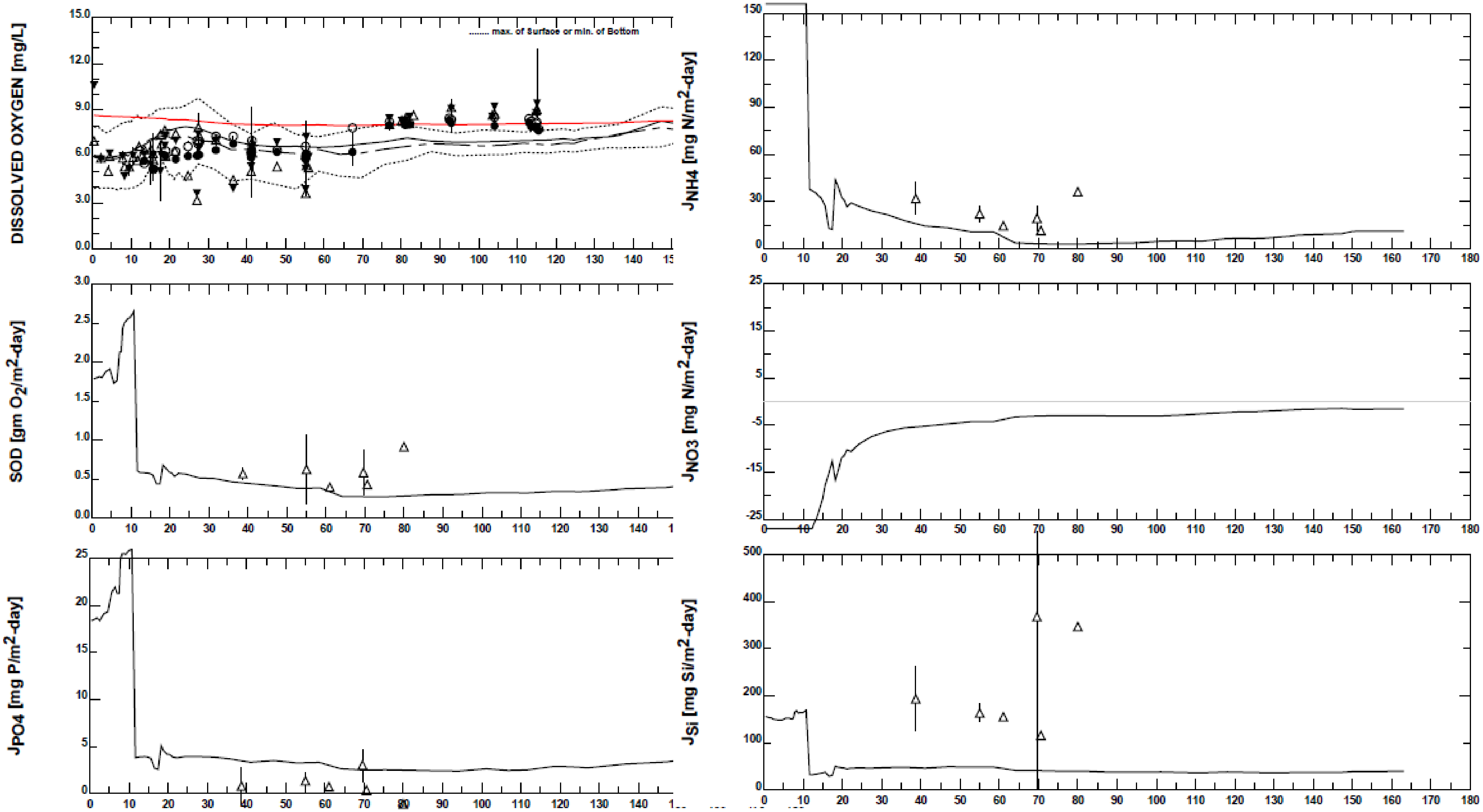
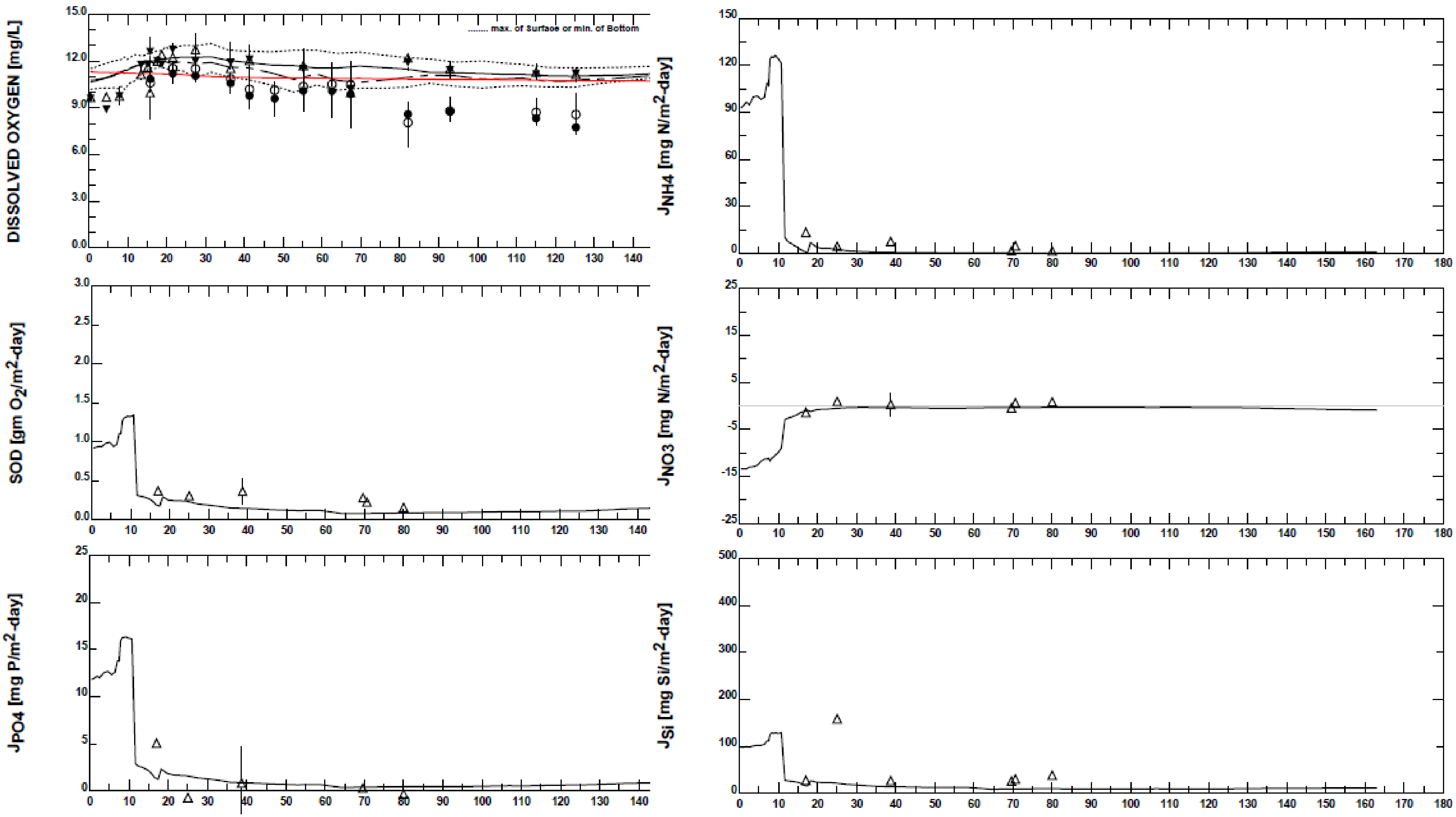



Fig. 3. Interannual and spatial variation in photic-zone integrated daily rates of GPP, $R_c$, and NCP (mmol $O_2$ $m^{-2}$ $d^{-1}$) measured at each station during the late spring (May through early June), summer (July through early September), and autumn (October through November) of 2002 and 2003. Error bars (±SD) demonstrate variability within each season for each station.

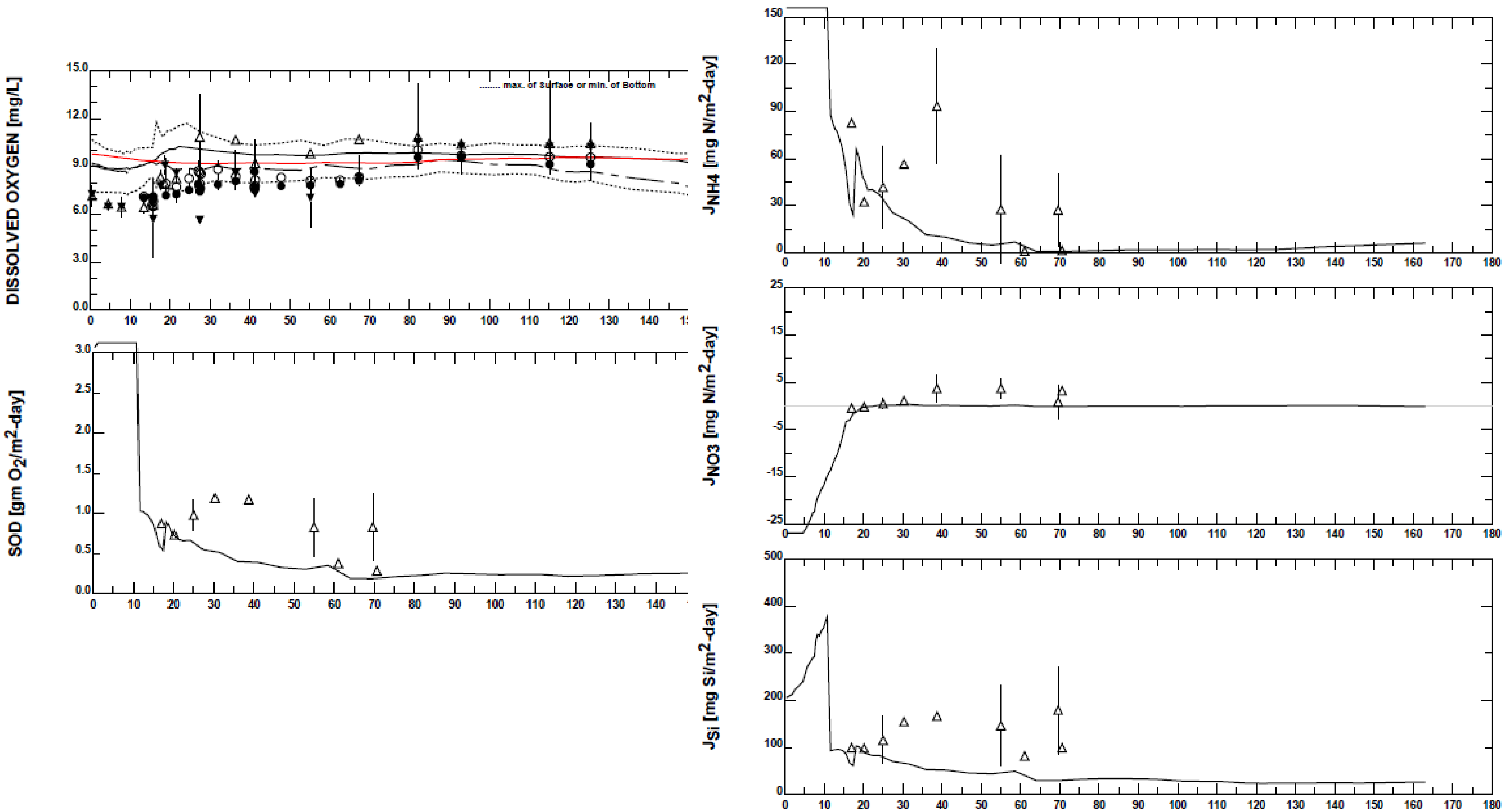
# WY 1989 Calibration:
# SOD / Nutrient Fluxes
# October 1988



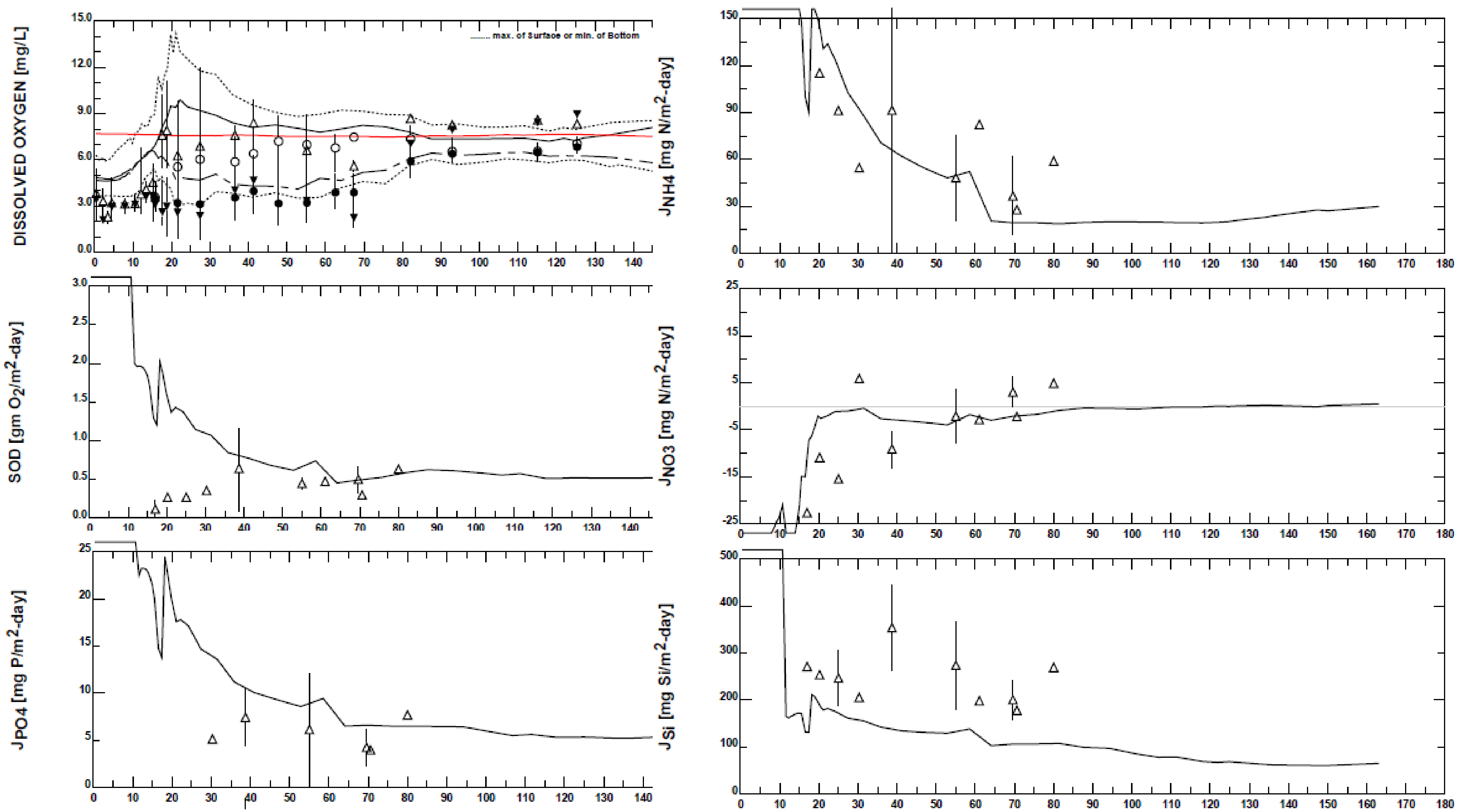
# WY 1989 Calibration:
# SOD / Nutrient Fluxes
## February 1989



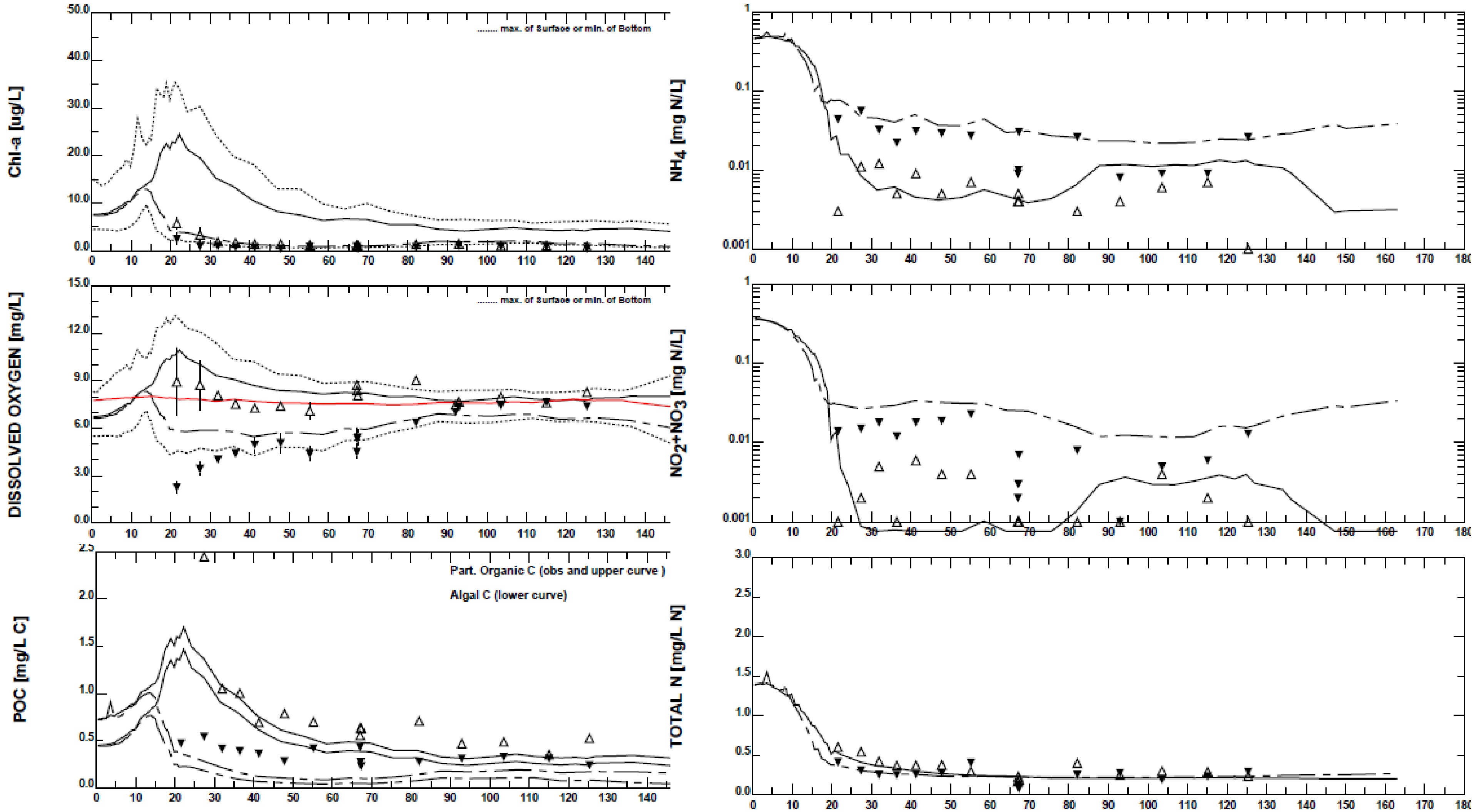
# WY 1989 Calibration:
# SOD / Nutrient Fluxes
# May 1989



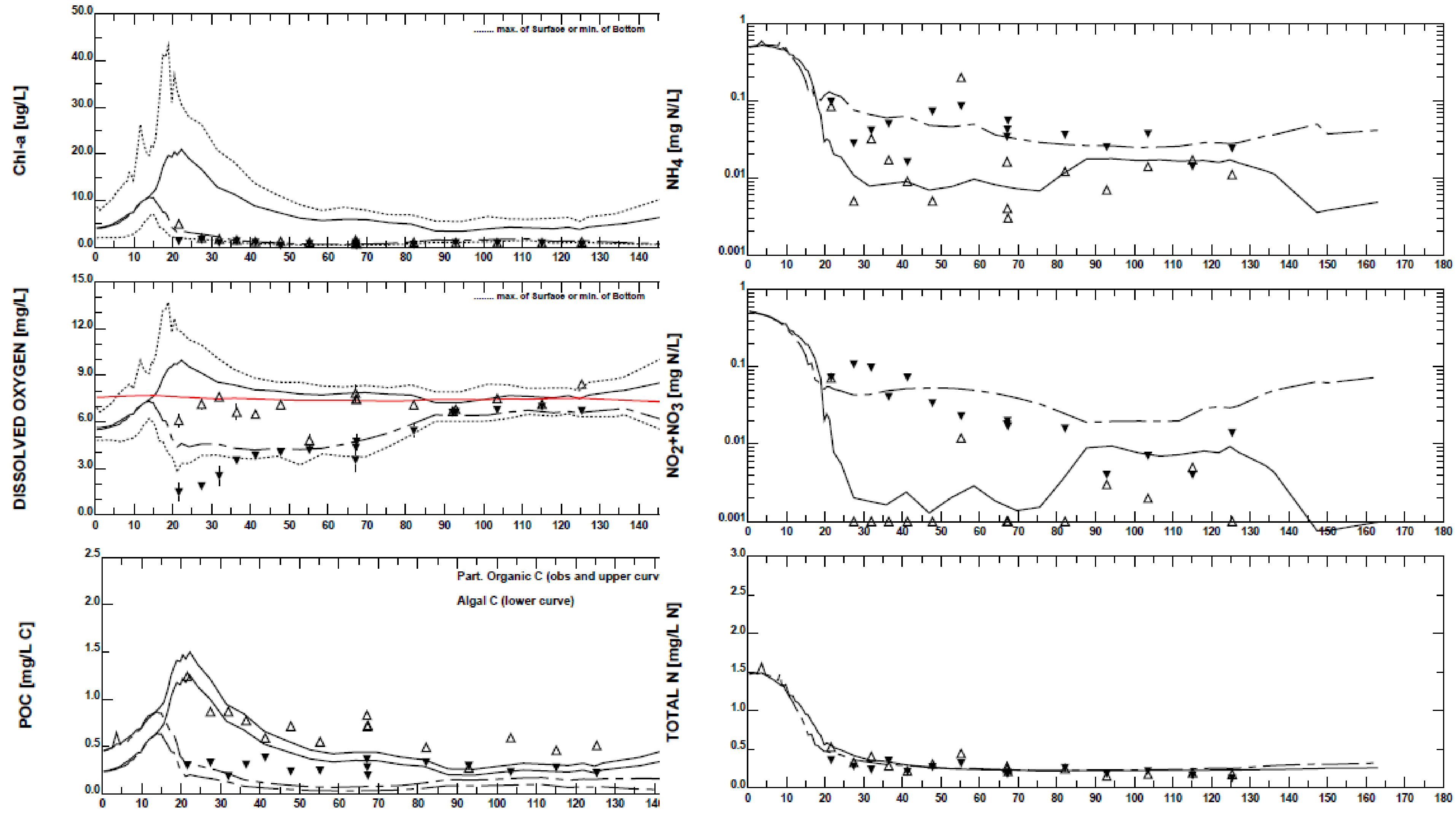
# WY 1989 Calibration:
# SOD / Nutrient Fluxes
# August 1989



# WY 1989 Calibration:
# Water Column
# July 1999

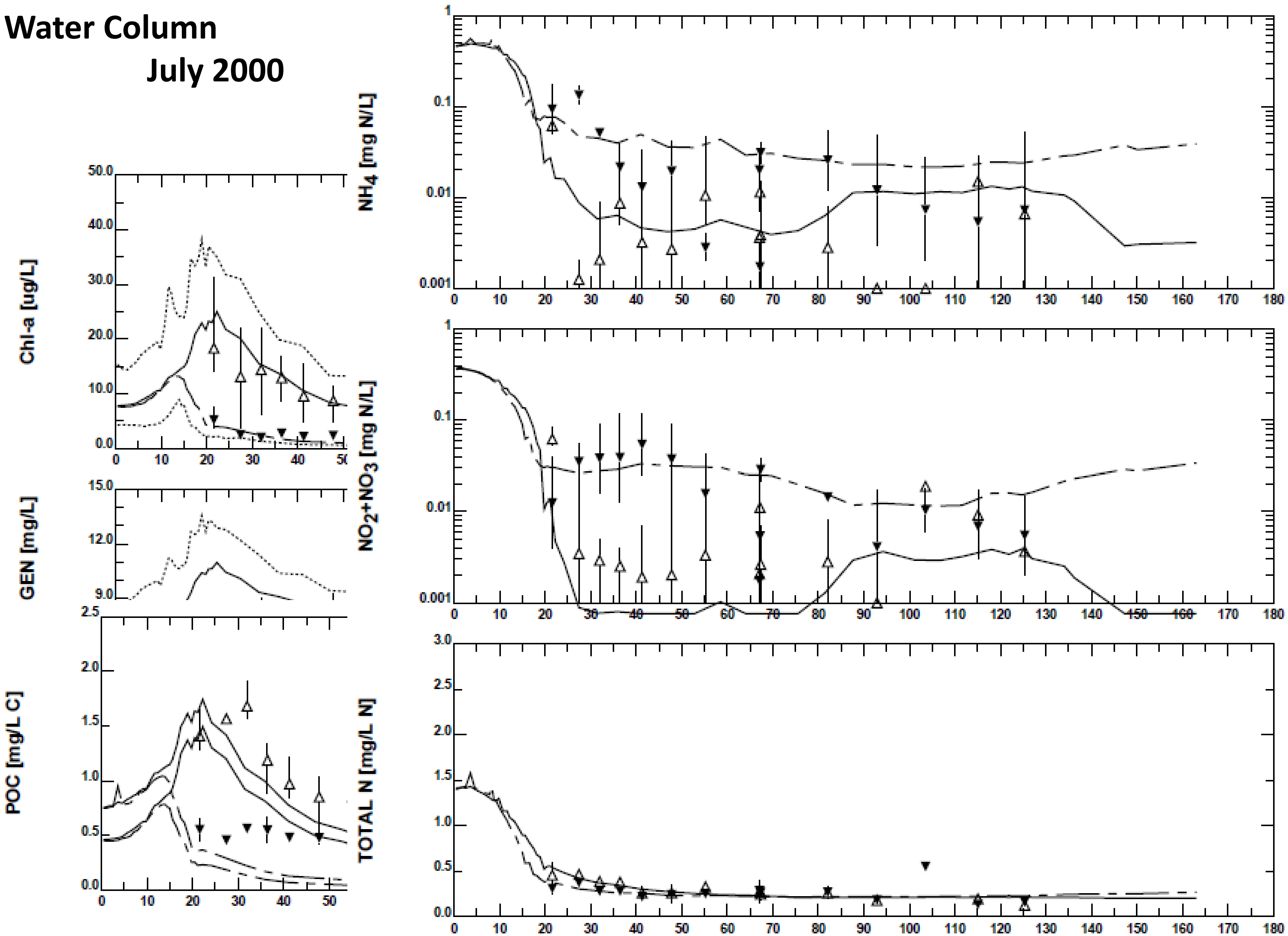


# WY 1989 Calibration:
# Water Column
## August 1999

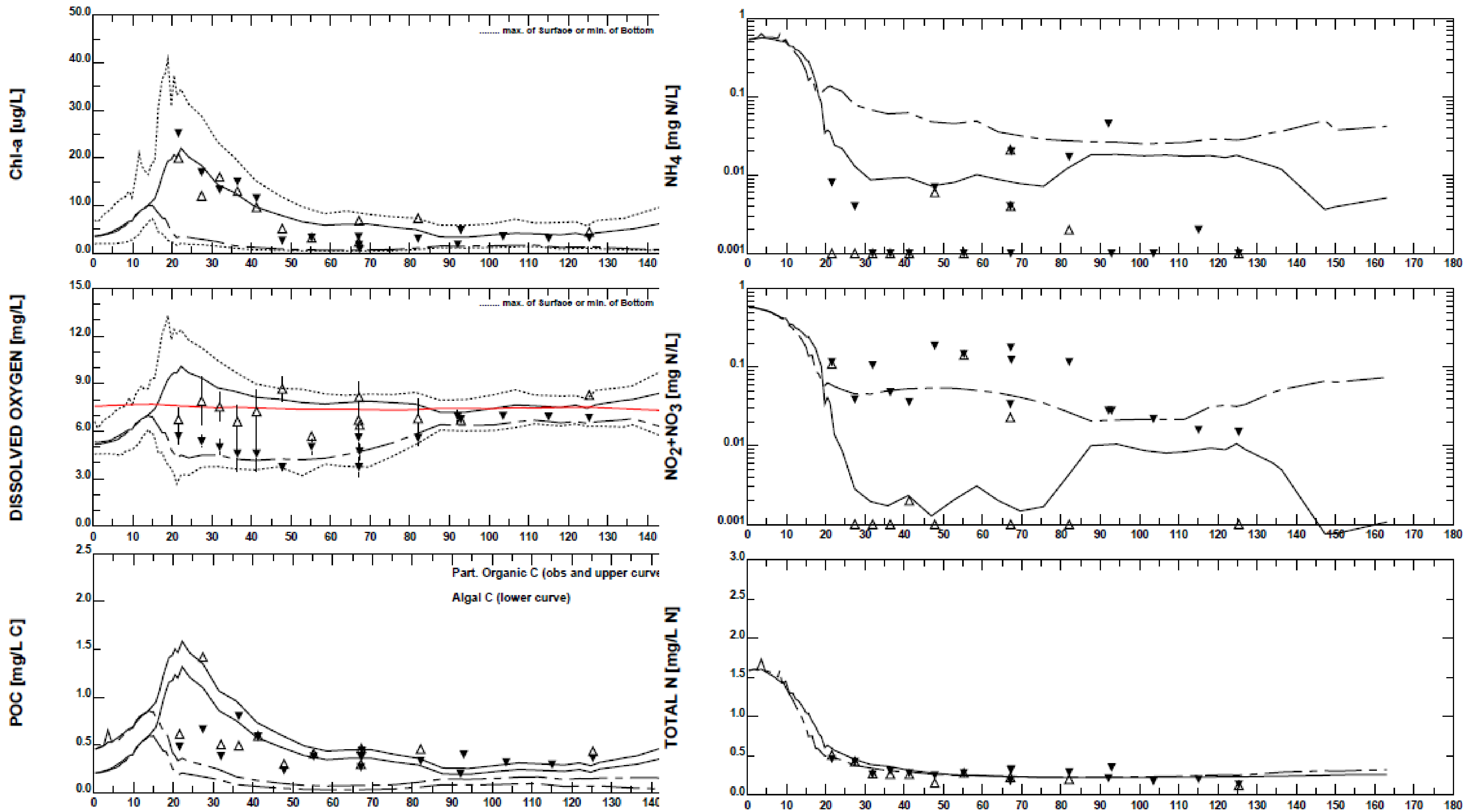


# WY 1989 Calibration: Water Column

July 2000

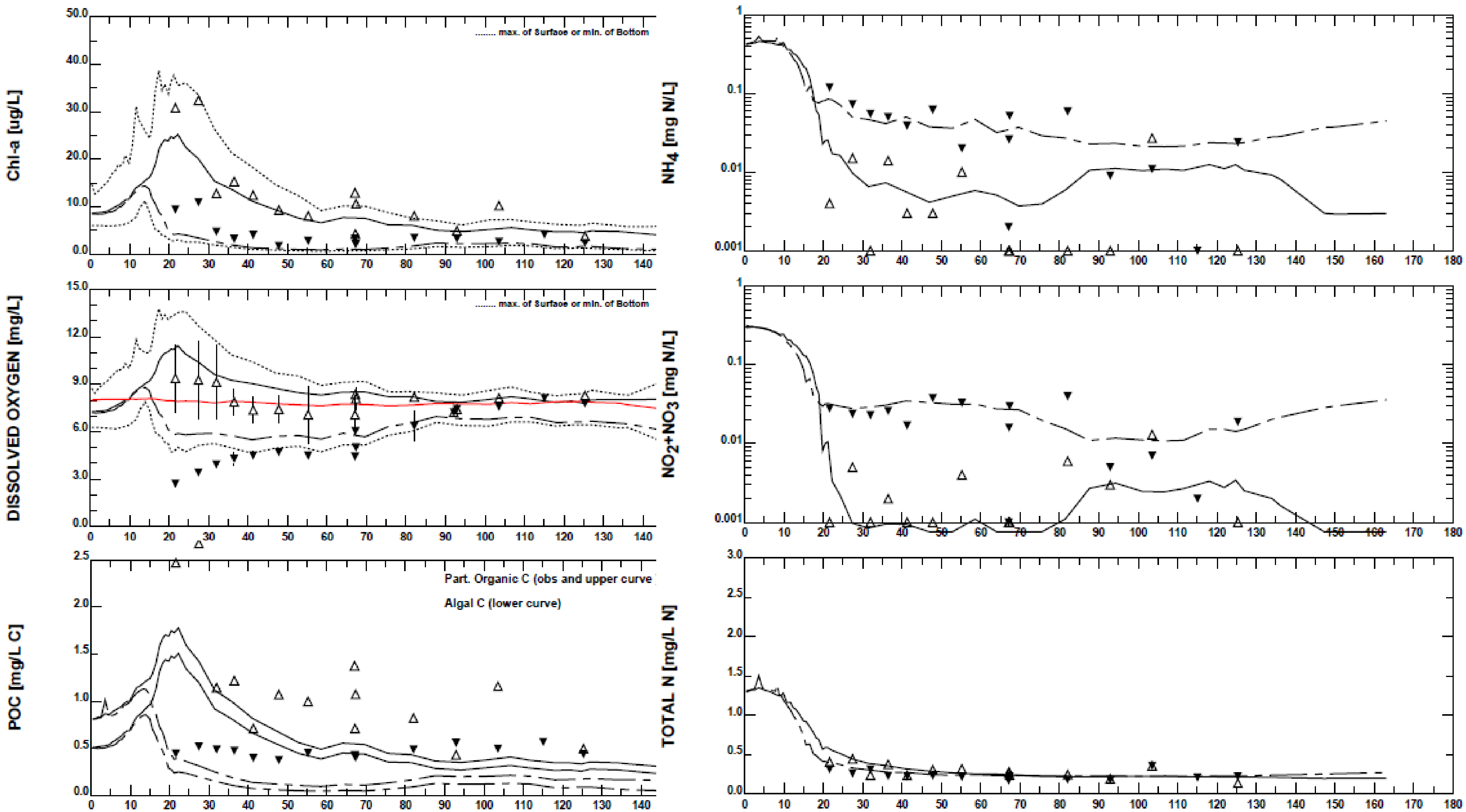


# WY 1989 Calibration:
# Water Column
## August 2000

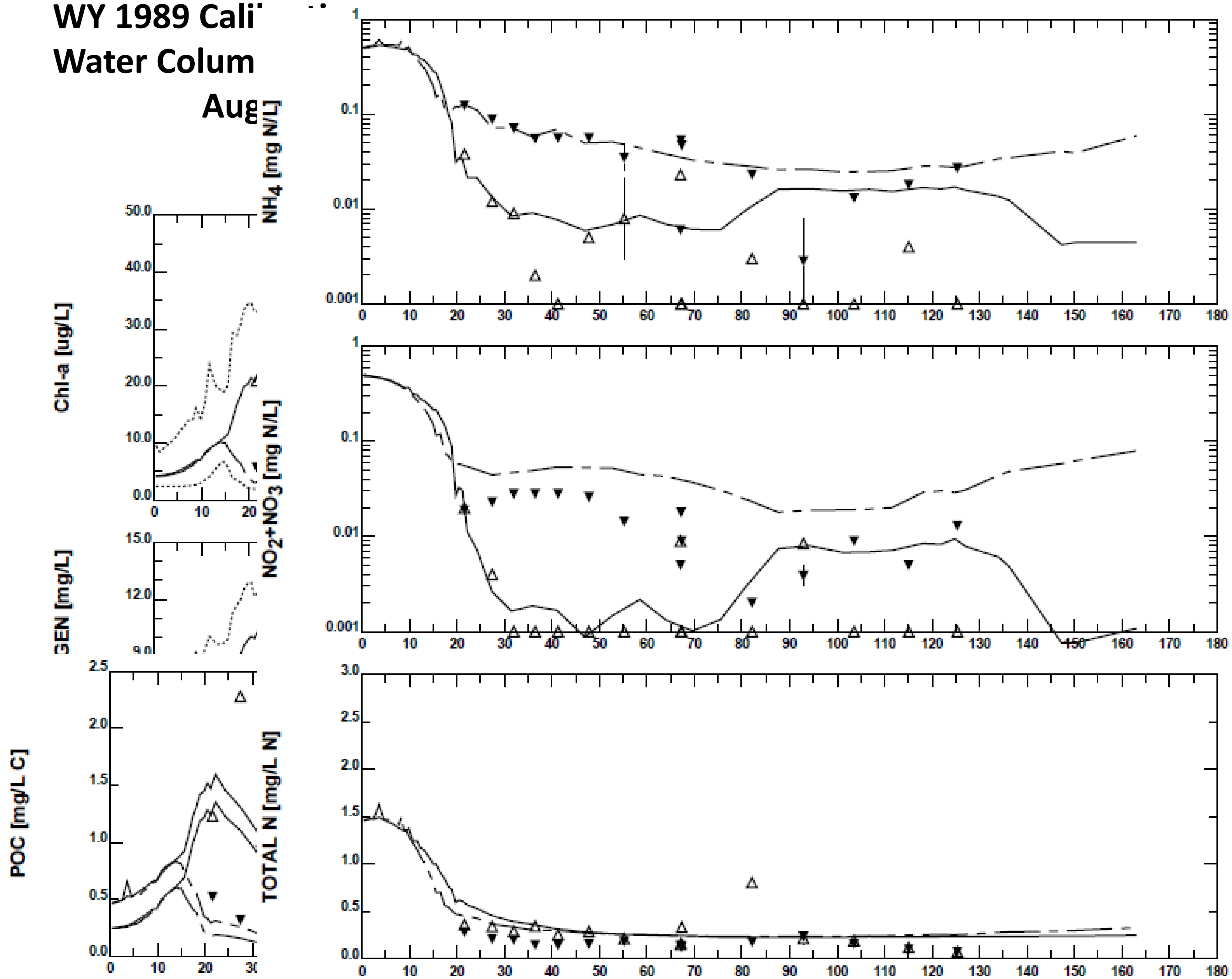


# WY 1989 Calibration: Water Column

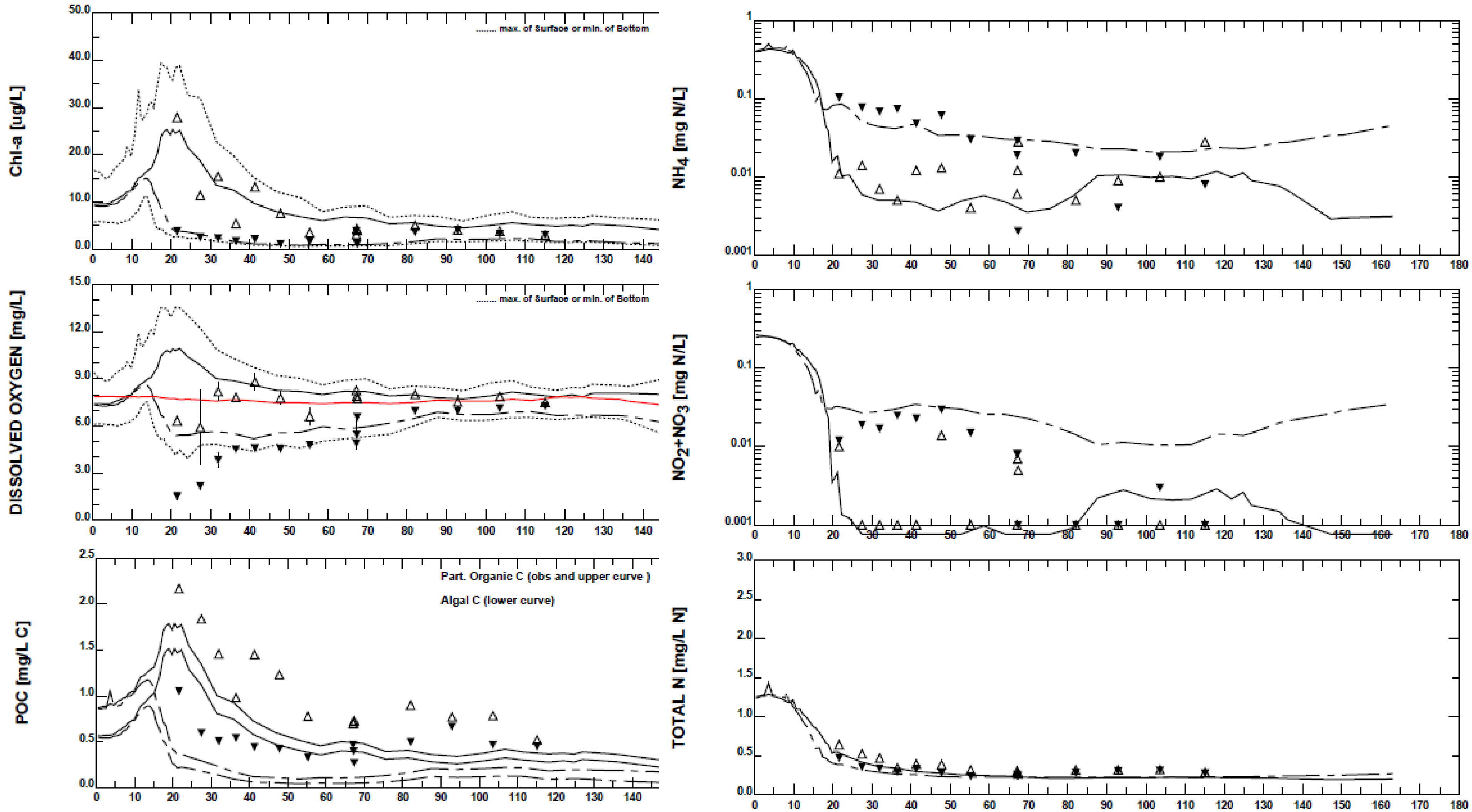
July 2001



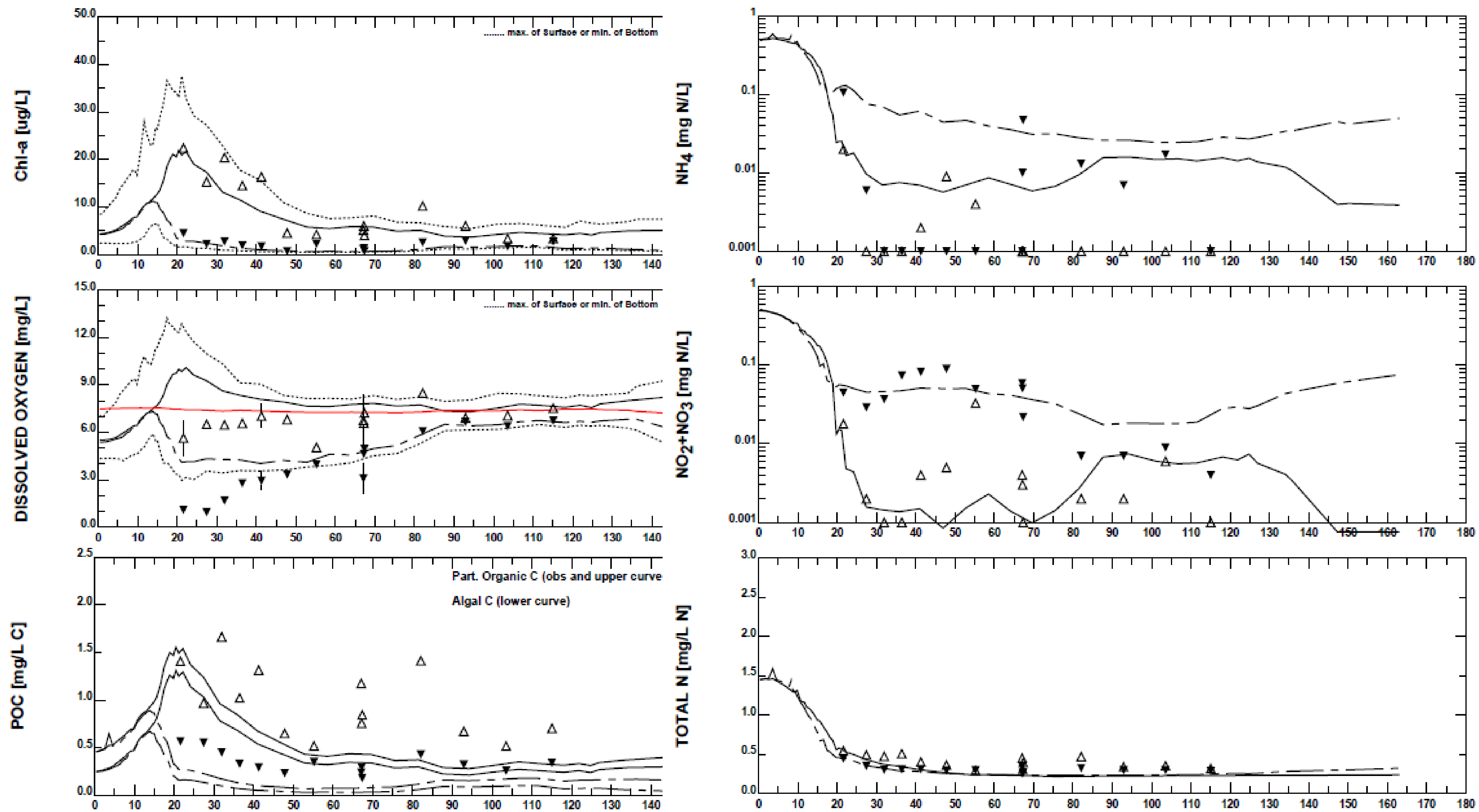
WY 1989 Cali
Water Colum
Aug



# WY 1989 Calibration:
# Water Column
## July 2002



# WY 1989 Calibration:
# Water Column
## August 2002



## Next Steps

- additional productivity and respiration data
- additional calibration – respiration rates, settling velocities, grazing, etc.
- transect flux computations
- high resolution LIS grid

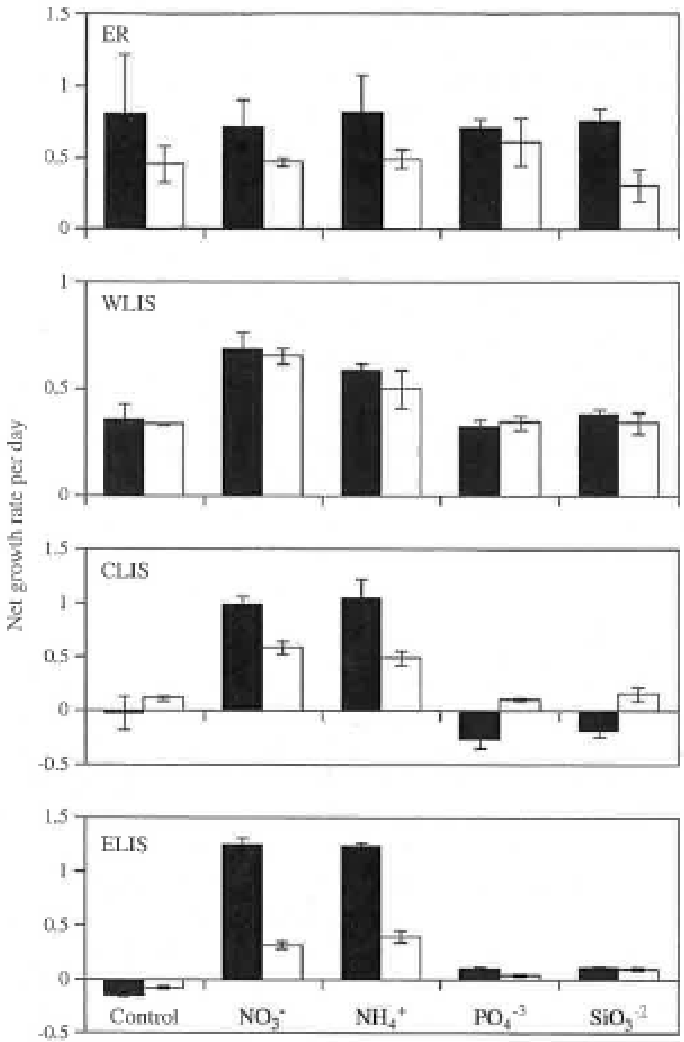



Fig. 2. Net growth rates of plankton communities at experimental stations (ER, WLIS, CLIS, ELIS) during summer, based on changes in levels of chlorophyll *a* (black bars) and POC (white bars). $NO_3^-$ is nitrate, $NH_4^+$ is ammonium, $PO_4^{-3}$ is orthophosphate, $SiO_3^{-2}$ is silicon. Error bars represent ± 1SD of triplicate measurements.

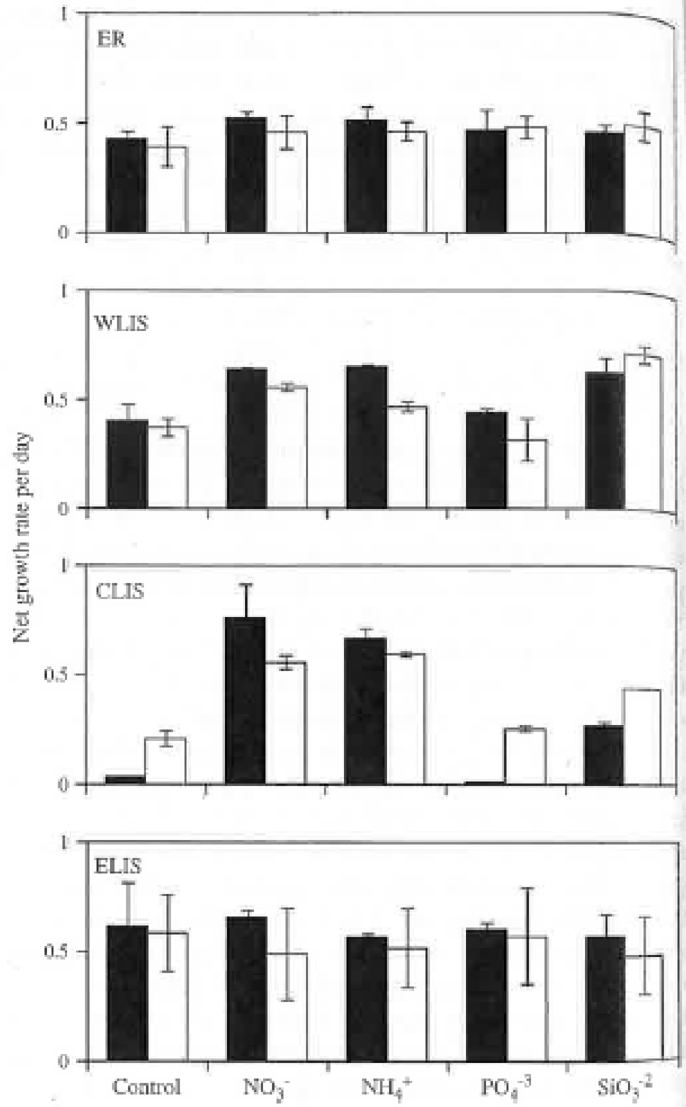
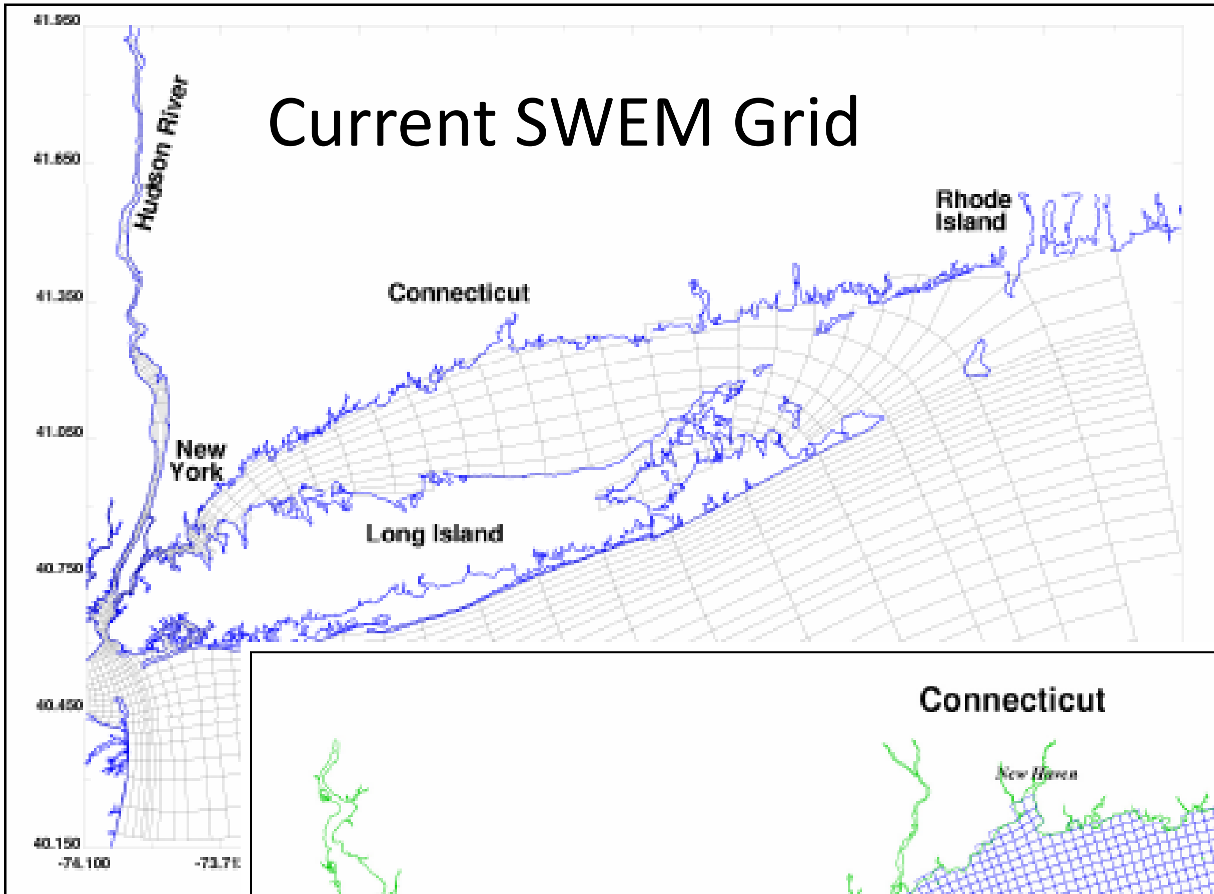
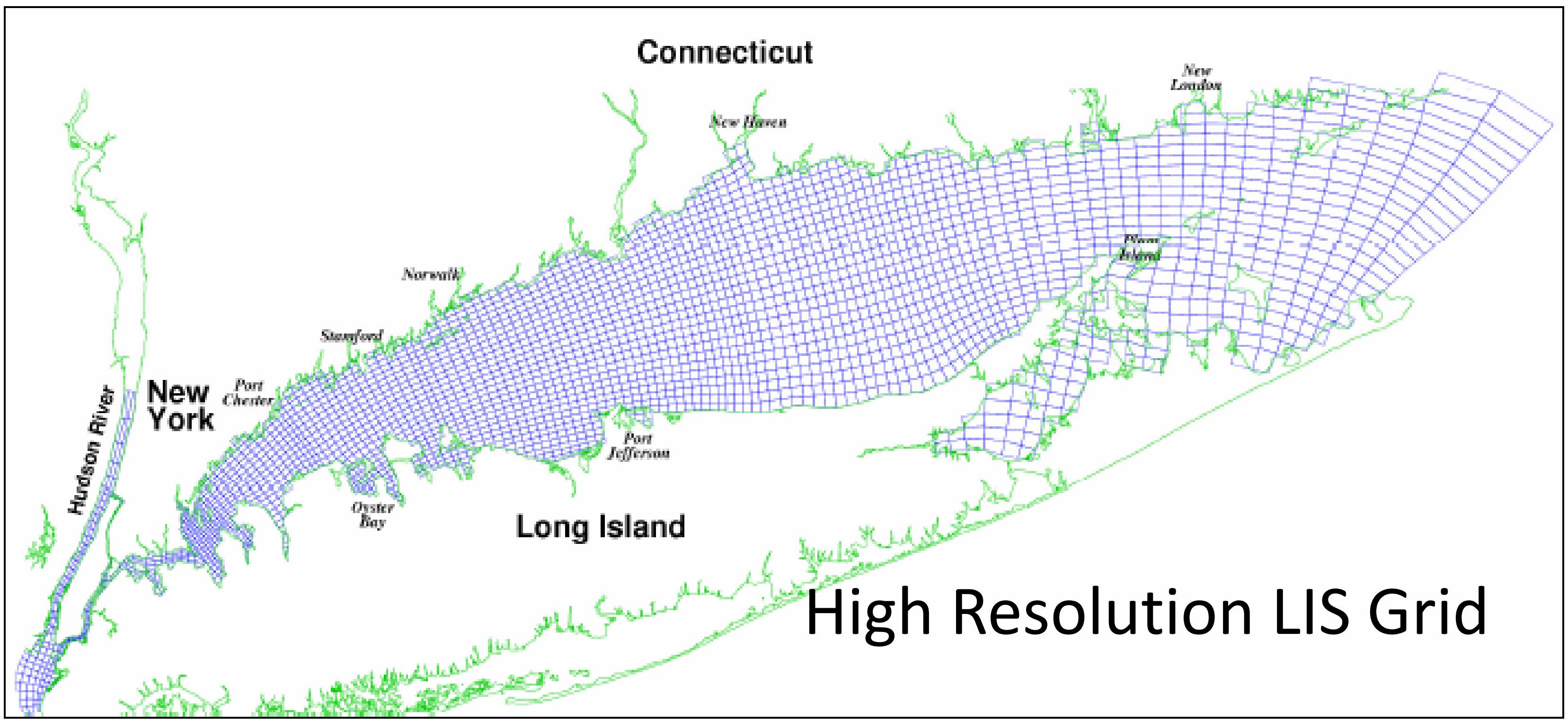



Fig. 3. Net growth rates of plankton communities at experimental stations (ER, WLIS, CLIS, ELIS) during spring, based on changes in levels of chlorophyll *a* (black bars) and POC (white bars). $NO_3^-$ is nitrate, $NH_4^+$ is ammonium, $PO_4^{-3}$ is orthophosphate, $SiO_3^{-2}$ is silicon. Error bars represent ± 1SD of triplicate measurements.


Current SWEM Grid
41.950
41.650
41.350
41.050
40.750
40.450
40.150
-74.100
Hudson River
Rhode Island
Connecticut
New York
Long Island


Connecticut
New London
New Haven
Norwalk
Stamford
Port Chester
New York
Hudson River
Plum Island
Port Jefferson
Oyster Bay
Long Island
High Resolution LIS Grid