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)

**TN**

<table>
<thead>
<tr>
<th>Water Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Load (lbs/day)</td>
<td>2000000</td>
<td>2200000</td>
<td>2100000</td>
<td>1800000</td>
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**NOx**

<table>
<thead>
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<th>2001</th>
<th>2002</th>
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<td>1400000</td>
<td>1300000</td>
<td>1000000</td>
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**TON**

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**NH4**

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<th>1999</th>
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<th>2001</th>
<th>2002</th>
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</thead>
<tbody>
<tr>
<td>Annual Load (lbs/day)</td>
<td>10000</td>
<td>12000</td>
<td>11000</td>
<td>8000</td>
</tr>
</tbody>
</table>

Legend:
- **USGS**
- **HDR|HQI**
## Model Coefficients:

<table>
<thead>
<tr>
<th>Systems</th>
<th>Units</th>
</tr>
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<tbody>
<tr>
<td>1 - Salinity (SAL)</td>
<td>PPT</td>
</tr>
<tr>
<td><strong>Phytoplankton</strong></td>
<td></td>
</tr>
<tr>
<td>2 - Winter Diatoms (PHYT1)</td>
<td>MG C/L</td>
</tr>
<tr>
<td>3 - Summer Assemblage (PHYT2)</td>
<td>MG C/L</td>
</tr>
<tr>
<td>4 - Fall Assemblage (PHYT3)</td>
<td>MG C/L</td>
</tr>
<tr>
<td><strong>Phosphorus</strong></td>
<td></td>
</tr>
<tr>
<td>5 - Refractory Particulate Organic (RPOP)</td>
<td>MG P/L</td>
</tr>
<tr>
<td>6 - Labile Particulate Organic (LPOP)</td>
<td>MG P/L</td>
</tr>
<tr>
<td>7 - Refractory Dissolved Organic (RDOP)</td>
<td>MG P/L</td>
</tr>
<tr>
<td>8 - Labile Dissolved Organic (LDOP)</td>
<td>MG P/L</td>
</tr>
<tr>
<td>9 - Total Dissolved Inorganic (PO4T)</td>
<td>MG P/L</td>
</tr>
<tr>
<td><strong>Nitrogen</strong></td>
<td></td>
</tr>
<tr>
<td>10 - Refractory Particulate Organic (RPON)</td>
<td>MG N/L</td>
</tr>
<tr>
<td>11 - Labile Particulate Organic (LPON)</td>
<td>MG N/L</td>
</tr>
<tr>
<td>12 - Refractory Dissolved Organic (RDON)</td>
<td>MG N/L</td>
</tr>
<tr>
<td>13 - Labile Dissolved Organic (LDON)</td>
<td>MG N/L</td>
</tr>
<tr>
<td>14 - Total Ammonia (NH4T)</td>
<td>MG N/L</td>
</tr>
<tr>
<td>15 - Nitrite + Nitrate (NO23)</td>
<td>MG N/L</td>
</tr>
<tr>
<td><strong>Silica</strong></td>
<td></td>
</tr>
<tr>
<td>16 - Biogenic - Unavailable (BSI)</td>
<td>MG SI/L</td>
</tr>
<tr>
<td>17 - Total Inorganic (SIT)</td>
<td>MG SI/L</td>
</tr>
</tbody>
</table>
Model Coefficients:

C**********************************************************************
C  CONSTANTS
C  ------
C  NAMES AND DESCRIPTIONS OF CONSTANTS
C**********************************************************************

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                      REGENERATION 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 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 FUNCTION)
C      = 4 KE IS SPATIALLY AND TEMPORALLY VARIABLE
C      (REQUIRES SEPARATE INPUT FILE)
C  5   TGROPT                      ALGAL GROWTH TEMPERATURE OPTION
C      = 0 USE ARRHENIUS TEMPERATURE CORRECTION FOR ALGAL GROWTH             1
C      = 1 USE TEMPERATURE OPTIMUM FORMULATION FOR ALGAL GROWTH
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
C Algal Group 1
C
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 11 K1BETA2 TEMPERATURE CORRECTION EFFECT ON GROWTH (DEG C)**-2 0.004
C
C IF <AGMOPT> = 0 THEN
C 12 K1C SATURATED PHYTOPLANKTON GROWTH RATE /DAY
C 13 K1T TEMPERATURE COEFFICIENT
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 INITIAL SLOPE OF PRODUCTION VS. IRRADIANCE MG C/MG CHL-EINSTEINS M**-2 7.
C 15 KNN1 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 19 K1RT TEMPERATURE COEFFICIENT
C 20 K1RG GROWTH-RATE-DEPENDENT RESPIRATION COEFFICIENT
C 21 K1GRZC DEATH RATE DUE TO GRAZING /DAY 0.120
C 22 K1GRZT TEMPERATURE COEFFICIENT
C 23 CCHL1 CARBON TO CHLOROPHYLL RATIO MG C/MG CHLA 40.0
C 24 CRBP11 CARBON TO PHOSPHOROUS RATIO - NON-P LIMITED MG C/MG P 50.0
C 25 CRBP12 CARBON TO PHOSPHOROUS 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
RECYCLE FRACTIONS

196 FRPOP REFRACATORY PARTICULATE ORGANIC PHOSPHOROUS 0.10
197 FLPOP LABILE PARTICULATE ORGANIC PHOSPHOROUS 0.25
198 FRDOP REFRACATORY DISSOLVED ORGANIC PHOSPHOROUS 0.10
199 FLDOP LABILE DISSOLVED ORGANIC PHOSPHOROUS 0.10
110 FP04 DISSOLVED INORGANIC PHOSPHOROUS 0.45
111 FRPON REFRACATORY PARTICULATE ORGANIC NITROGEN 0.10
112 FLPON LABILE PARTICULATE ORGANIC NITROGEN 0.30
113 FRDON REFRACATORY DISSOLVED ORGANIC NITROGEN 0.125
114 FLDON LABILE DISSOLVED ORGANIC NITROGEN 0.125
115 FNH4 AMMONIA 0.35
116 FRPOC REFRACATORY PARTICULATE ORGANIC CARBON 0.50
117 FLPOC LABILE PARTICULATE ORGANIC CARBON 0.40
118 FRDOC REFRACATORY DISSOLVED ORGANIC CARBON 0.10
119 FLDOC LABILE DISSOLVED ORGANIC CARBON 0.45

PHOSPHORUS HYDROLYSIS/MINERALIZATION RATES AT 20 DEG C

120 K57C HYDROLYSIS RATE OF RPPOP TO RDOP /DAY 0.010
121 K57T TEMPERATURE COEFFICIENT 1.000
122 K68C HYDROLYSIS RATE OF LPPOP TO LDOP /DAY 0.085
123 K68T TEMPERATURE COEFFICIENT 1.000
124 K79C MINERALIZATION RATE OF RDOP TO P04 /DAY 0.025
125 K79T TEMPERATURE COEFFICIENT 1.000
126 K89C MINERALIZATION RATE OF LDOP TO P04 /DAY 0.100
127 K89T TEMPERATURE COEFFICIENT 1.000

NITROGEN HYDROLYSIS/MINERALIZATION RATES AT 20 DEG C

128 K1012C HYDROLYSIS RATE OF RPON TO RDON /DAY 0.088
129 K1012T TEMPERATURE COEFFICIENT 1.000
130 K1113C HYDROLYSIS RATE OF LPON TO LDON /DAY 0.050
131 K1113T TEMPERATURE COEFFICIENT 1.000
132 K1214C MINERALIZATION RATE OF RDON TO NH4 /DAY 0.008
133 K1214T TEMPERATURE COEFFICIENT 1.000
134 K1314C MINERALIZATION RATE OF LDON TO NH4 /DAY 0.005
135 K1314T TEMPERATURE COEFFICIENT 1.000

NITRIFICATION/DENITIFICATION RATES

136 K1415C NITRIFICATION RATE AT 20 DEG C /DAY 0.100
137 K1415T TEMPERATURE COEFFICIENT 1.000
138 KNIT HALF SATURATION CONSTANT FOR NITRIFICATION MG 02/L 1.0
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 saturating light intensity.
Algal Growth Formulations:

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

\[ P^B = P^B_m \frac{I}{\sqrt{I^2 + I_k^2}} \]

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\(^{-1}\))
- \( I_k = \frac{P^B_m}{\alpha} \)

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

$\Delta$ D.O. over 3-4 hr incubations and then fit to a BZI model
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
August 2000
WY 1989 Calibration:
Water Column
July 2001

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Graphs showing various parameters including:
- CH-a [µg/L]
- NH₄ [mg N/L]
- DISSOLVED OXYGEN [mg/L]
- NO₂-NO₃ [mg N/L]
- POC [mg/L C]
- TOTAL N [mg/L N]

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Max. or surface or min. of bottom

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Footnotes or additional details could be included here if necessary.
WY 1989 Calibration
Water Column
August 2001
WY 1989 Calibration:
Water Column
July 2002

[Graphs showing data for various parameters such as Chl-a [ug/L], NH$_4$ [mg/L], Dissolved Oxygen [mg/L], NO$_2$+NO$_3$ [mg/L], POC [mg/L], and TOTAL N [mg/L]]
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). $\text{NO}_3^-$ is nitrate, $\text{NH}_4^+$ is ammonium, $\text{PO}_4^{3-}$ is orthophosphate, $\text{SiO}_2^2$ is silicon. Error bars represent $\pm 1$SD 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). $\text{NO}_3^-$ is nitrate, $\text{NH}_4^+$ is ammonium, $\text{PO}_4^{3-}$ is orthophosphate, $\text{SiO}_2^2$ is silicon. Error bars represent $\pm 1$SD of triplicate measurements.