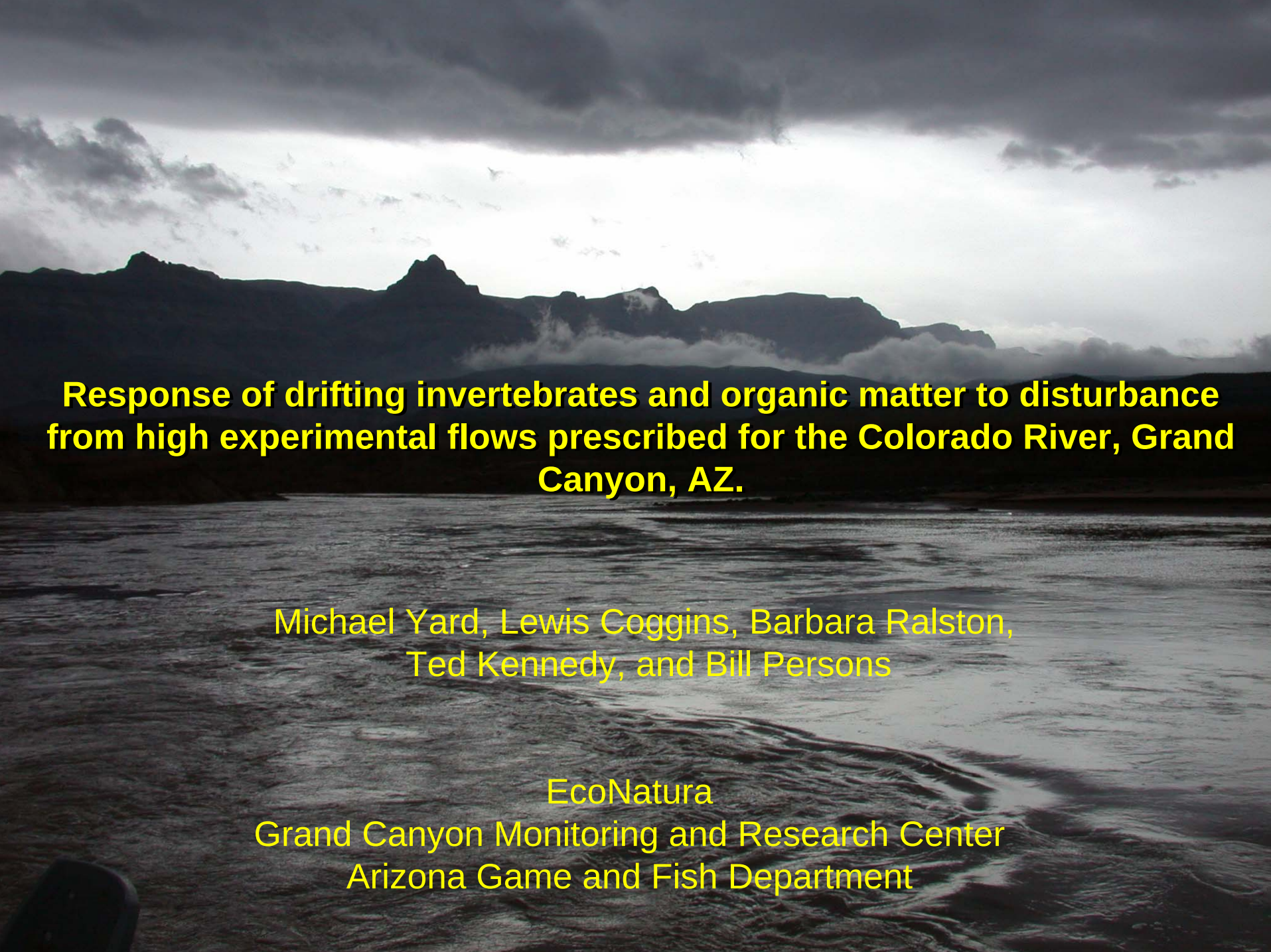


# Response of drifting invertebrates and organic matter to disturbance from high experimental flows prescribed for the Colorado River, Grand Canyon, AZ.

Michael Yard, Lewis Coggins, Barbara Ralston,
Ted Kennedy, and Bill Persons

EcoNatura
Grand Canyon Monitoring and Research Center
Arizona Game and Fish Department

# Primary Study Objectives:

- Determine if BHBF had a disruptive effect on invertebrate drift
- Determine if invertebrate drift concentrations returned to baseline conditions following flood event.
- Determine the different origins of the drift (benthic/terrestrial).
- Determine if supply limitations for coarse particulate organic matter (CPOM) occurred over the duration of the flood period
- Determine if the distribution of different CPOM size fractions varied over the flood period.
- Determine if the quantity of zooplankton varied over the duration of the flood period

# STUDY AREA

- Single Site – above LCR (60.8 RM)
- 3 Replicates / Sample
- 18 Samples

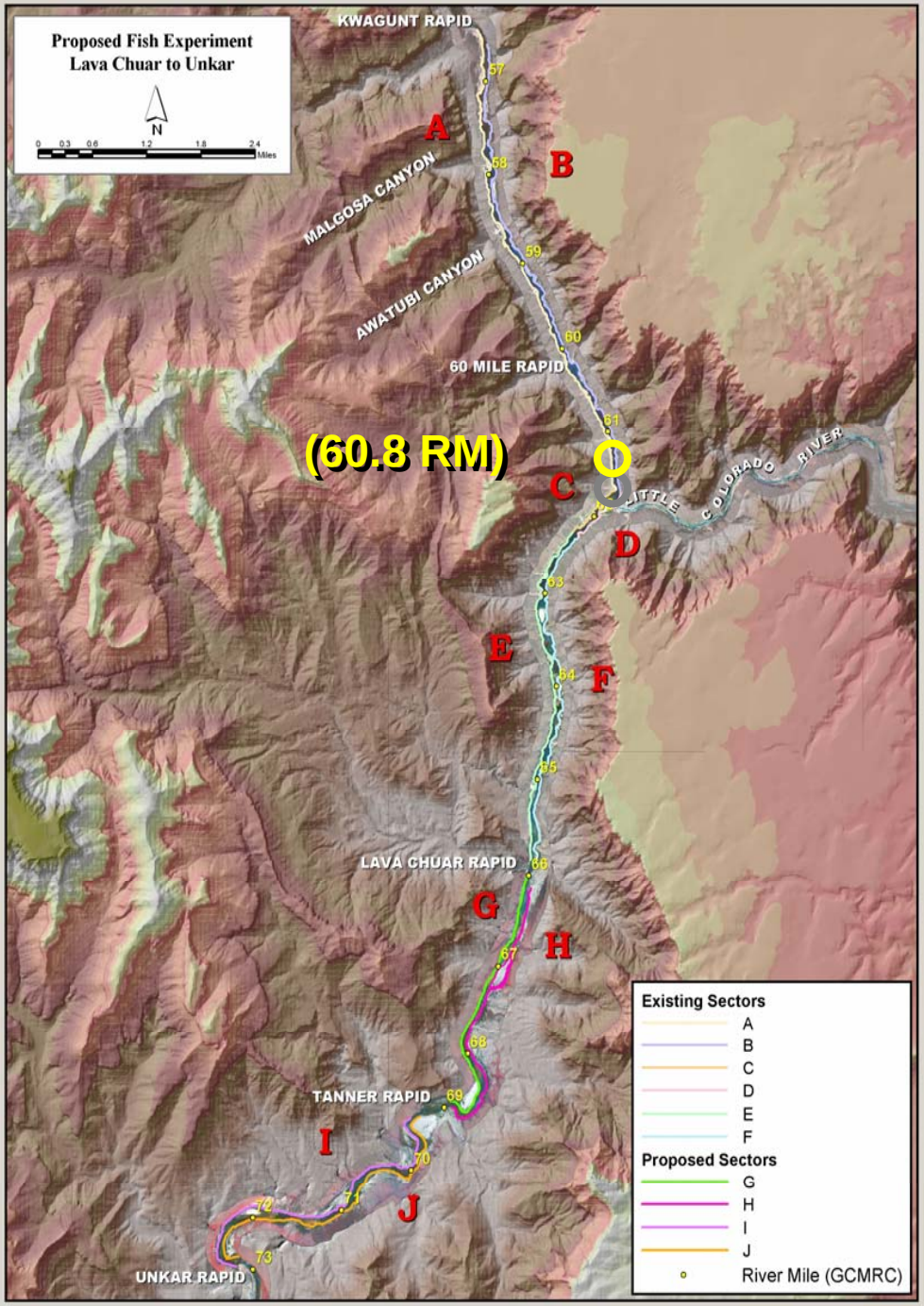
- Pre BHBF Period
  - 4 days
  - 24 Hr Sampling Interval

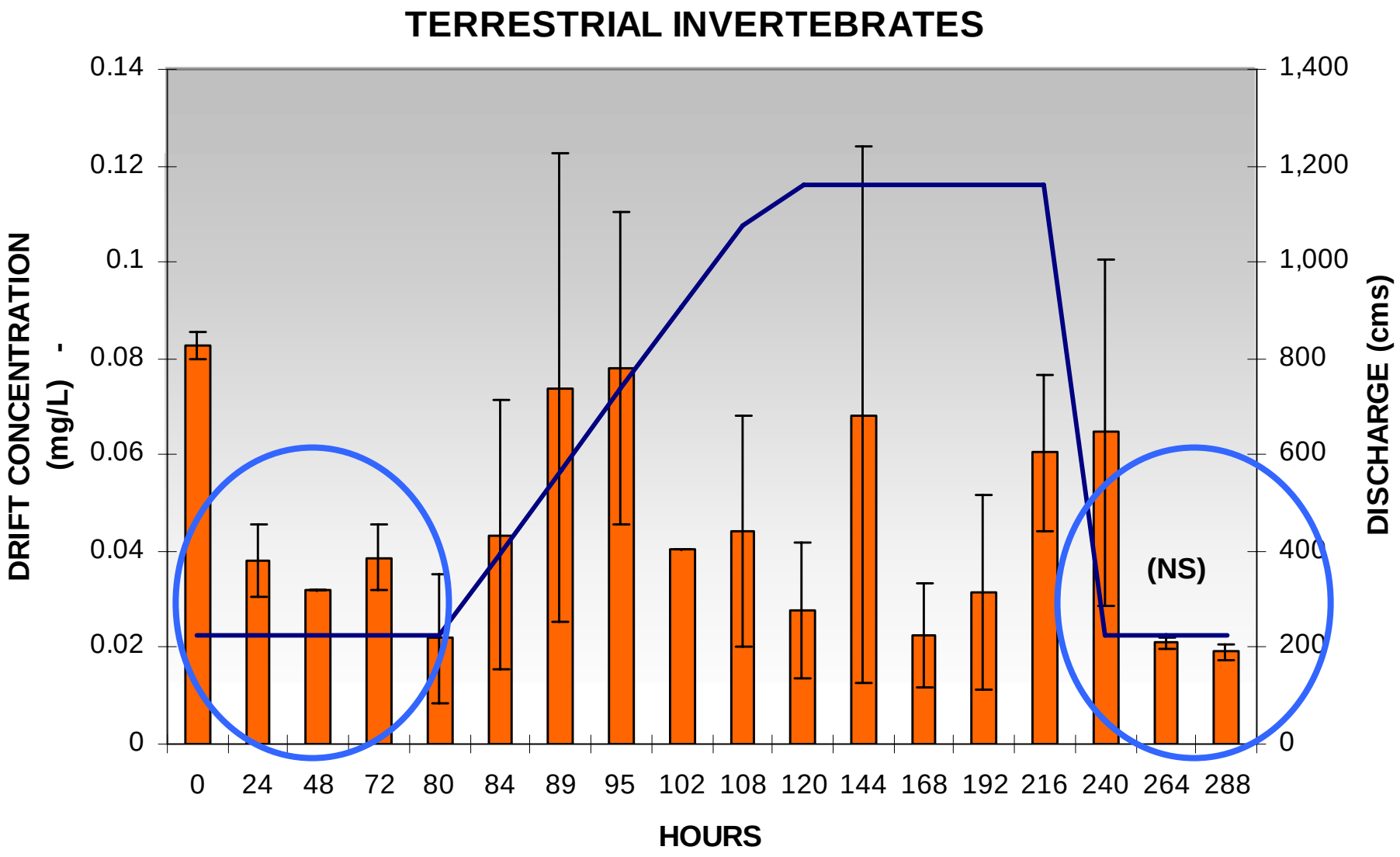
- Ascending Limb of BHBF
  - 26 Hours
  - 6 Hr Sampling Interval

- Stable Crest of BHBF
  - 3 days
  - 24 Hr Sampling Interval

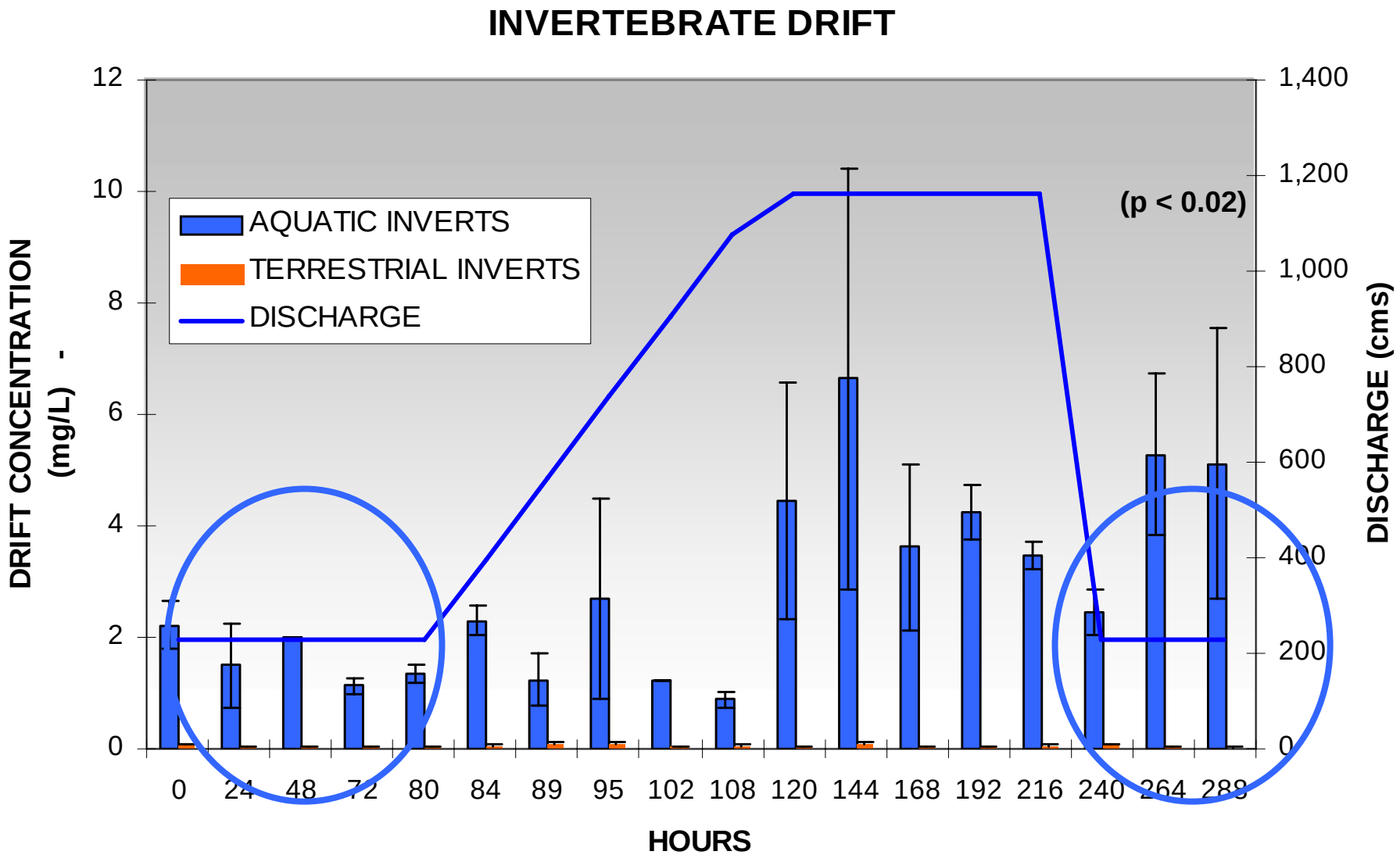
- Descending Limb of BHBF
  - No Sampling

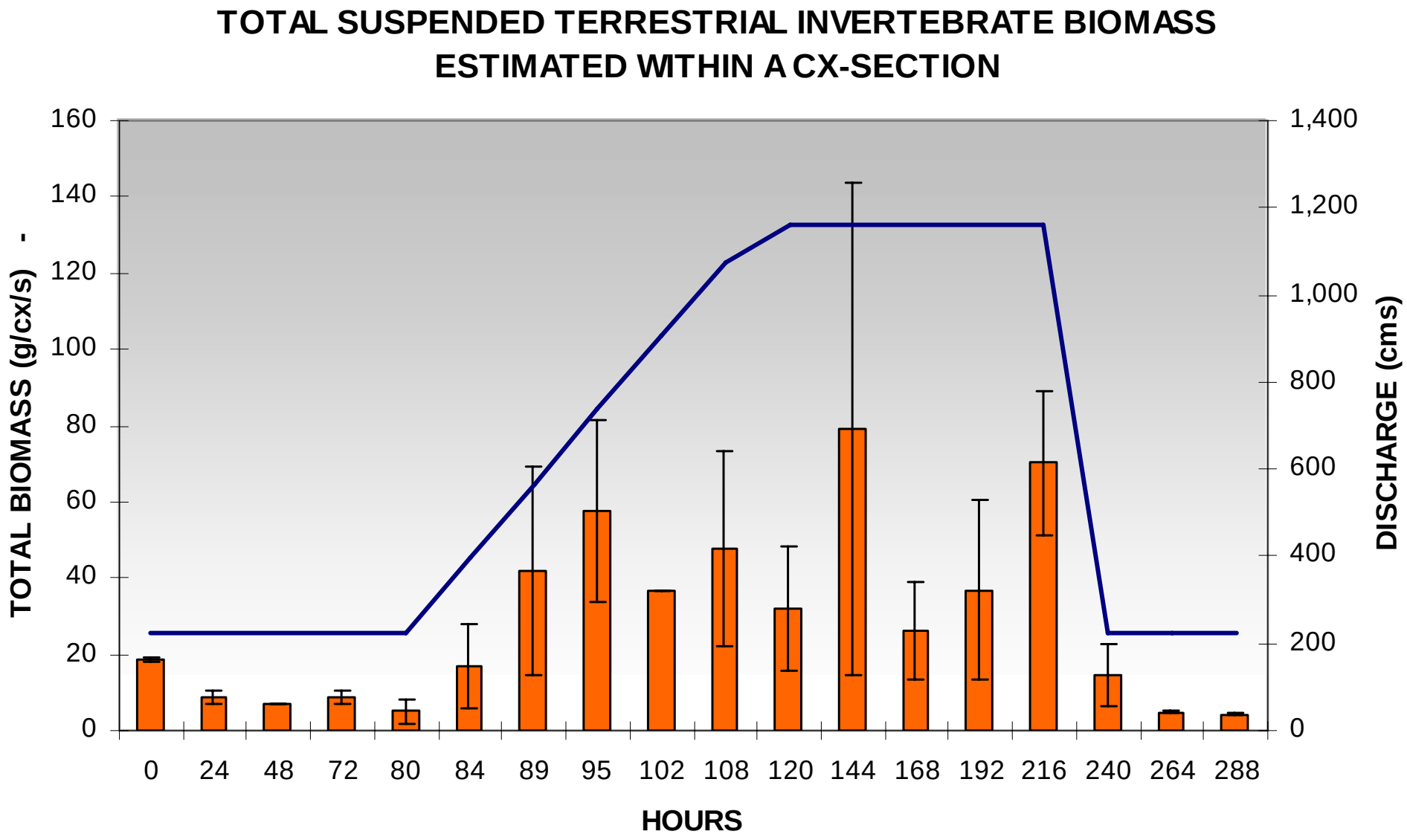
- Post BHBF Period
  - 3 days
  - 24 Sampling Interval

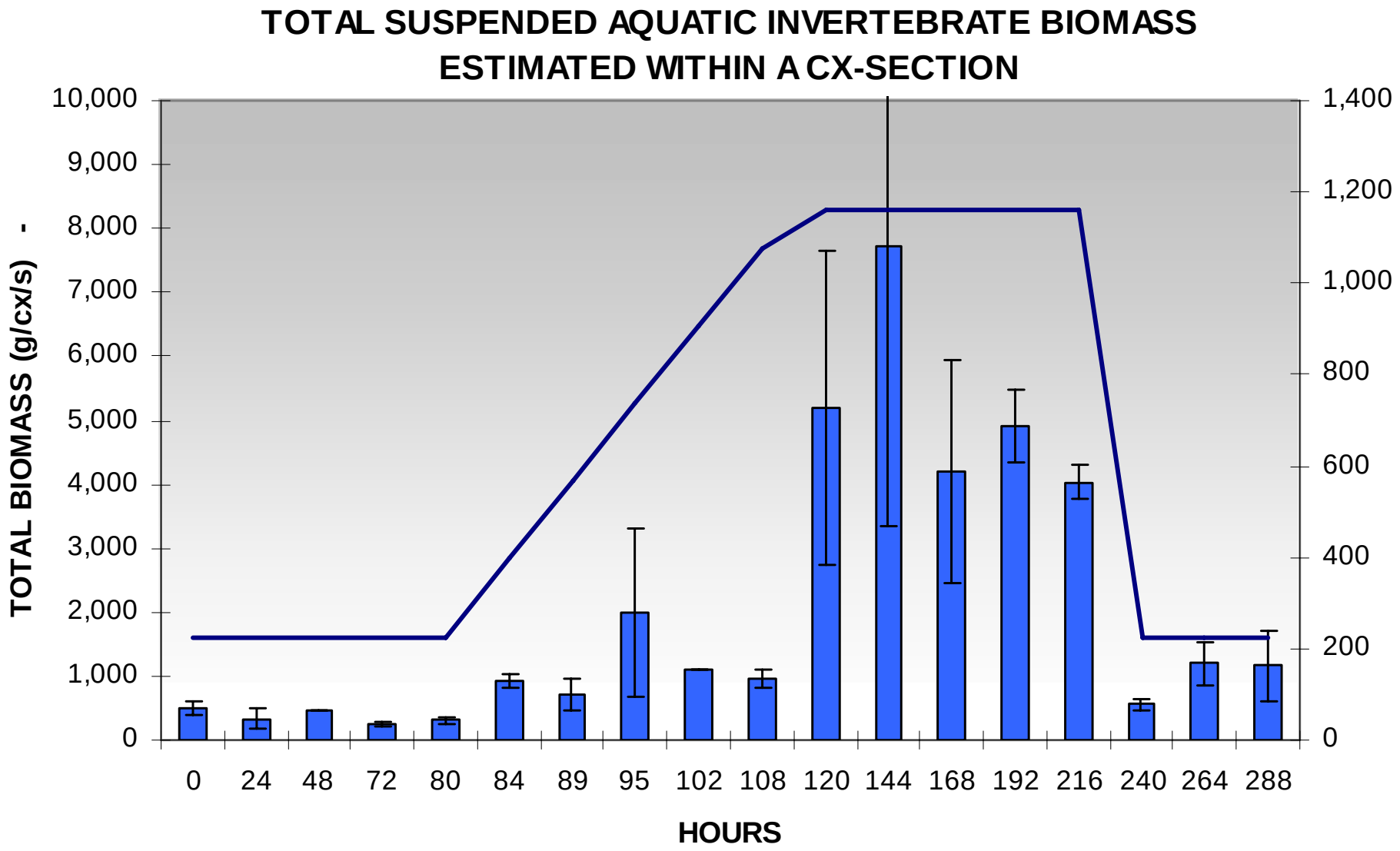


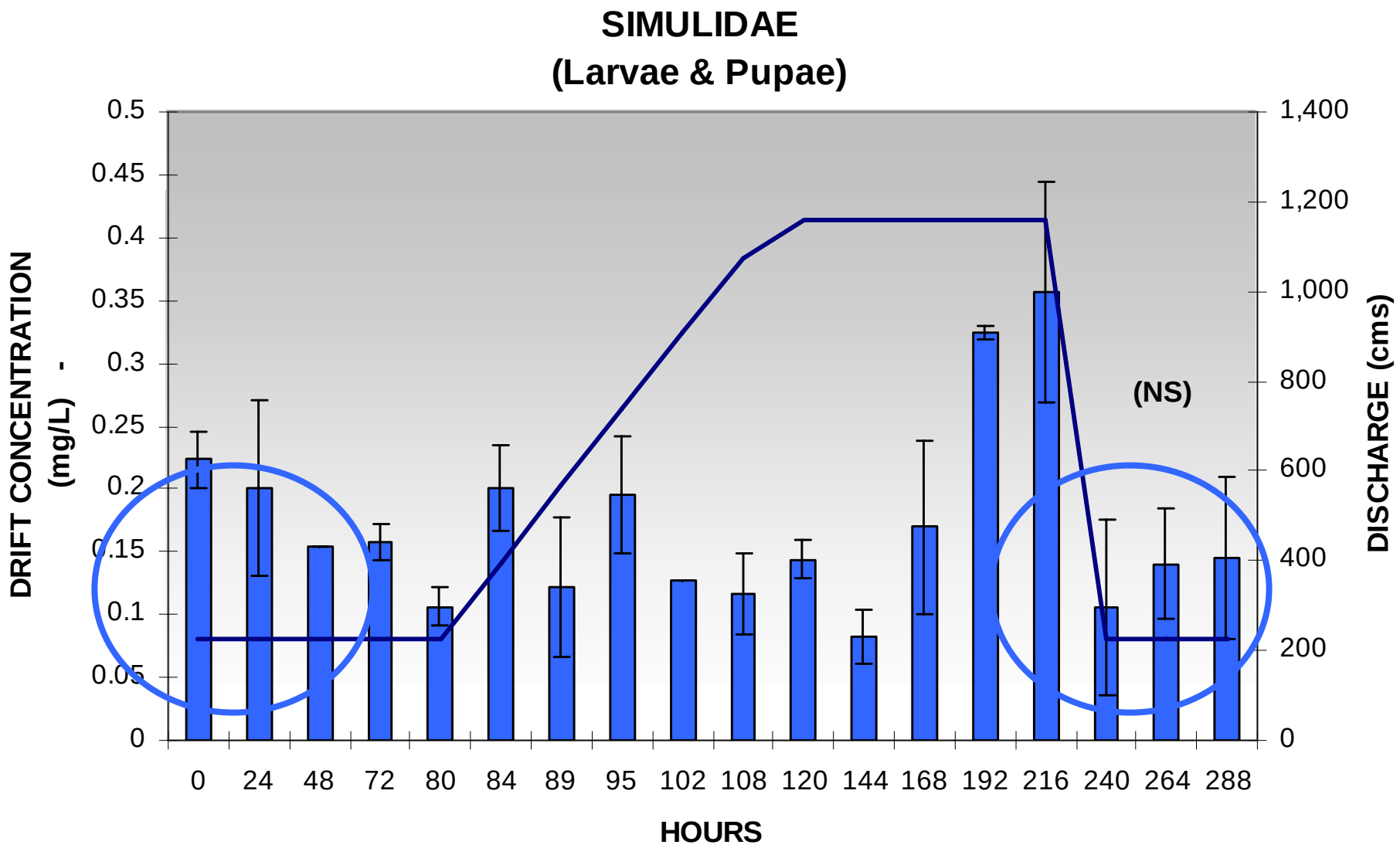

TERRESTRIAL INVERTEBRATES
DRIFT CONCENTRATION (mg/L) -
DISCHARGE (cms)
HOURS
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1,400
1,200
1,000
800
600
400
200
0
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288
(NS)

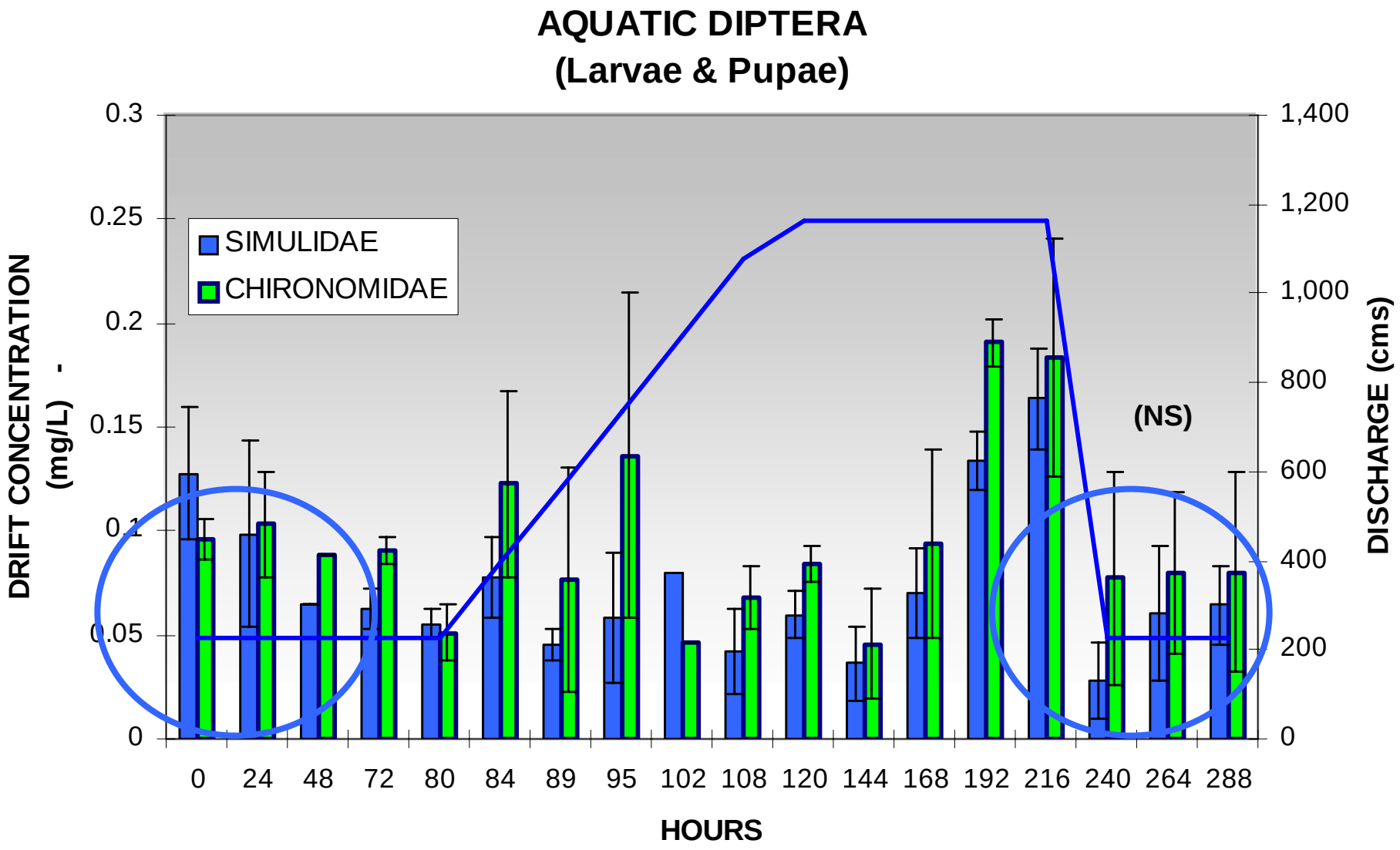
# RESULTS

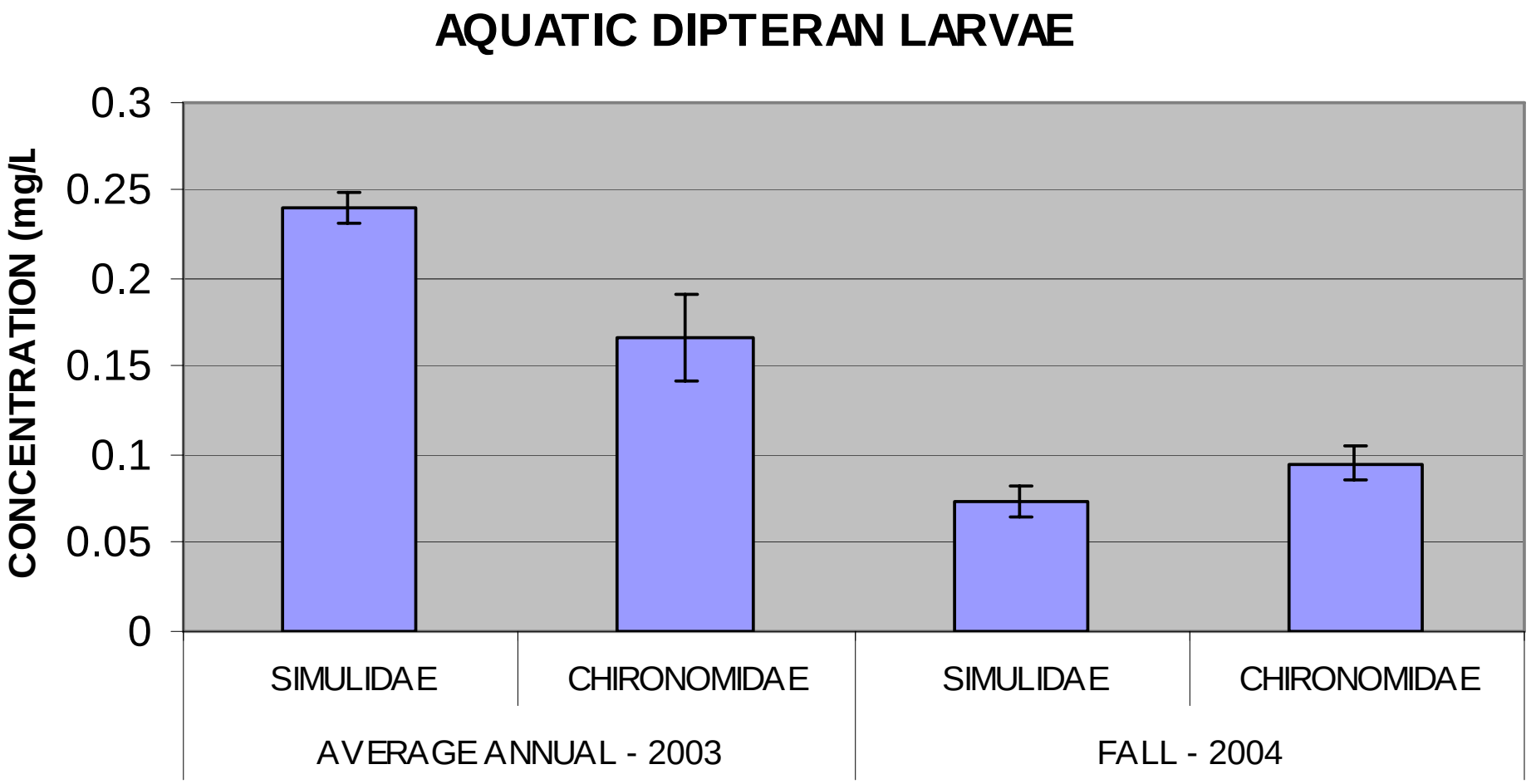

INVERTEBRATE DRIFT
DRIFT CONCENTRATION (mg/L) -
DISCHARGE (cms)
HOURS
AQUATIC INVERTS
TERRESTRIAL INVERTS
DISCHARGE
(p < 0.02)
0
2
4
6
8
10
12
0
200
400
600
800
1,000
1,200
1,400
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288

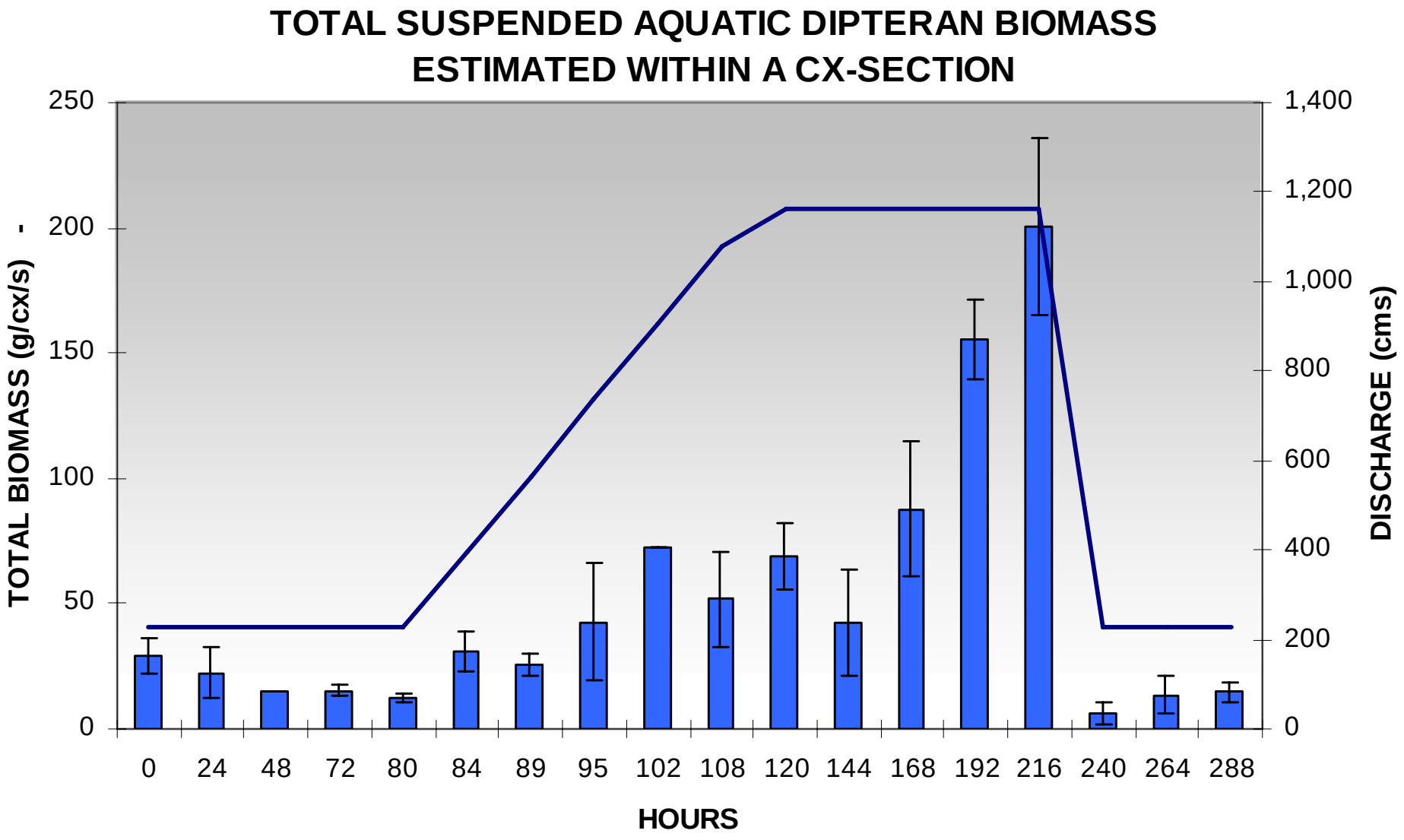

TOTAL SUSPENDED TERRESTRIAL INVERTEBRATE BIOMASS
ESTIMATED WITHIN A CX-SECTION
TOTAL BIOMASS (g/cx/s) -
DISCHARGE (cms)
HOURS
0
20
40
60
80
100
120
140
160
0
200
400
600
800
1,000
1,200
1,400
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288

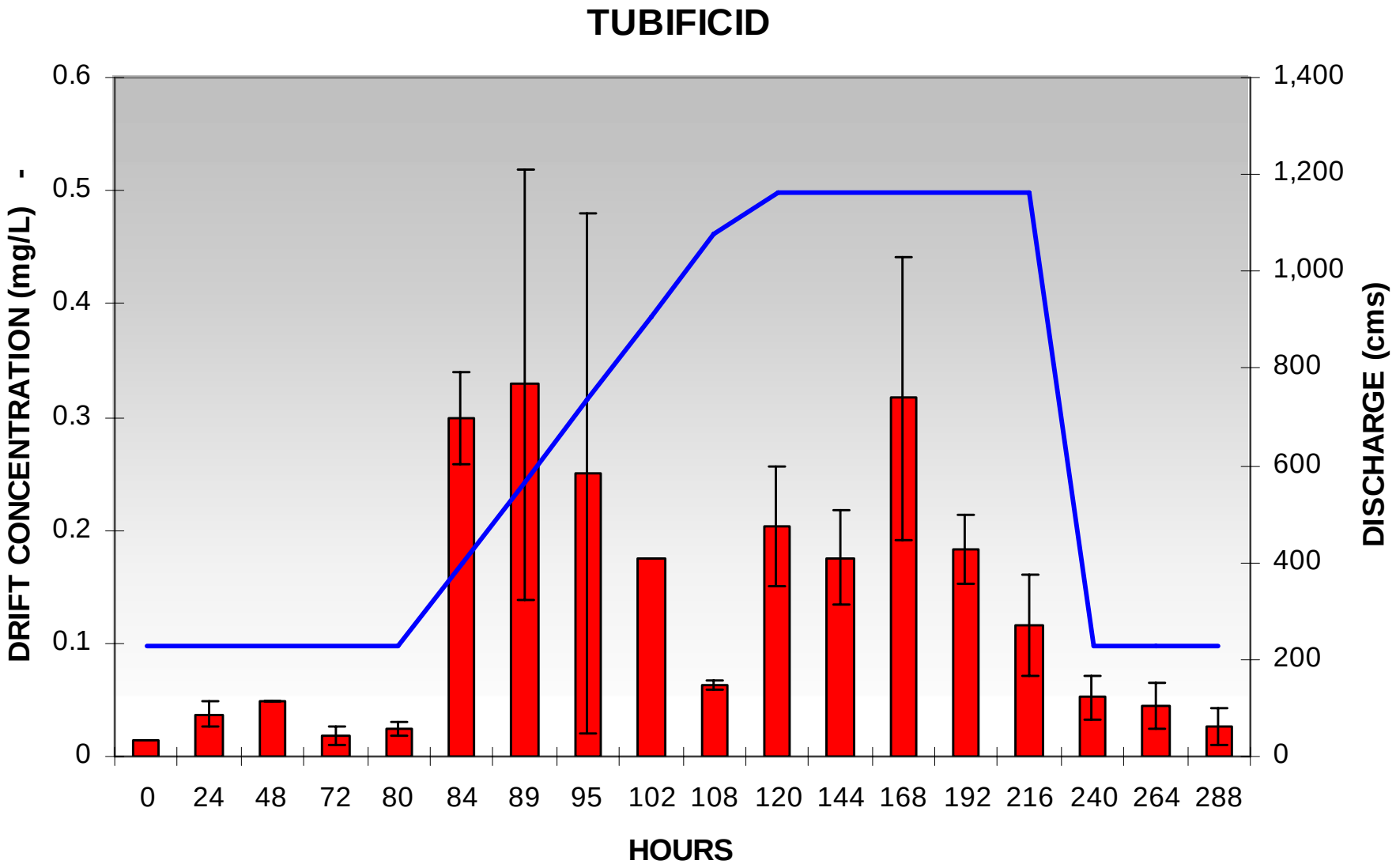

TOTAL SUSPENDED AQUATIC INVERTEBRATE BIOMASS
ESTIMATED WITHIN A CX-SECTION
TOTAL BIOMASS (g/cx/s) -
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1,400
1,200
1,000
800
600
400
200
0
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288
HOURS

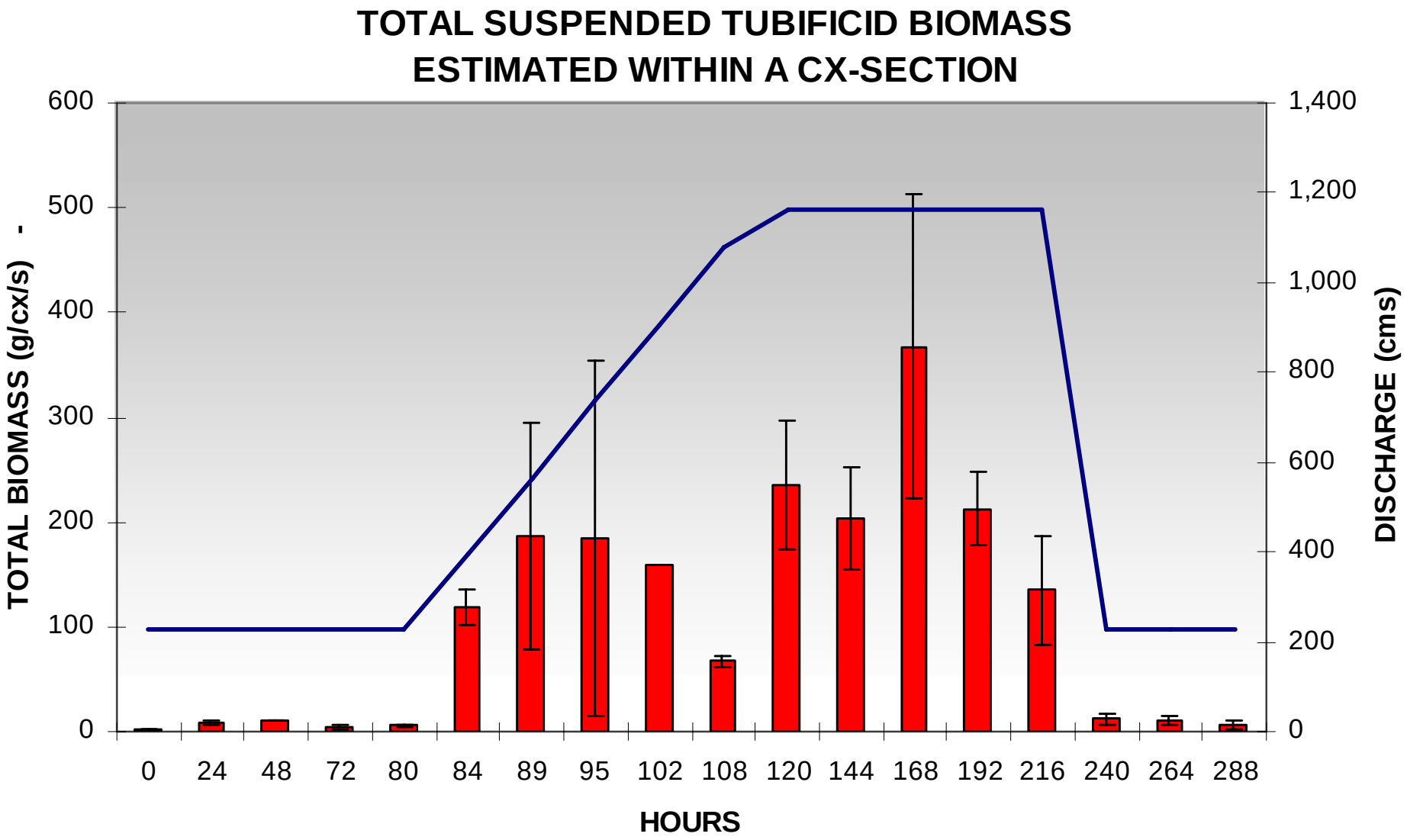

SIMULIDAE
(Larvae & Pupae)
DRIFT CONCENTRATION
(mg/L)
DISCHARGE (cms)
HOURS
(NS)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1,400
1,200
1,000
800
600
400
200
0
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288

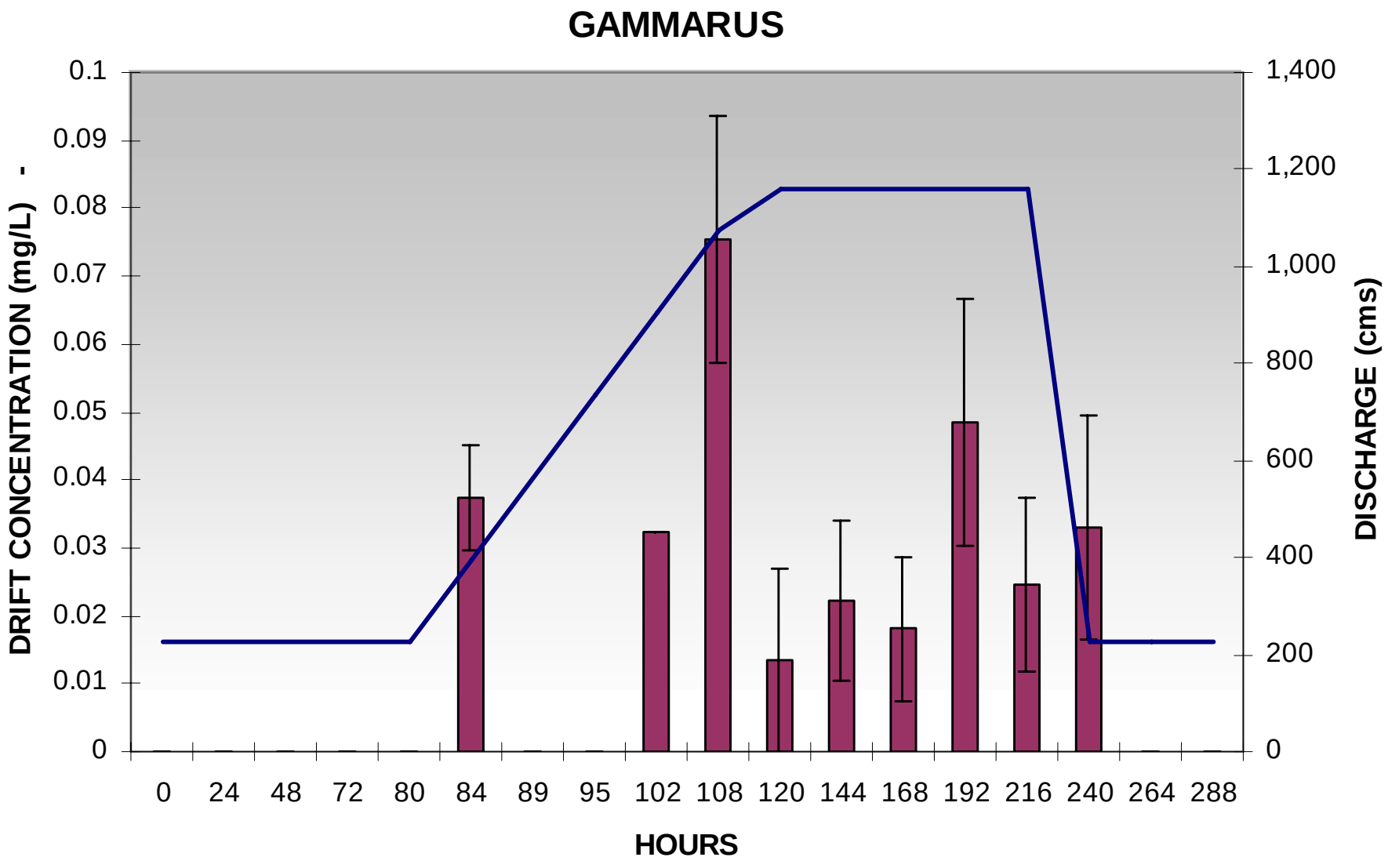

AQUATIC DIPTERA
(Larvae & Pupae)
SIMULIDAE
CHIRONOMIDAE
(NS)
DRIFT CONCENTRATION
(mg/L) -
DISCHARGE (cms)
HOURS
0.3
0.25
0.2
0.15
0.1
0.05
0
1,400
1,200
1,000
800
600
400
200
0
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288

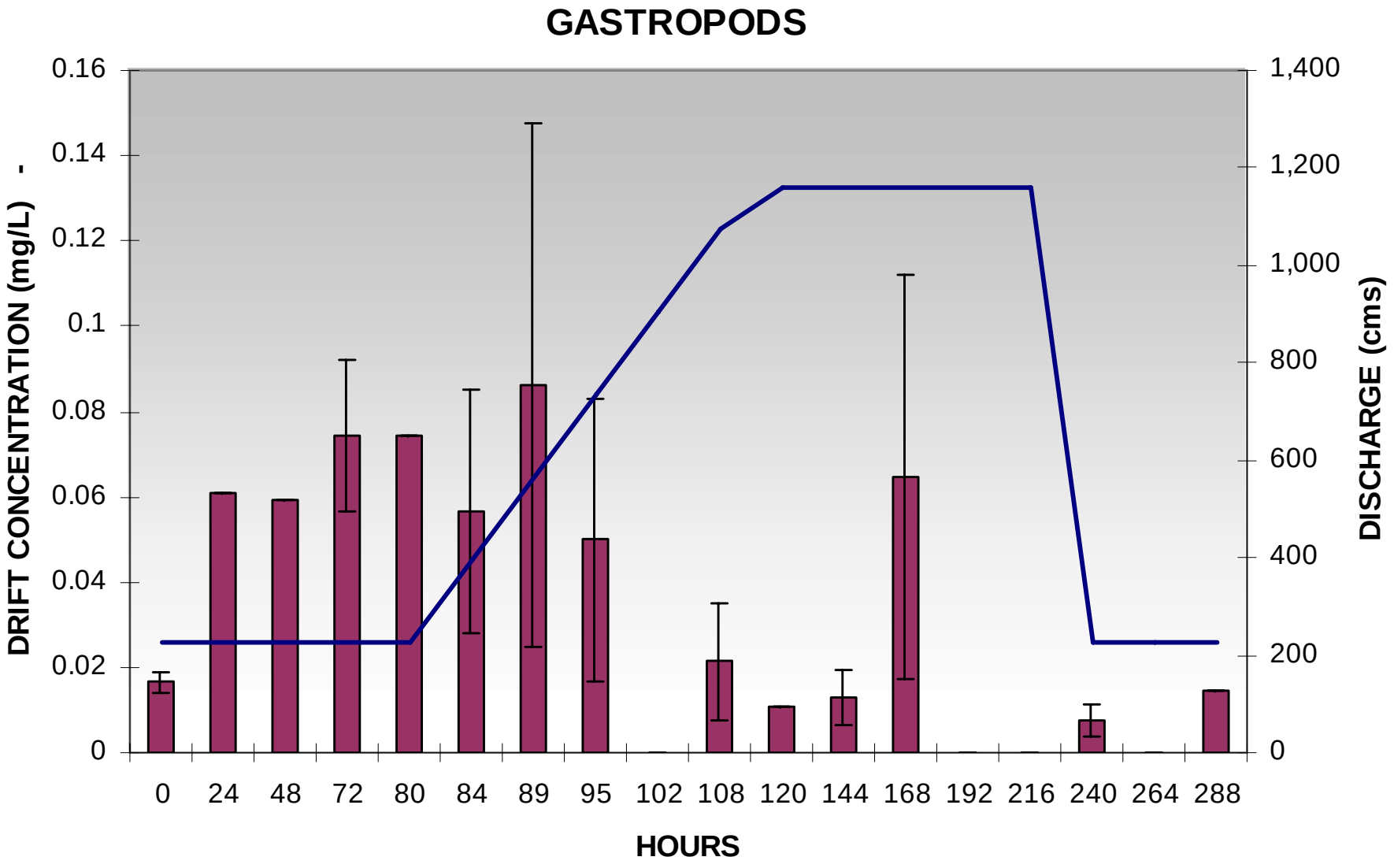

AQUATIC DIPTERAN LARVAE
CONCENTRATION (mg/L
0.3
0.25
0.2
0.15
0.1
0.05
0
SIMULIDAE
CHIRONOMIDAE
SIMULIDAE
CHIRONOMIDAE
AVERAGE ANNUAL - 2003
FALL - 2004

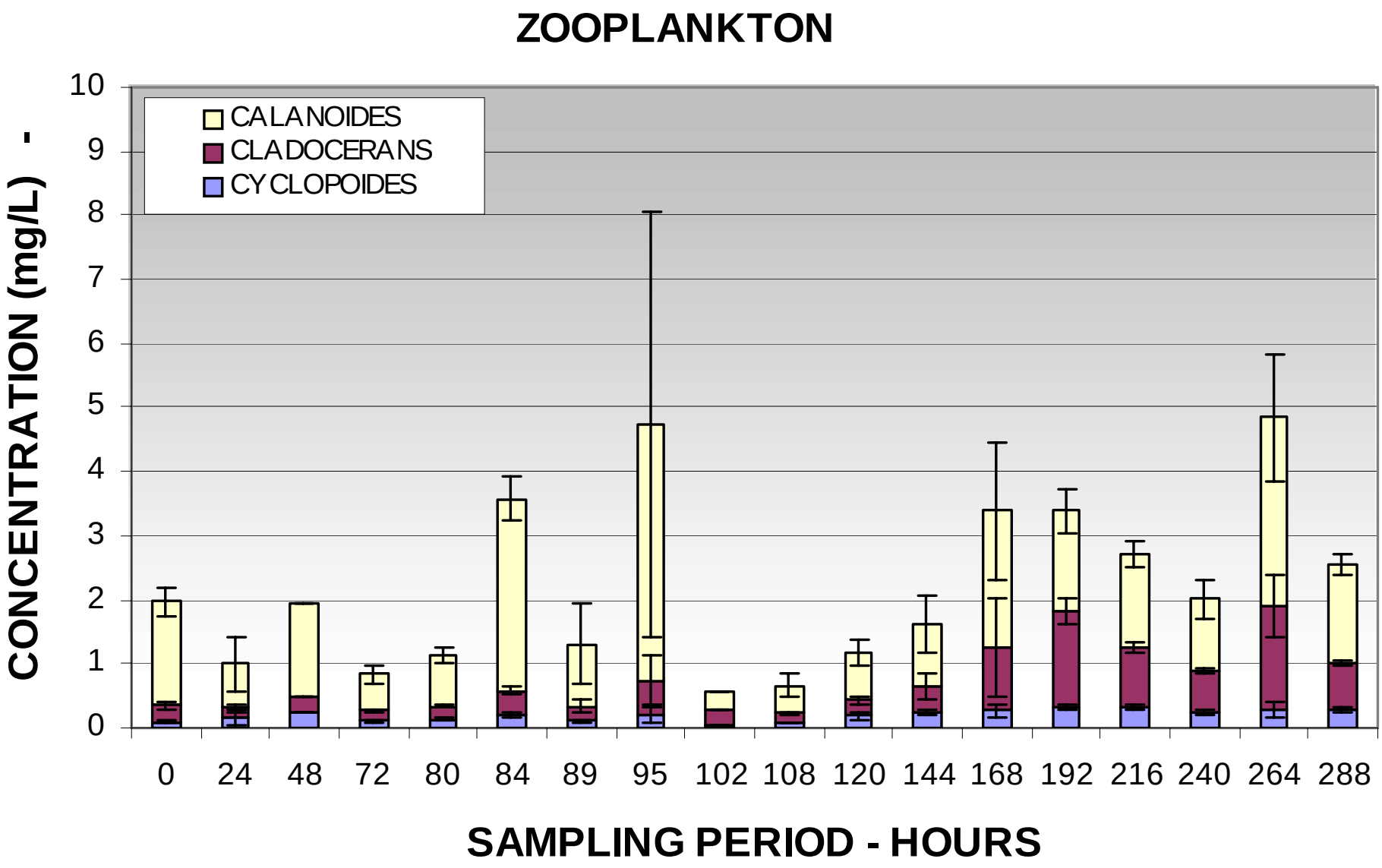

TOTAL SUSPENDED AQUATIC DIPTERAN BIOMASS
ESTIMATED WITHIN A CX-SECTION
TOTAL BIOMASS (g/cx/s) -
DISCHARGE (cms)
HOURS
250
200
150
100
50
0
1,400
1,200
1,000
800
600
400
200
0
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288

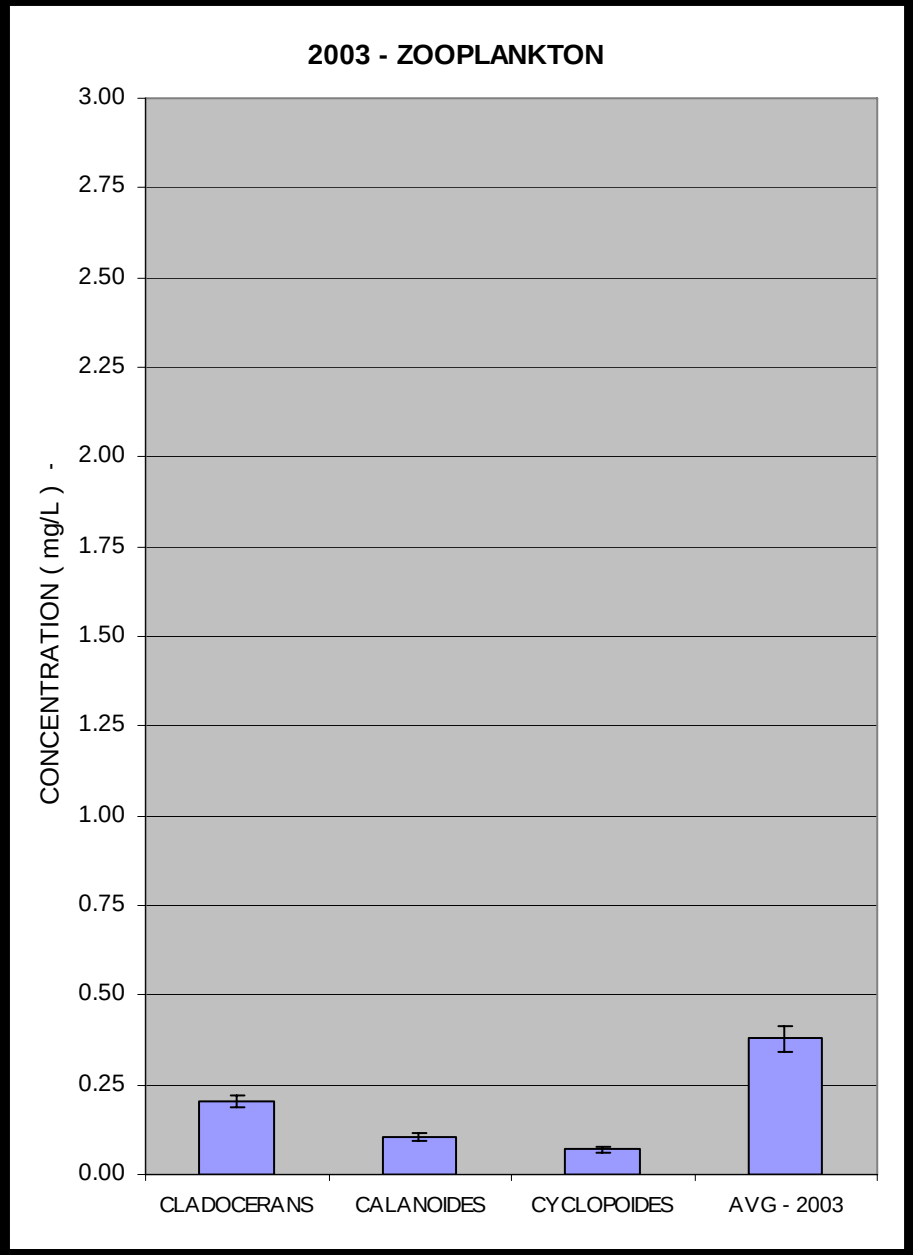

TUBIFICID
DRIFT CONCENTRATION (mg/L) -
DISCHARGE (cms)
HOURS
0.6
0.5
0.4
0.3
0.2
0.1
0
1,400
1,200
1,000
800
600
400
200
0
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288

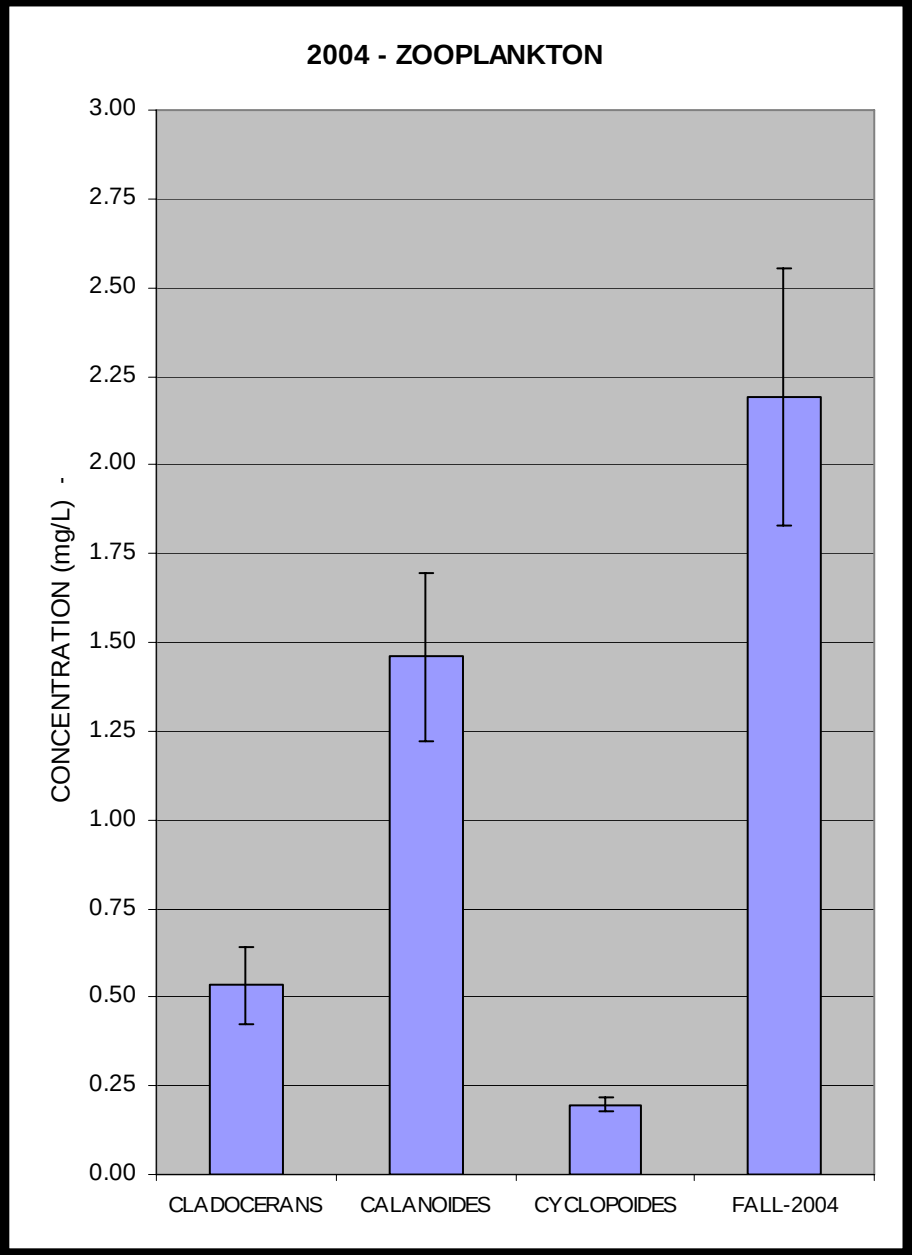

TOTAL SUSPENDED TUBIFICID BIOMASS
ESTIMATED WITHIN A CX-SECTION
TOTAL BIOMASS (g/cx/s) -
DISCHARGE (cms)
HOURS
600
500
400
300
200
100
0
1,400
1,200
1,000
800
600
400
200
0
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288


GAMMARUS
DRIFT CONCENTRATION (mg/L) -
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1,400
1,200
1,000
800
600
400
200
0
DISCHARGE (cms)
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288
HOURS

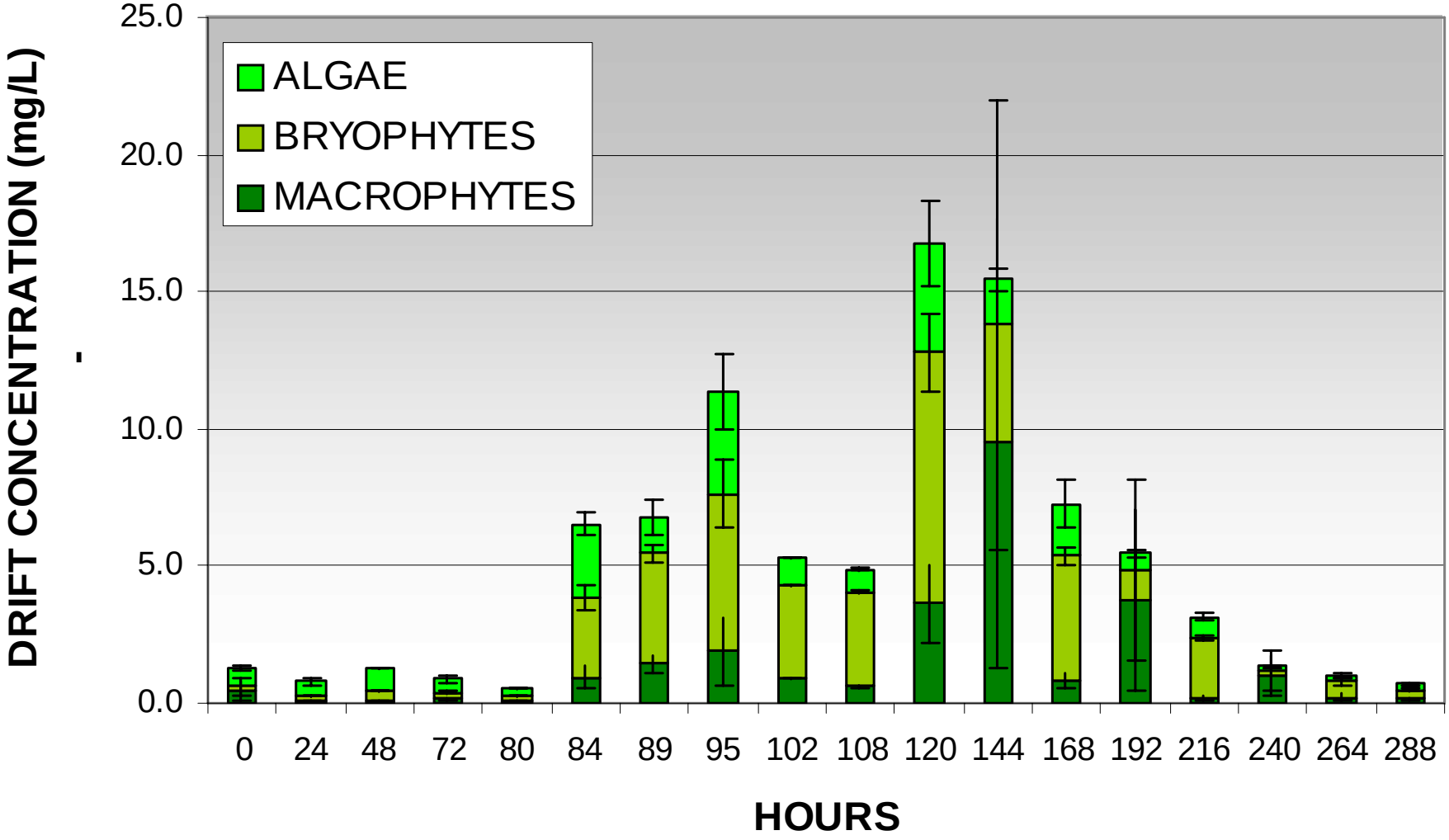

GASTROPODS
DRIFT CONCENTRATION (mg/L) -
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1,400
1,200
1,000
800
600
400
200
0
DISCHARGE (cms)
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288
HOURS

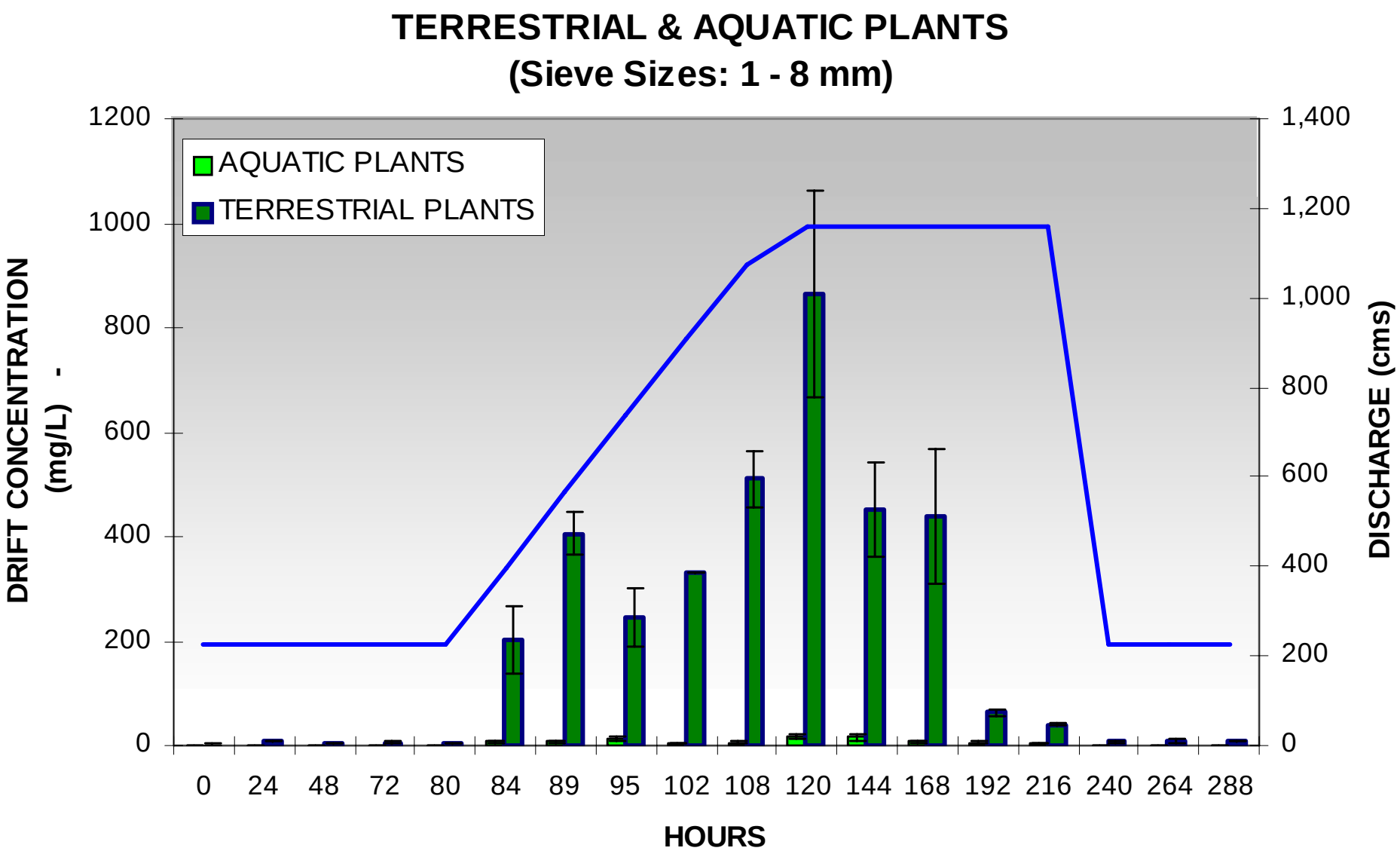

ZOOPLANKTON
CALANOIDES
CLADOCERANS
CYCLOPOIDES
CONCENTRATION (mg/L) -
0
1
2
3
4
5
6
7
8
9
10
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288
SAMPLING PERIOD - HOURS

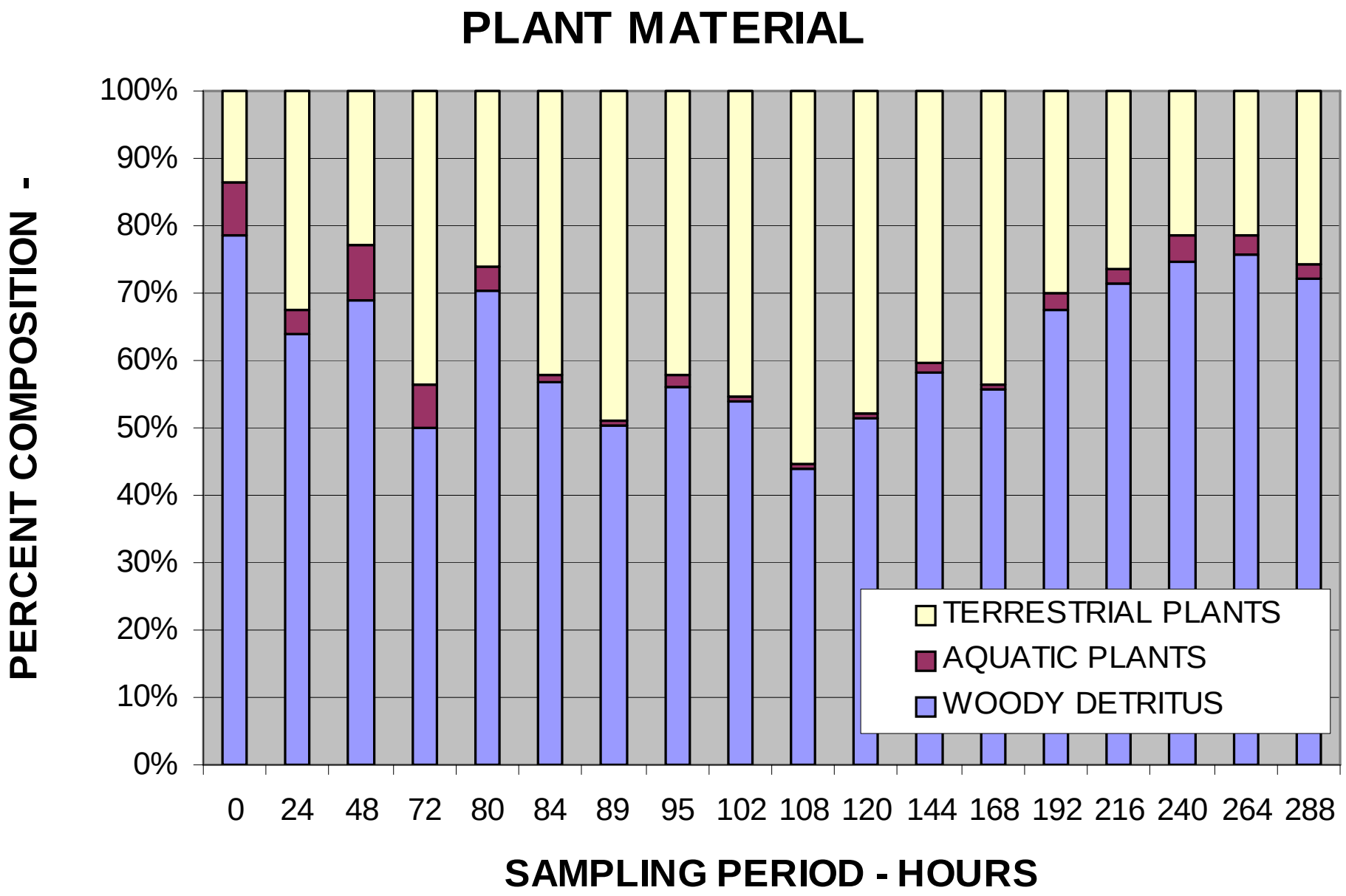

2003 - ZOOPLANKTON
CONCENTRATION ( mg/L ) -
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
CLADOCERANS
CALANOIDES
CYCLOPOIDES
AVG - 2003

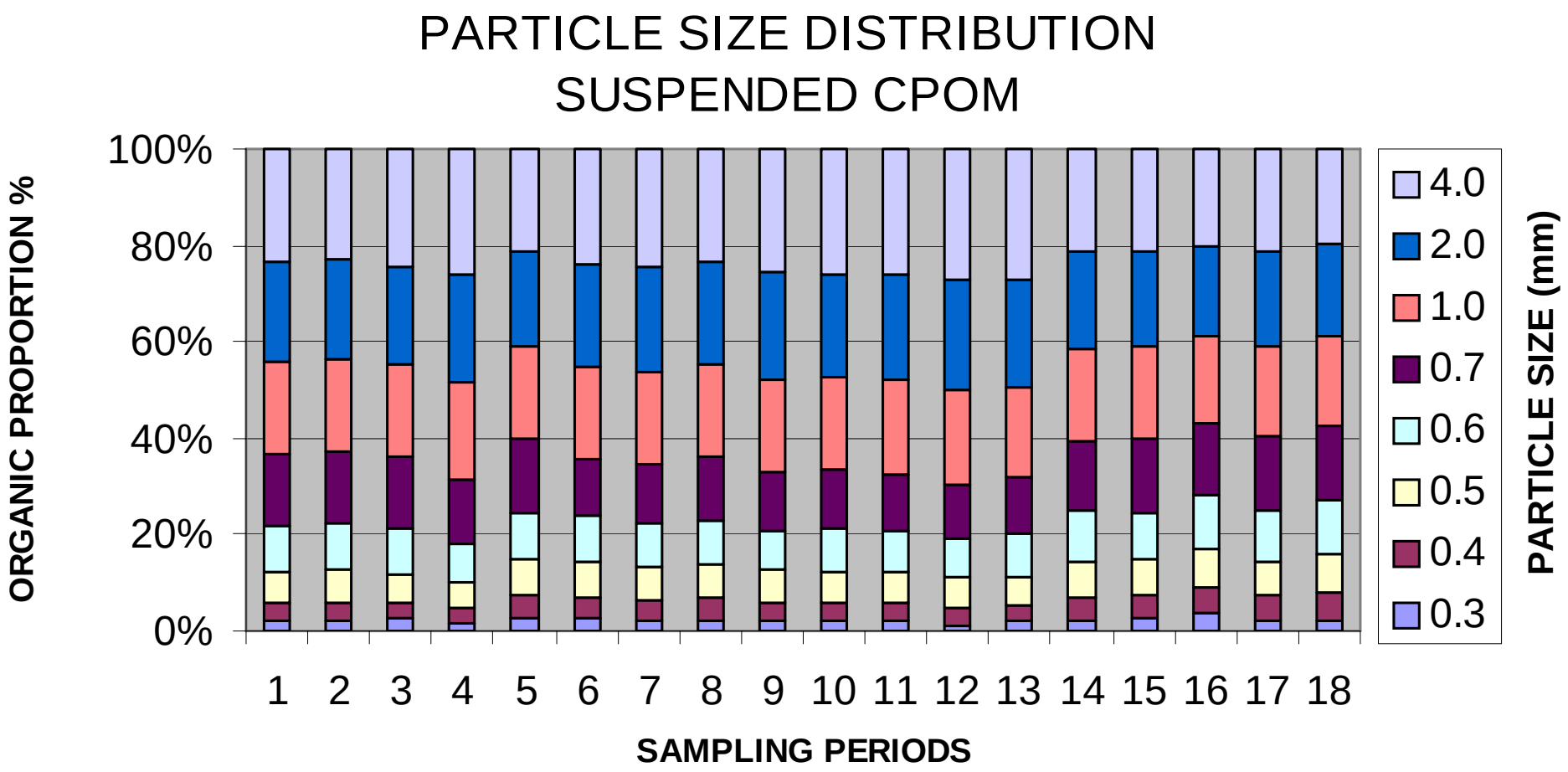

2004 - ZOOPLANKTON
CONCENTRATION (mg/L) -
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
CLADOCERANS
CALANOIDES
CYCLOPOIDES
FALL-2004

# AQUATIC PLANTS
# (Sieve Sizes: 1 - 8 mm)

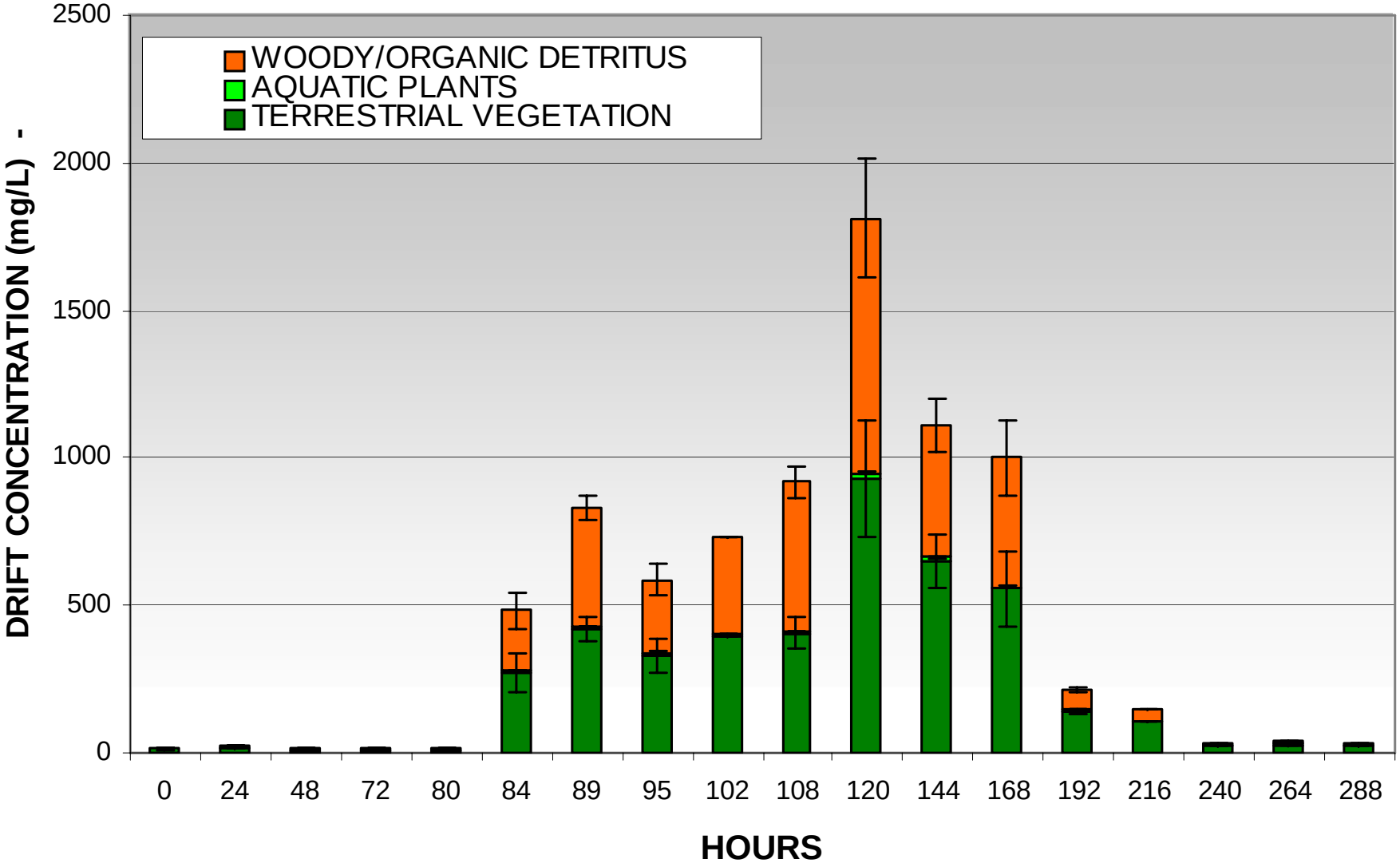



TERRESTRIAL & AQUATIC PLANTS
(Sieve Sizes: 1 - 8 mm)
AQUATIC PLANTS
TERRESTRIAL PLANTS
DRIFT CONCENTRATION
(mg/L) -
DISCHARGE (cms)
HOURS
0
200
400
600
800
1000
1200
1,400
1,200
1,000
0 24 48 72 80 84 89 95 102 108 120 144 168 192 216 240 264 288


PLANT MATERIAL
PERCENT COMPOSITION -
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
24
48
72
80
84
89
95
102
108
120
144
168
192
216
240
264
288
SAMPLING PERIOD - HOURS
TERRESTRIAL PLANTS
AQUATIC PLANTS
WOODY DETRITUS


PARTICLE SIZE DISTRIBUTION
SUSPENDED CPOM
ORGANIC PROPORTION %
100%
80%
60%
40%
20%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
SAMPLING PERIODS
4.0
2.0
1.0
0.7
0.6
0.5
0.4
0.3
PARTICLE SIZE (mm)

# COARSE PARTICULATE ORGANIC MATTER



# Assumptions

- Gross Primary Production
  - 2,000 gC/yr
- Net Primary Production
  - 25% - 500 gC/yr
- Litter Retention
  - 100%
- Accumulation Period
  - 8 yrs
- Decomposition Rate
  - 10% Annually
- Production Area
  - Contiguous Riparian Corridor
  - Riparian Zone Width
    - 15 m (width) x 2
  - Corridor Length
    - 124 km
  - Upstream Production Area
    - 370 ha
- Available Riparian Litter
  - 2,425 gC/m^2 (AFDM)
- Total Riparian CPOM
  - 8,455 MgC (AFDM)

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- Gross Primary Production
  - 2,000 gC/yr
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    - 124 km
  - Upstream Production Area
    - 370 ha
- Available Riparian Litter
  - 2,425 gC/m^2 (AFDM)
- Total Riparian CPOM
  - 8,455 MgC (AFDM)

- Estimates
  - Resettlement Percentage
    - 10%
  - Average Concentration
    - 0.398 g/L (SE ± 0.035)
  - Total Organic Export
    - 356,944 MgC AFDM (264 hr )
  - Total Organic Contribution from
    - **Riparian Zone - 2.5%**
    - **Aquatic Primary Production – (Unknown)**
    - **Paria River Drainage < = 97.5%**

# conclusions

- Macro-invertebrate drift levels appear to return to seasonally low levels during the fall period.
- Aquatic dipteran larvae (Chironomids & Simulids) are the most abundant macro-invertebrate in the drift
- Invertebrate drift levels returned to nominal levels following BHBF flood
- Source of organic material (CPOM) appears to originate from the terrestrial environment
- The bulk quantity of terrestrial CPOM appears to be supplied from tributaries rather than from the local riparian corridor
- Over 40% of the CPOM was less than 0.7 mm sieve size.
- Particle size distribution for CPOM remained consistent throughout the entire BHBF period.
- Supply limitation for bulk CPOM was not observed during the duration of the flood period
- Zooplankton concentrations appears to have increased due changes in the withdrawl level for the reservoir