AFWO WQ Monitoring Program
Nutrient Levels below Iron Gate Reservoir
2001 to 2004

AFWO WQ Monitoring Program 2001 – 2004

- Funding: USFWS (Flow Study); In-kind contributions: Yurok, Karuk, and NCRWQCB
- Program Accomplishments:
  - Hydrolabs
    - May through September/October
    - Sites: IG, K1, K2, SC, BC, SV, HC, SA, OR, WPC, TR, TC, TG
    - Temperature, Specific Conductance, pH, Dissolved Oxygen,
    - ~ 1.7 million data points
  - Independent temperature probes at sonde study sites and other locations (Tidbits)
  - Air Temperature and Relative Humidity Data (IG, SV, TG, LWS, WPC)
  - Nutrient Evaluations
    - May through September (general monitoring)
    - **IG, K1, K2, SC, BC, SV, HC, SA, OR, WPC, TR, TC, TG**
    - **Abv IG in 2002 results soon**
    - **Special studies**
    - ~ 10,000 water samples

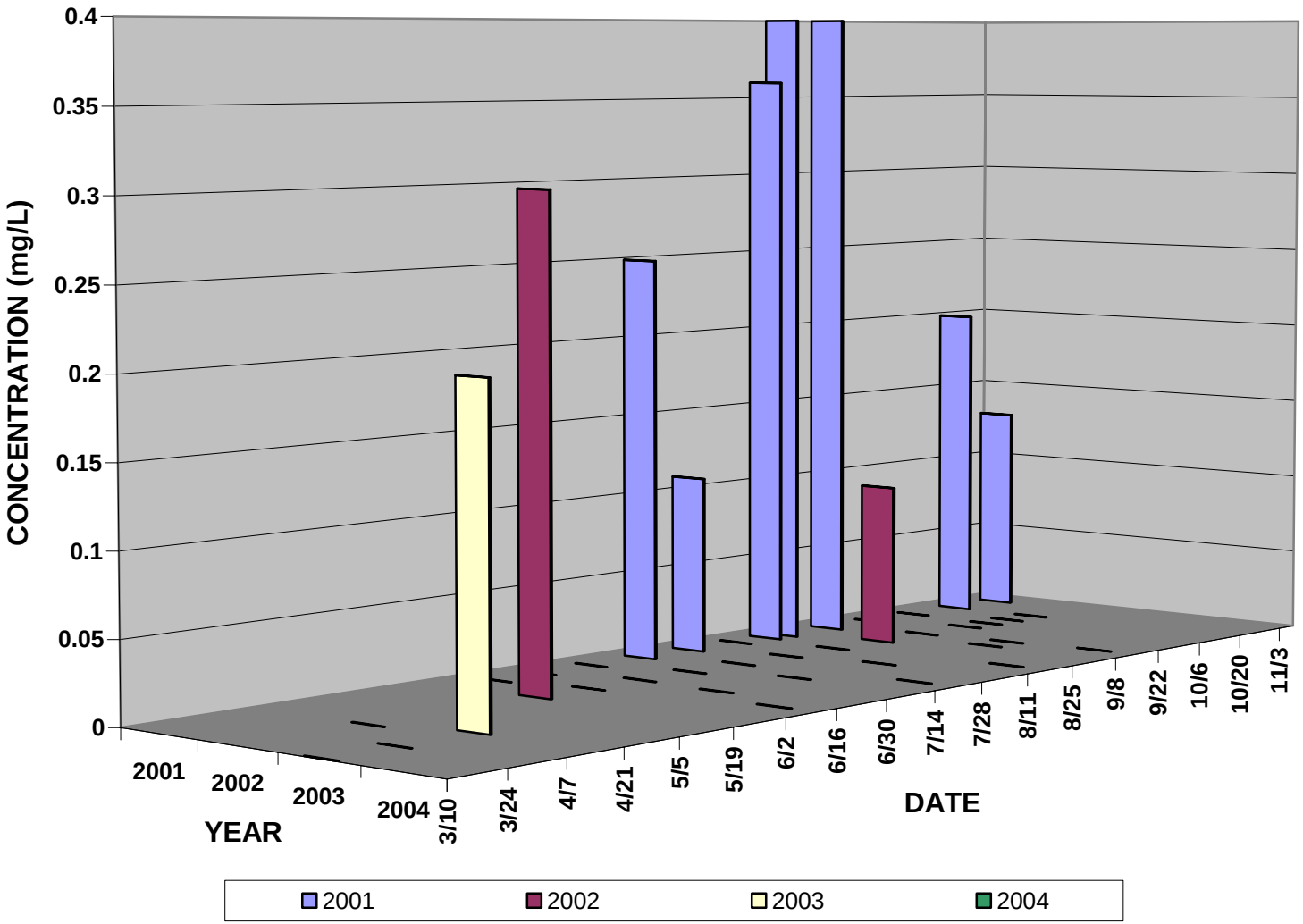
Why document nutrient concentrations in the Klamath River?

- Water Quality is identified as a limiting factor for fishery restoration
- Combined, grab and sonde data provide information on "cause and effect" relationships. For example, high phosphorus loading would be expected to result in a high diurnal fluctuation in DO and pH.
- Support regulatory processes
  - TMDL; Klamath River and tributaries
  - FERC Relicensing
- Improve understanding of effects on the ecosystem
  - Primary productivity>fish diseases (Probable linkage to the intermediate host (M. speciosa))

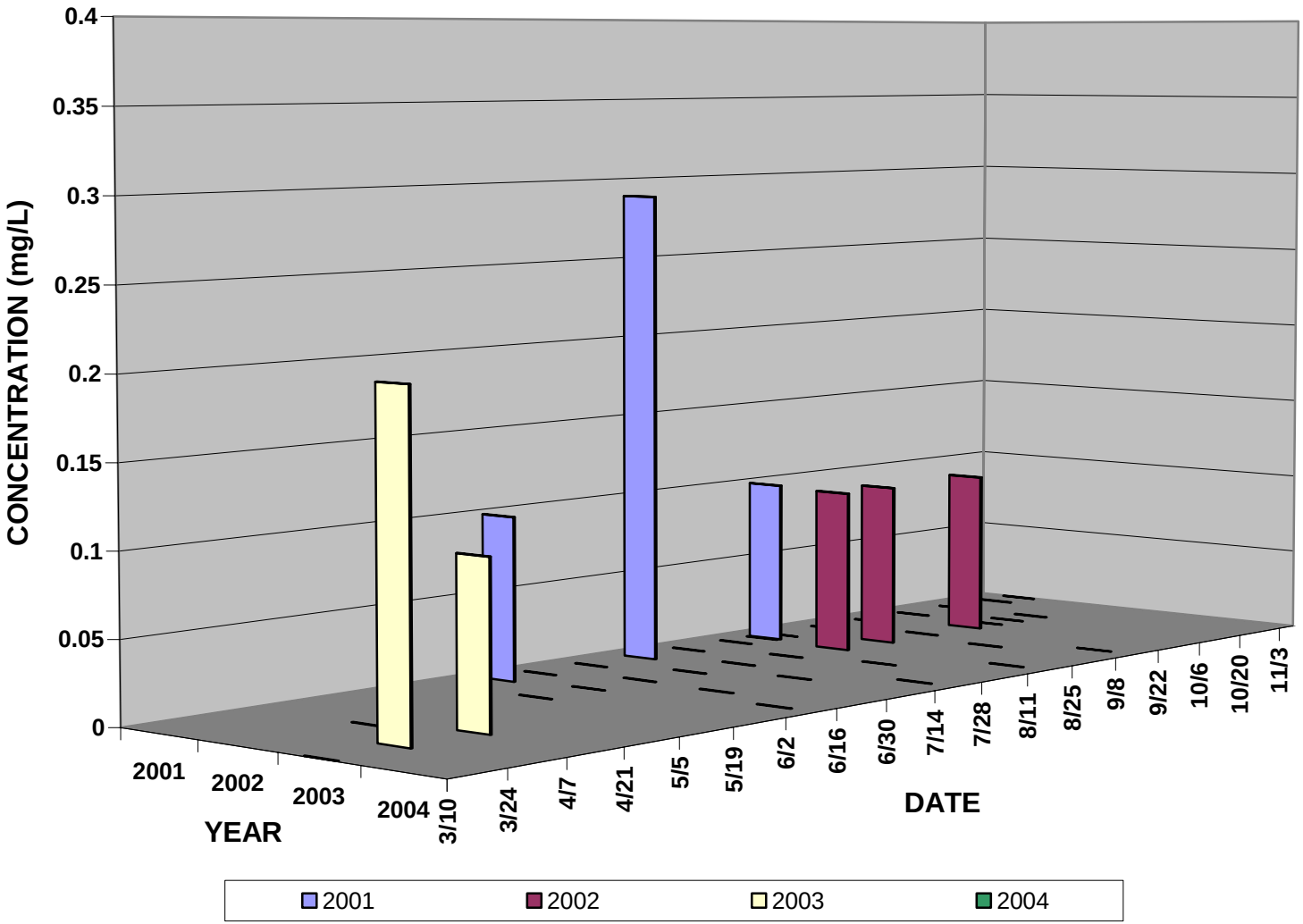
Constituents Assessed

- Nitrogen species
- Phosphorus species
- Total Organic Carbon
- Alkalinity
- Ca/Mg
- Total and Fecal Coliform
- Chlorophyll a/ pheophytin
- TDS/NFR

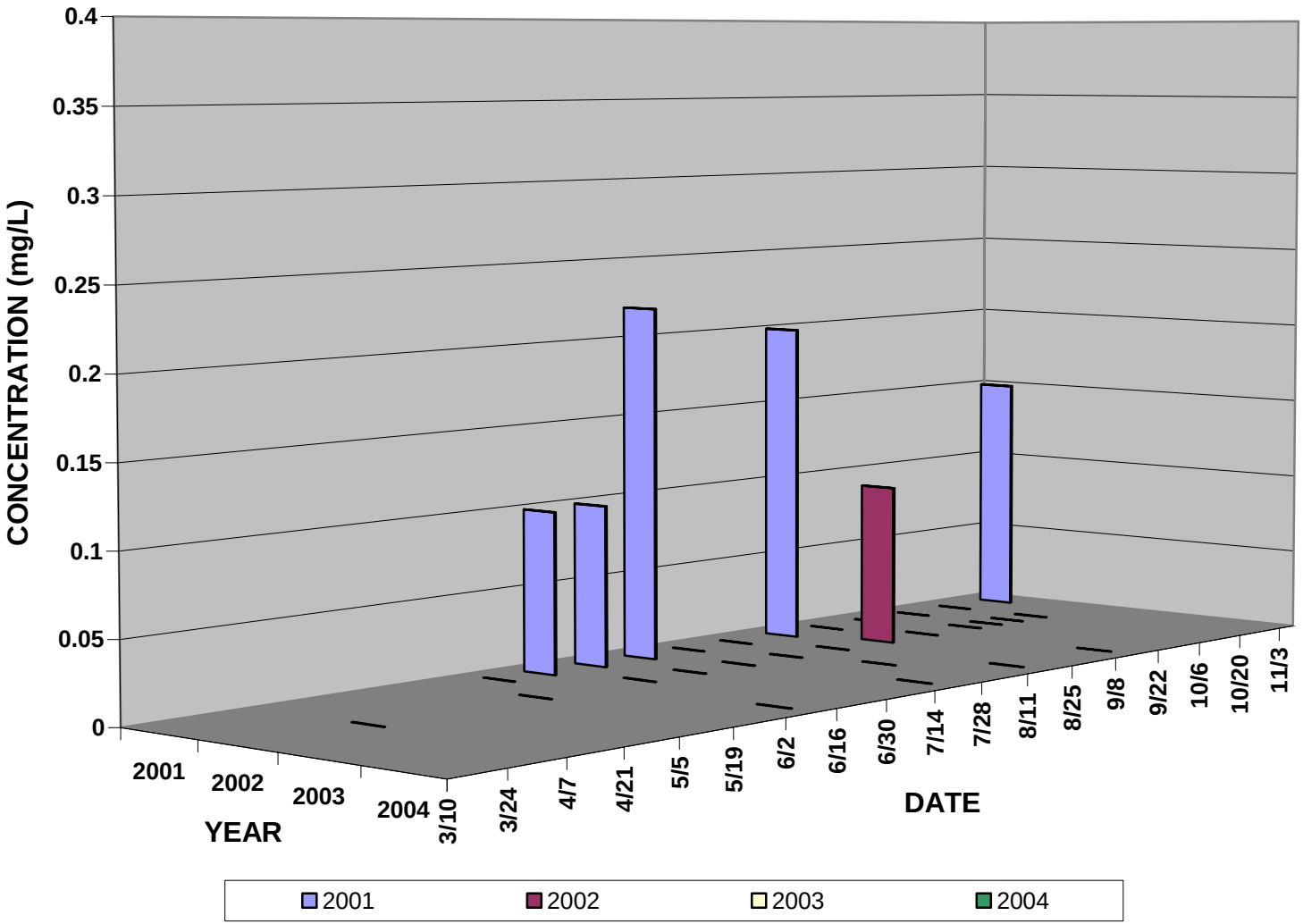
Ammonia (as Nitrogen) in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004



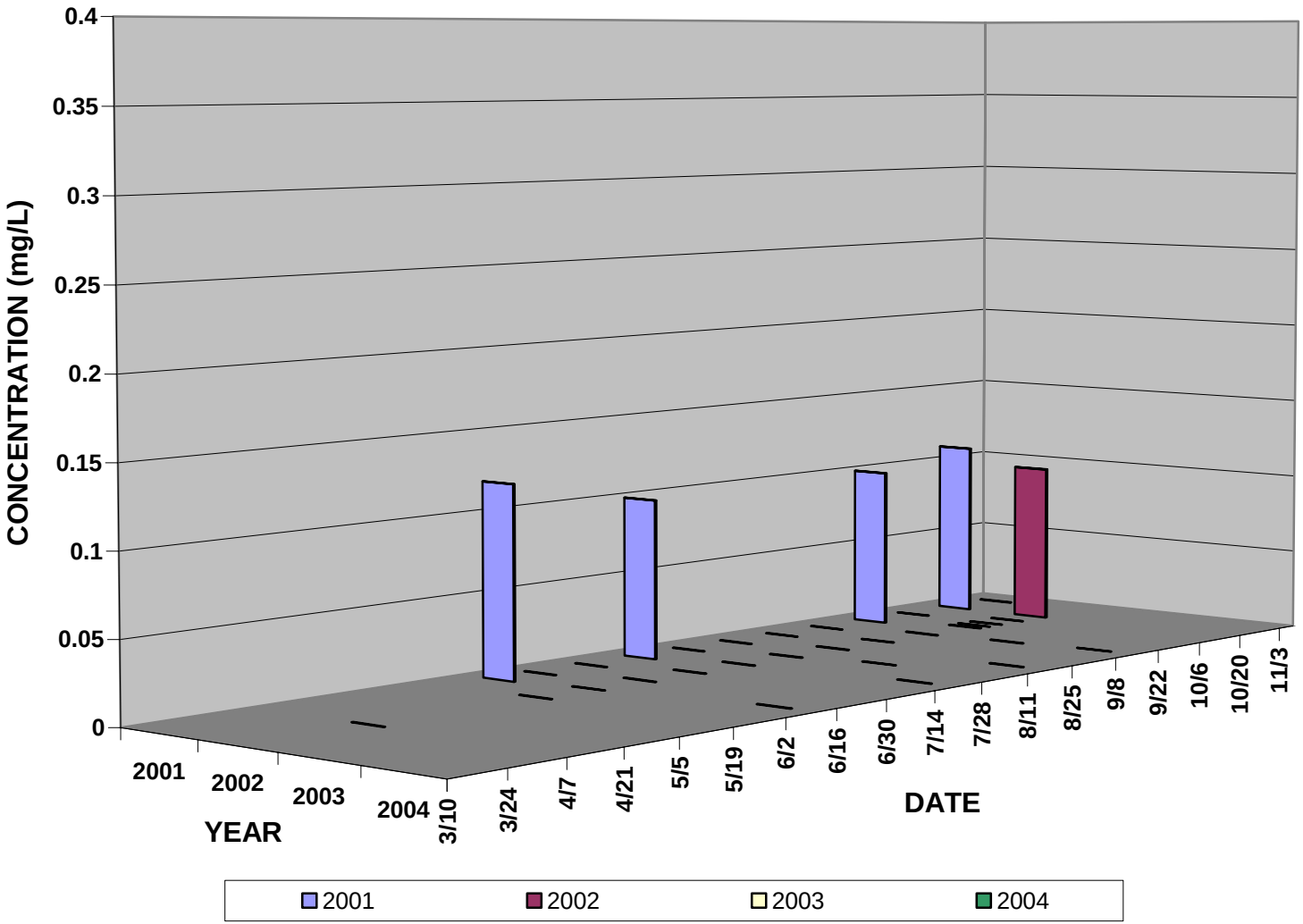
Ammonia (as Nitrogen) in the Shasta River near the mouth, 2001 to 2004



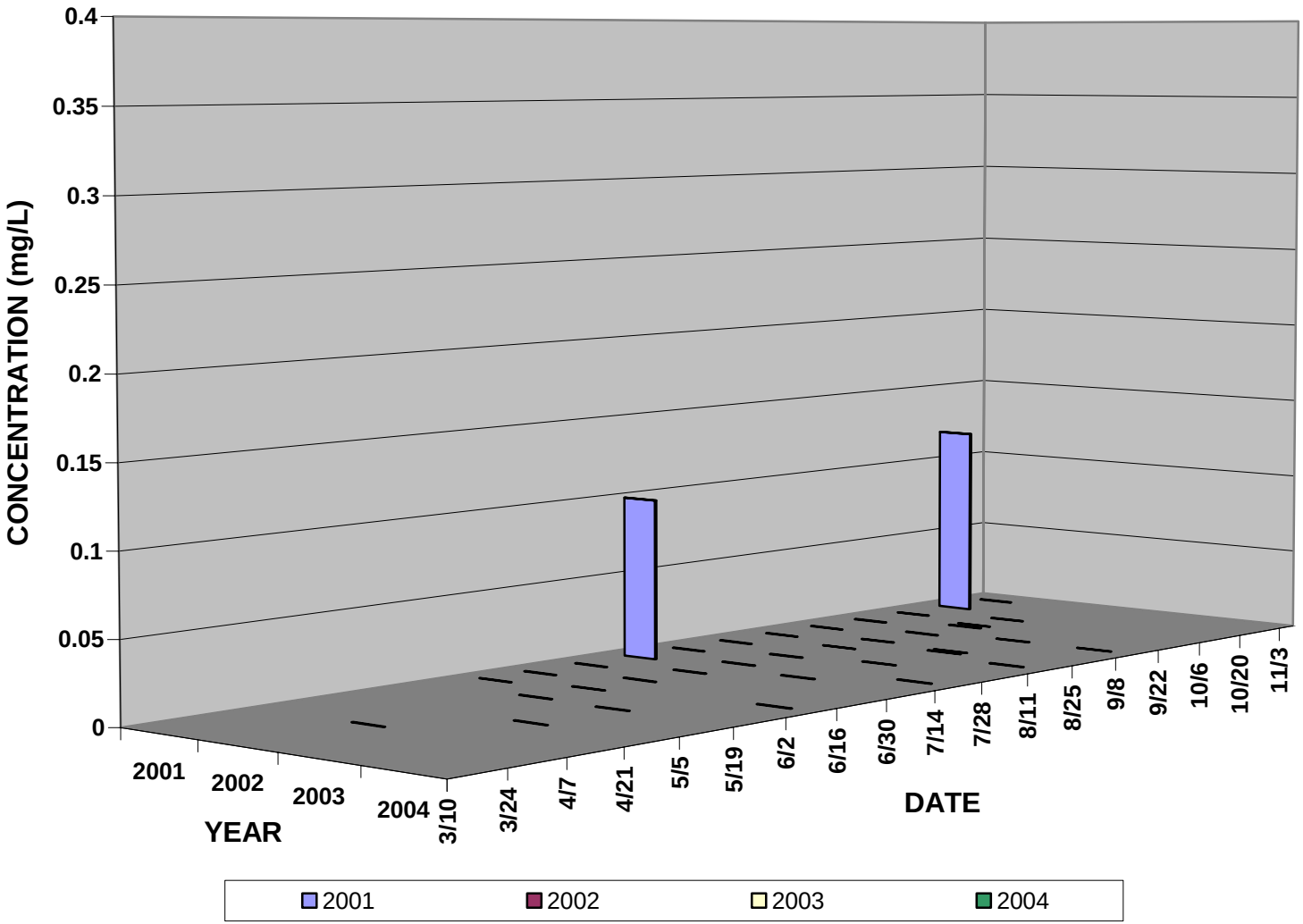
Ammonia (as Nitrogen) in the Klamath River at the Seiad Valley Gage
2001 to 2004



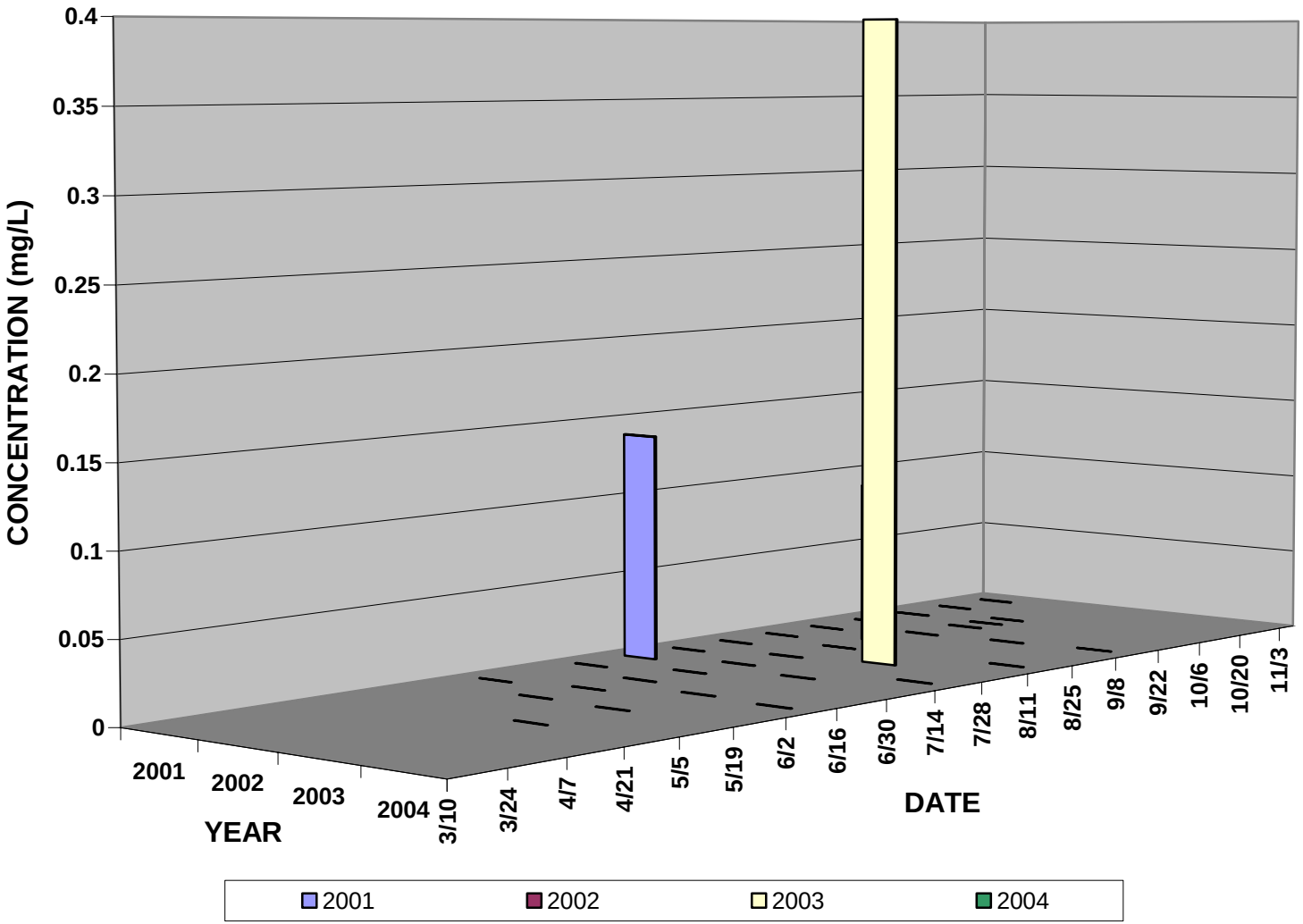
Ammonia (as Nitrogen) in the Klamath River at Orleans, 2001 to 2004



Ammonia (as Nitrogen) in the Trinity River near Weitchpec, 2001 to 2004



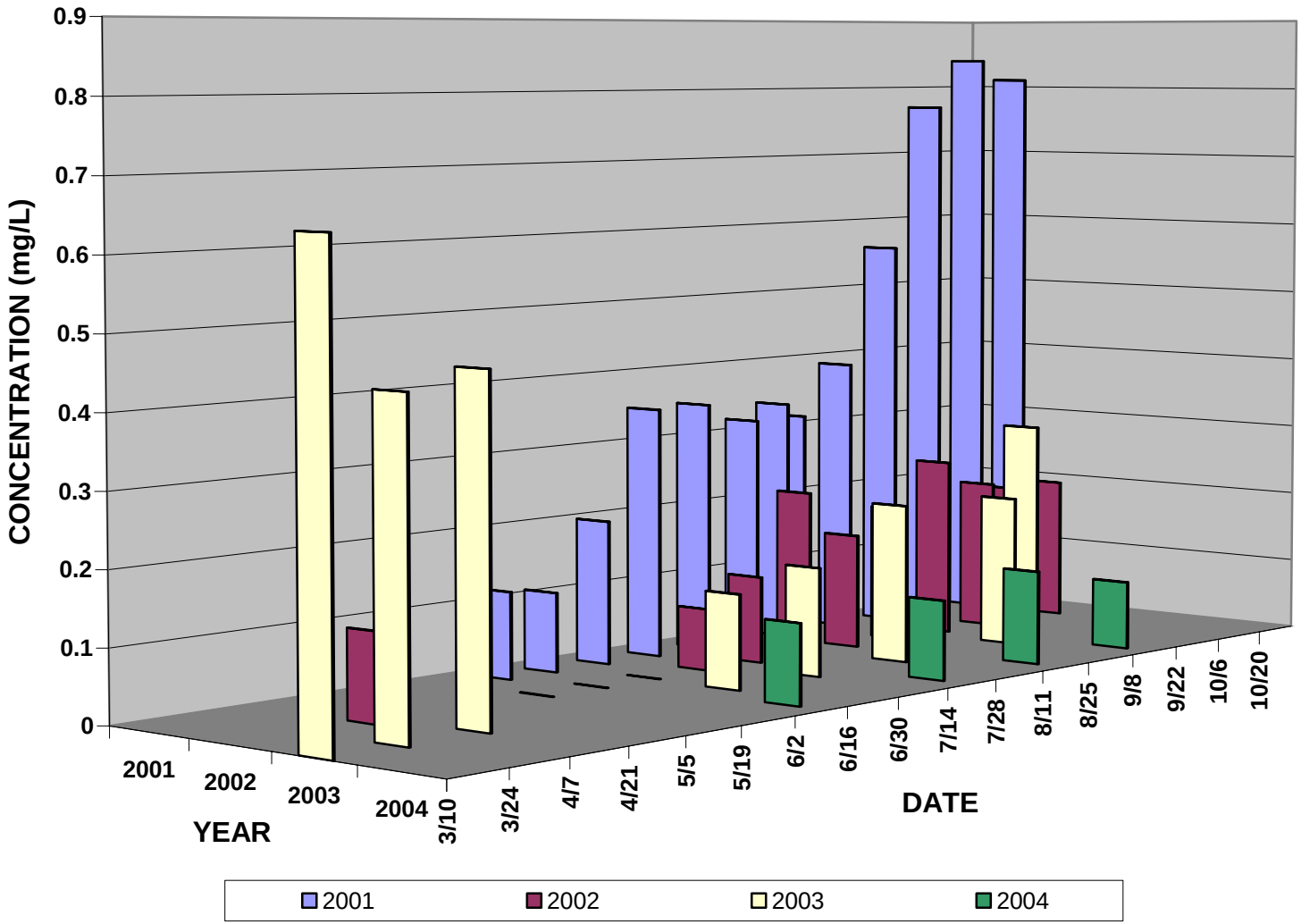
Ammonia (as Nitrogen) in the Klamath River at the Turwar Gage, 2001 to 2004

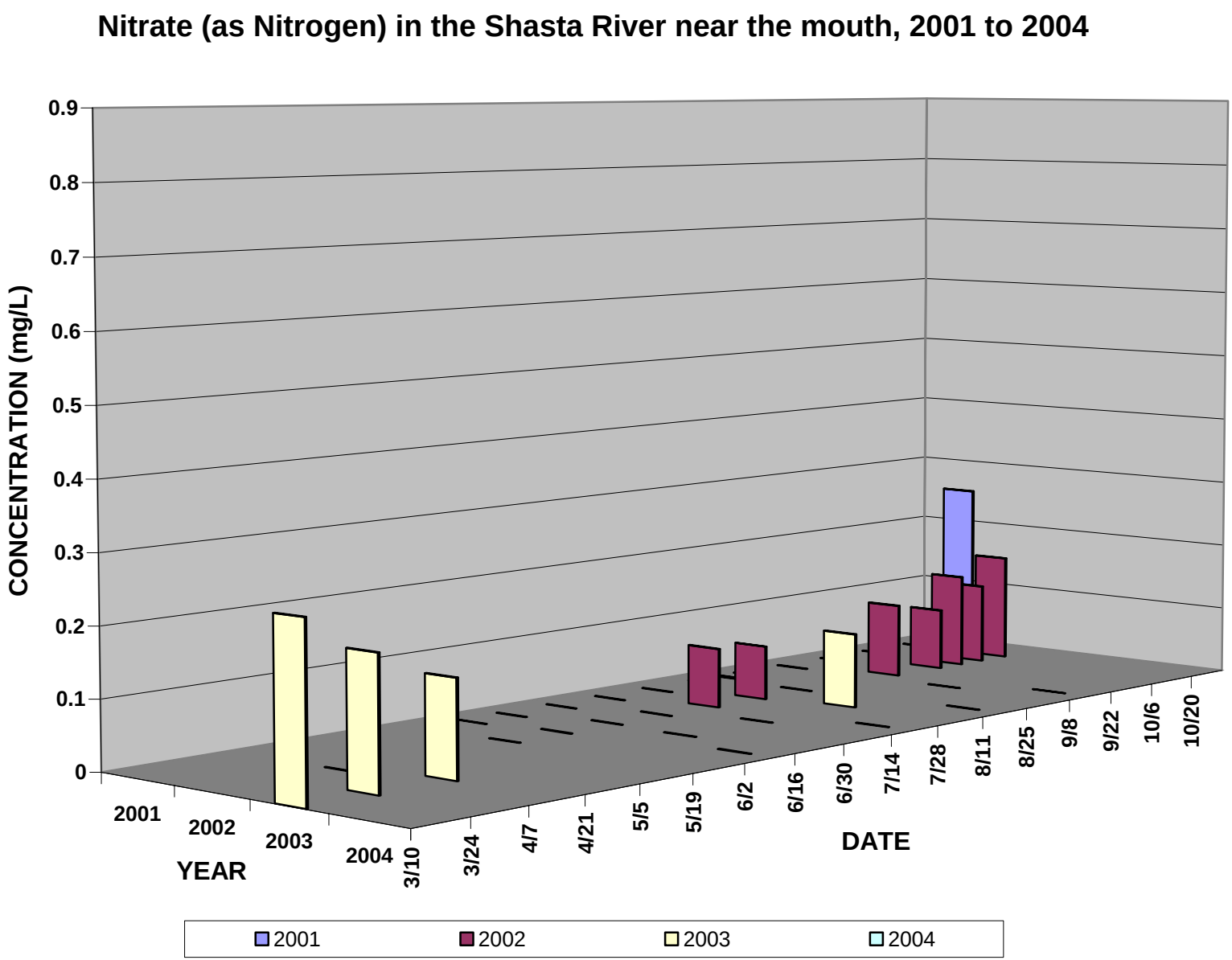


Ammonia - Summary

- Ammonia highest in 2001 at Iron Gate
- Decreasing levels at downstream sites
- Shasta River emits fairly low ammonia levels
- Toxicity issues have **not** yet been addressed

Nitrate (as Nitrogen) in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004




Nitrate (as Nitrogen) in the Shasta River near the mouth, 2001 to 2004
CONCENTRATION (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
DATE
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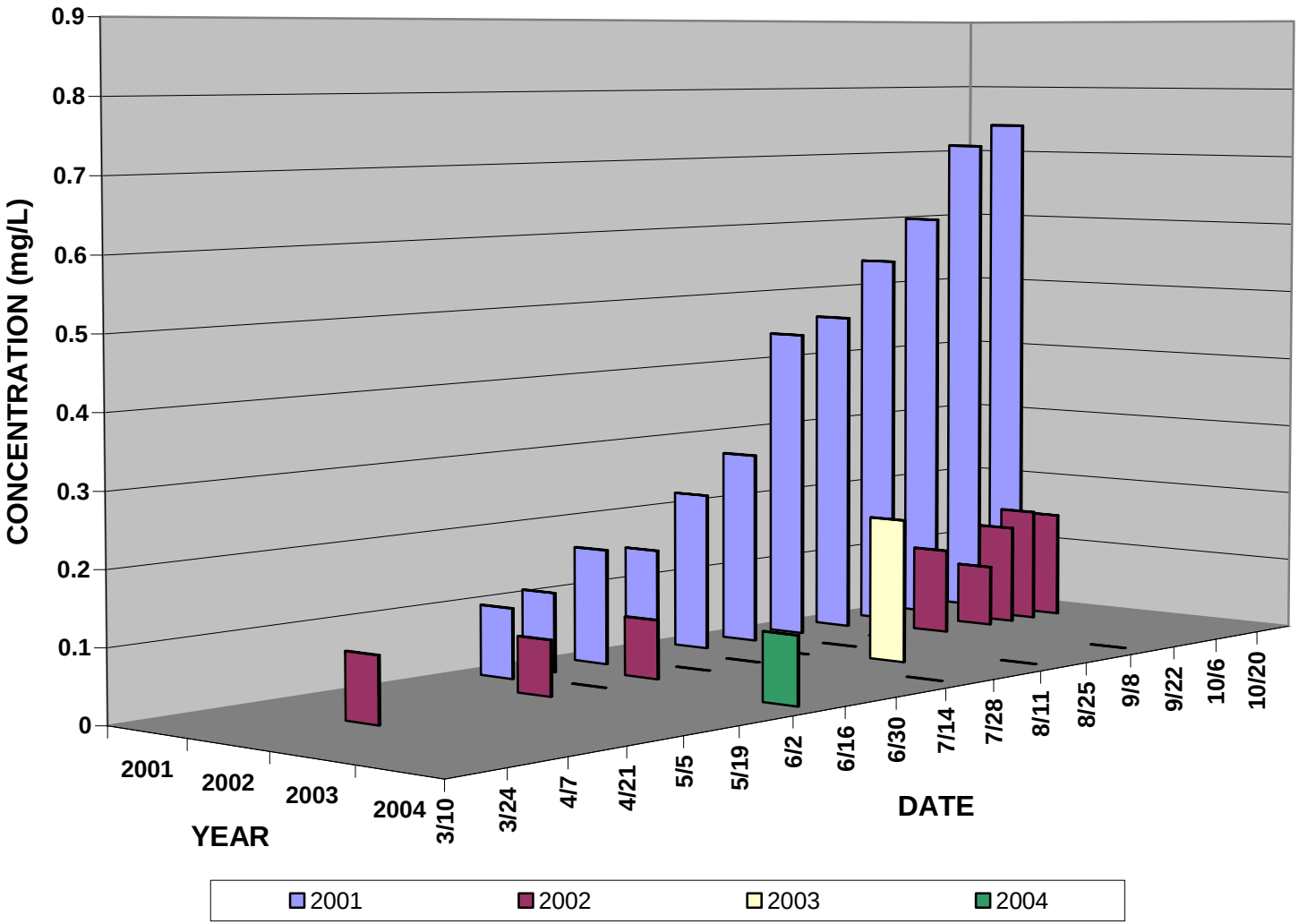
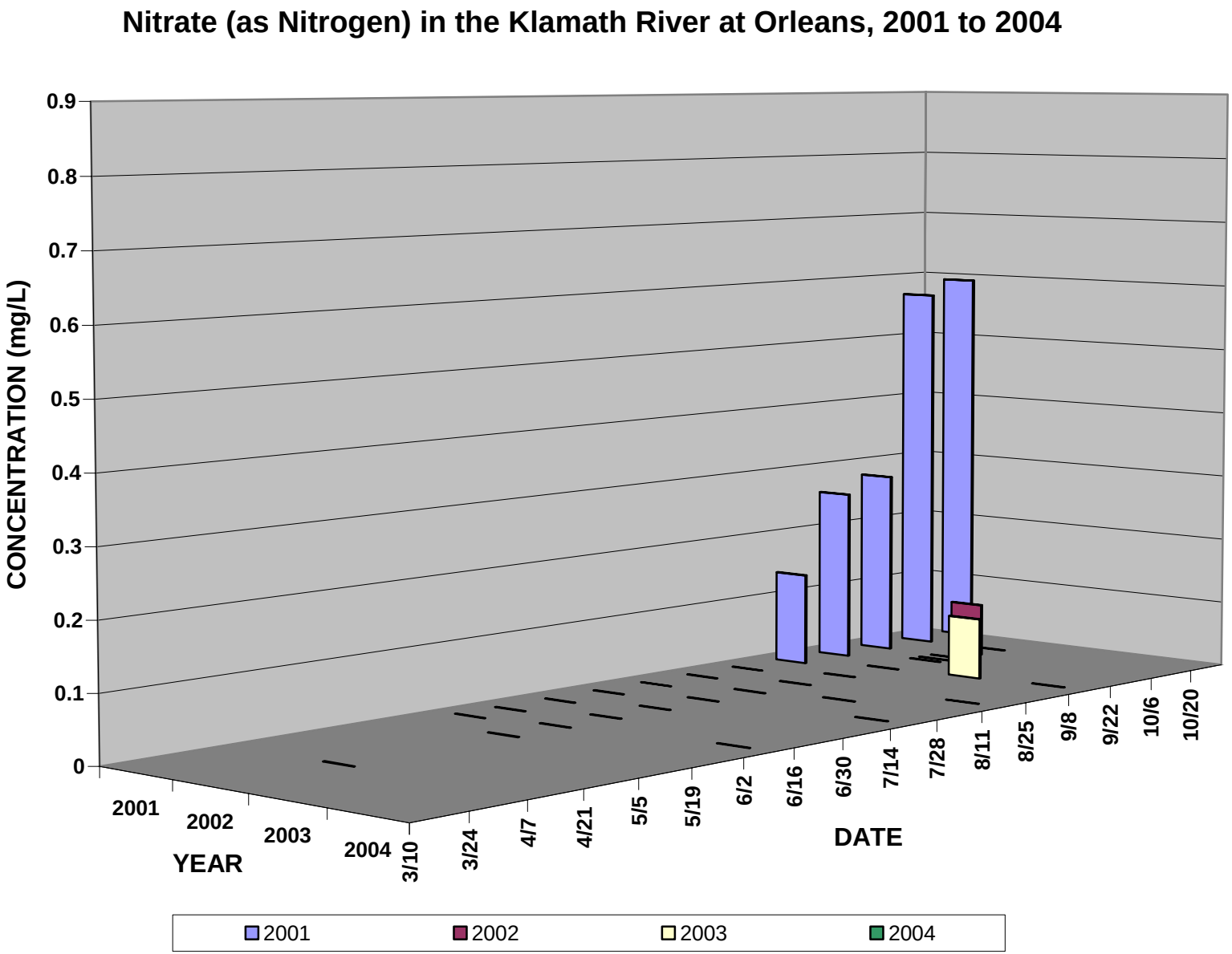
2003
2004

Nitrate (as Nitrogen) in the Klamath River at the Seiad Valley Gage, 2001 to 2004




Nitrate (as Nitrogen) in the Klamath River at Orleans, 2001 to 2004
CONCENTRATION (mg/L)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
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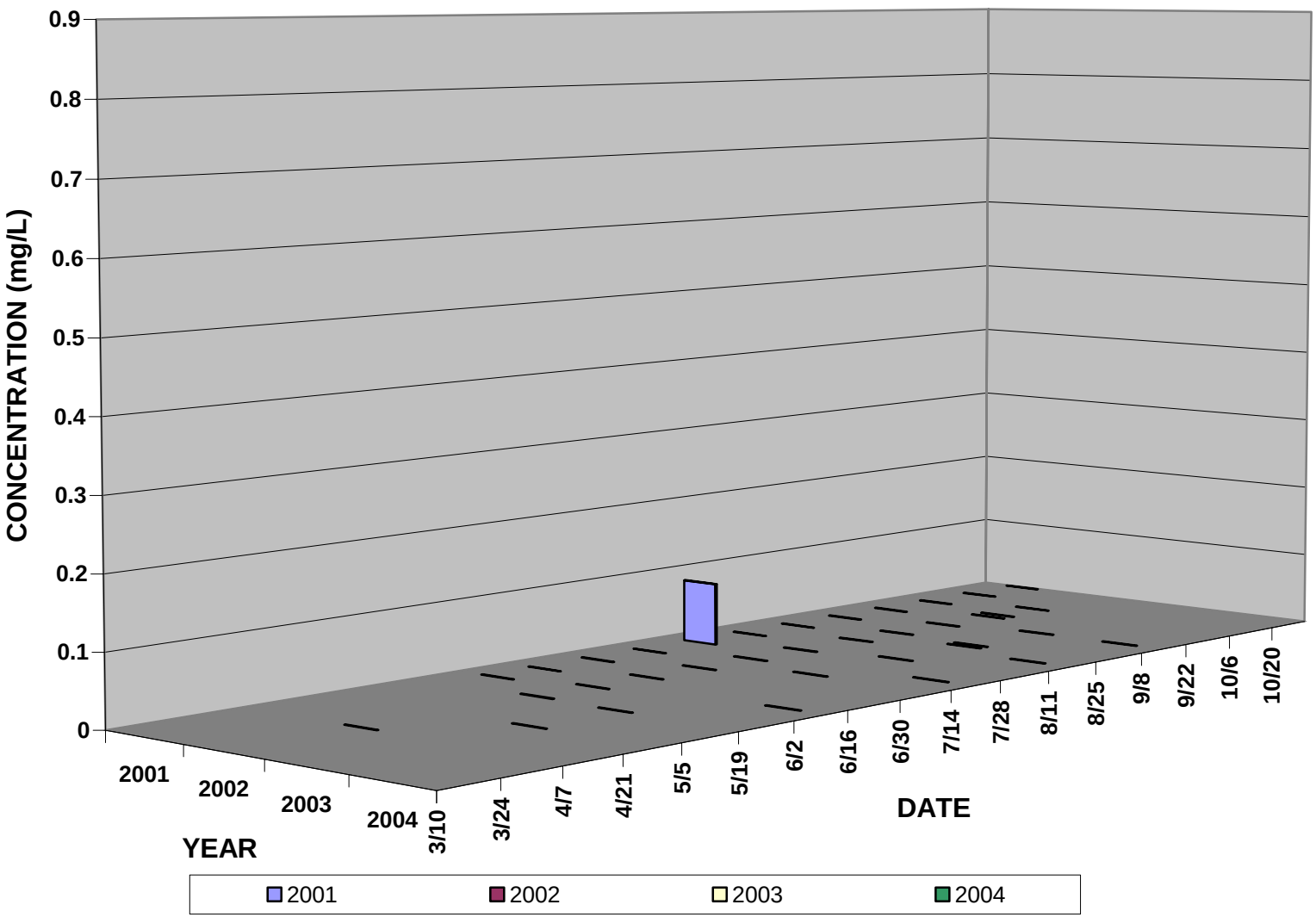
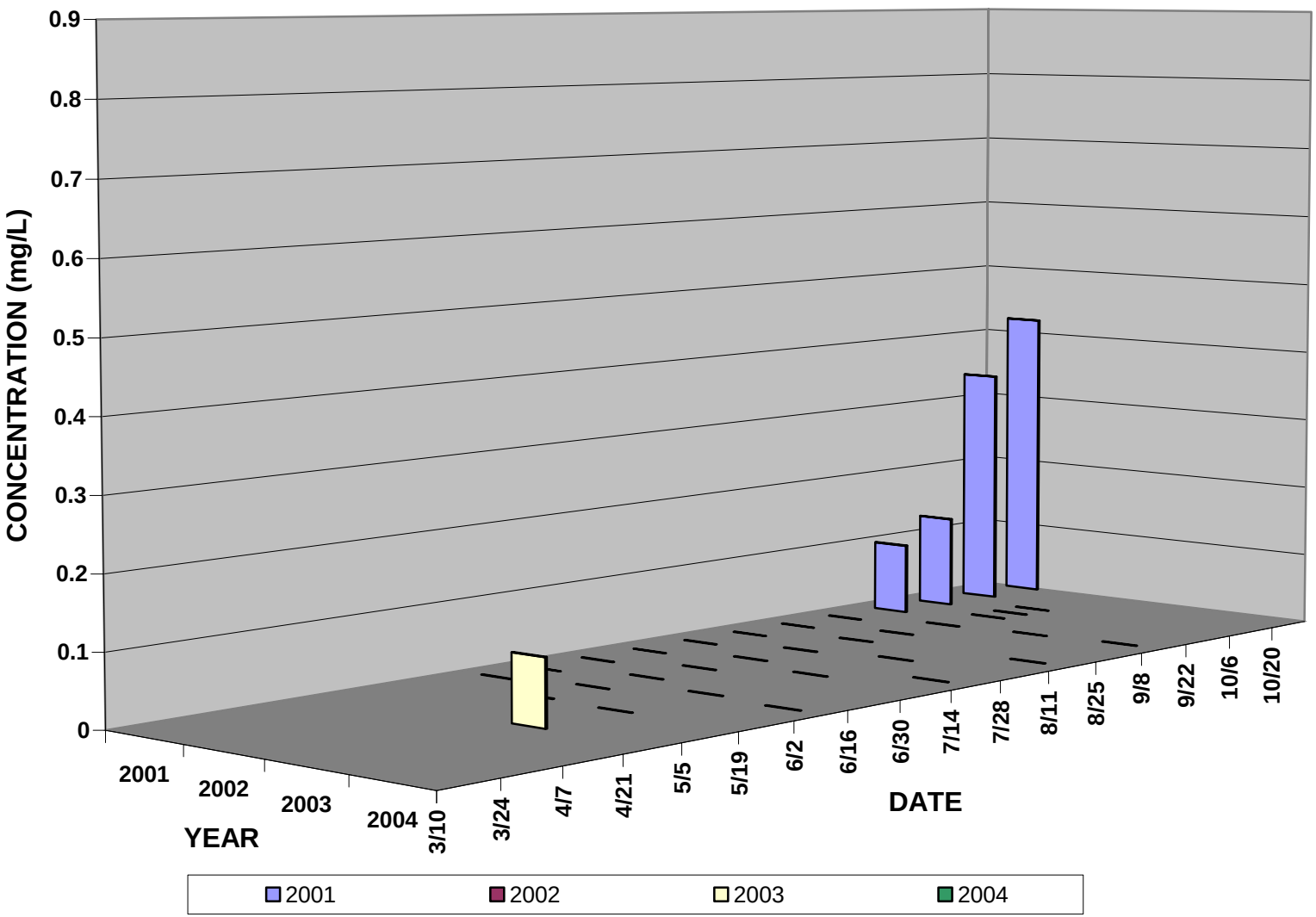
2002
2003
2004

Nitrate (as Nitrogen) in the Trinity River near Weitchpec, 2001 to 2004



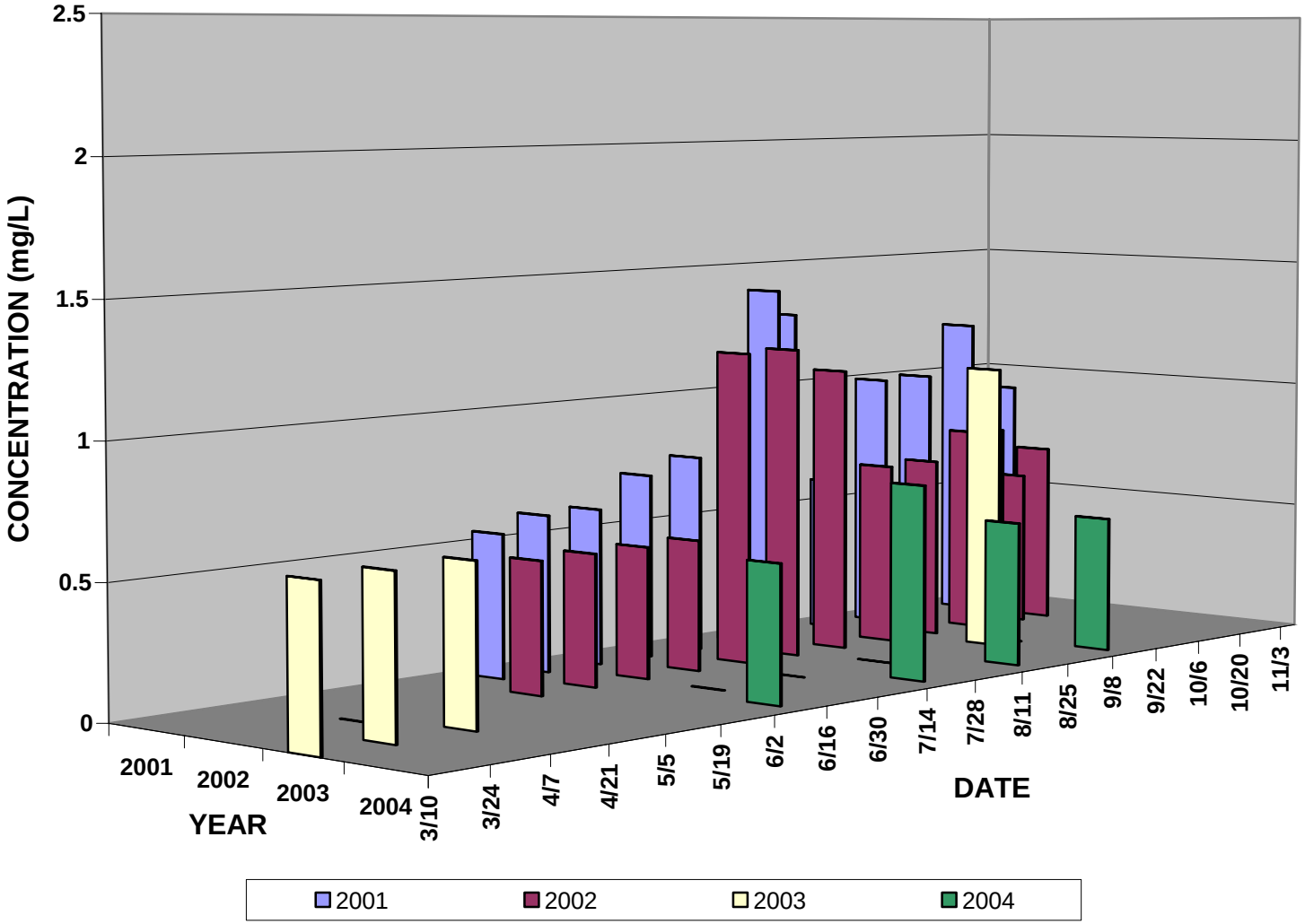
Nitrate (as Nitrogen) in the Klamath River at Turwar, 2001 to 2004



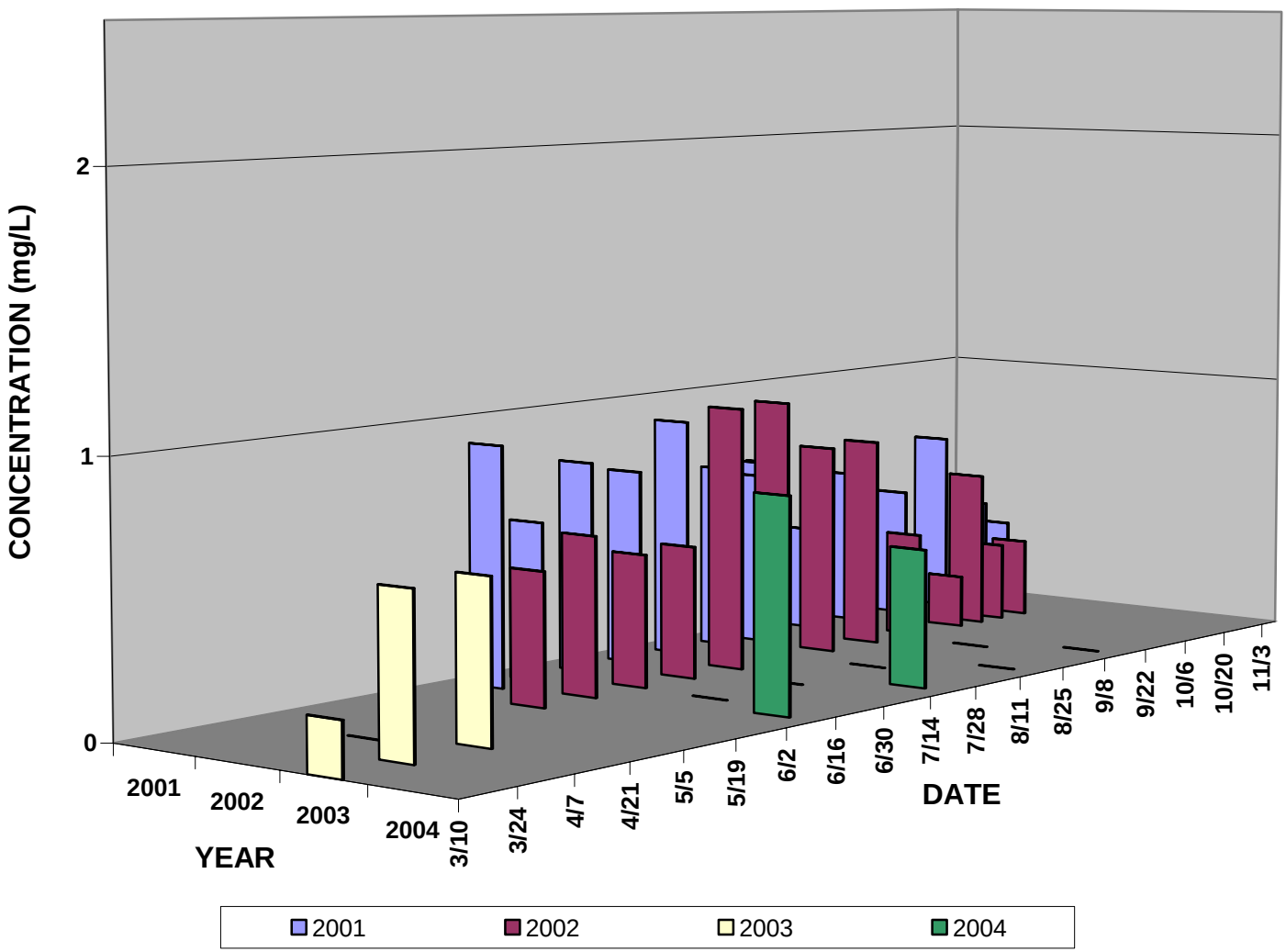
Nitrate - Summary

- Nitrate also highest in 2001 at Iron Gate. Detectable levels observed at all mainstem sites during this year, in particular the fall.
- Decreasing levels at downstream sites due to tributary accretion.
- Shasta River is contributing to loading, but fairly small amounts due to low flow and low concentrations

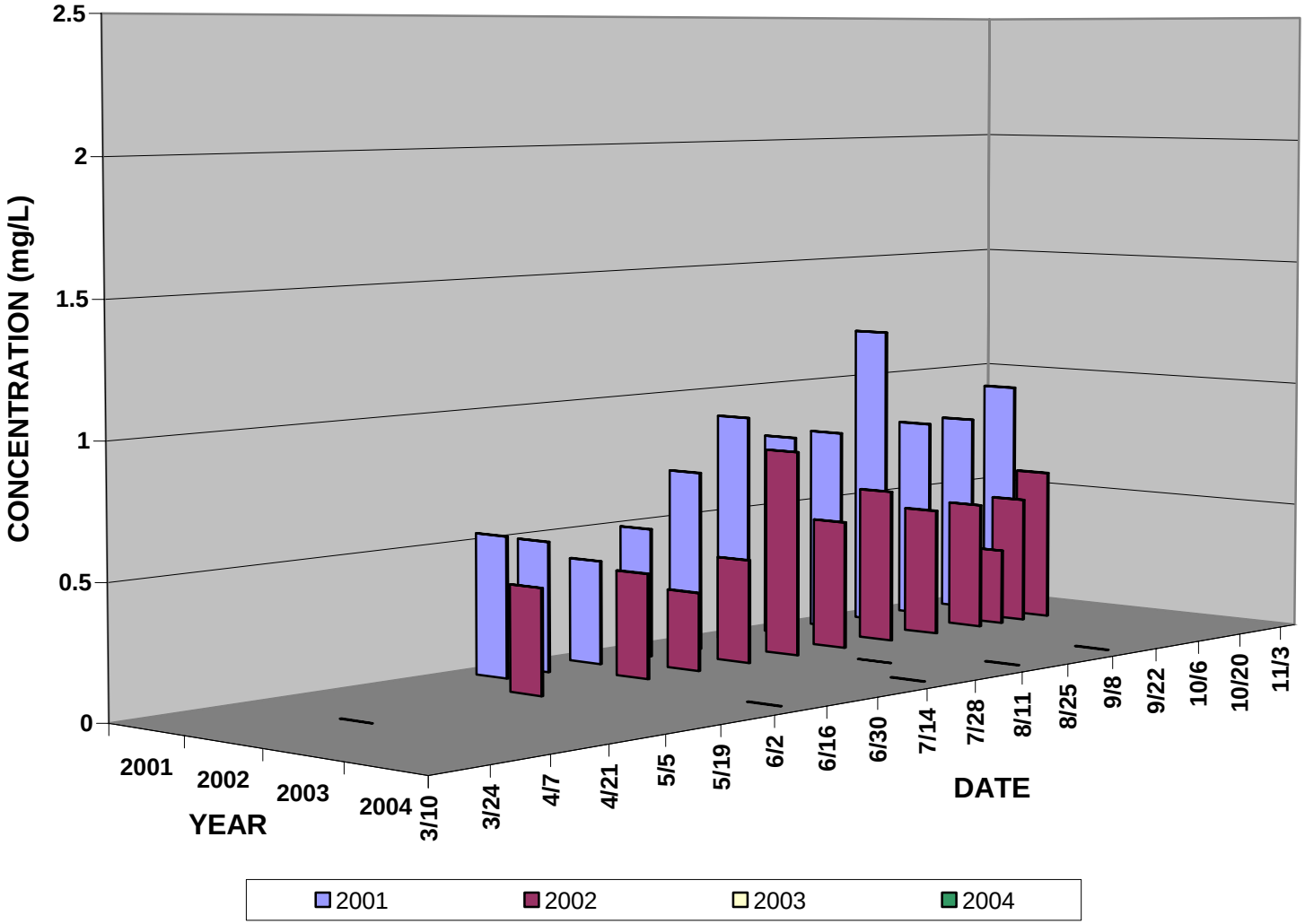
Total Kjeldahl Nitrogen (TKN) in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004



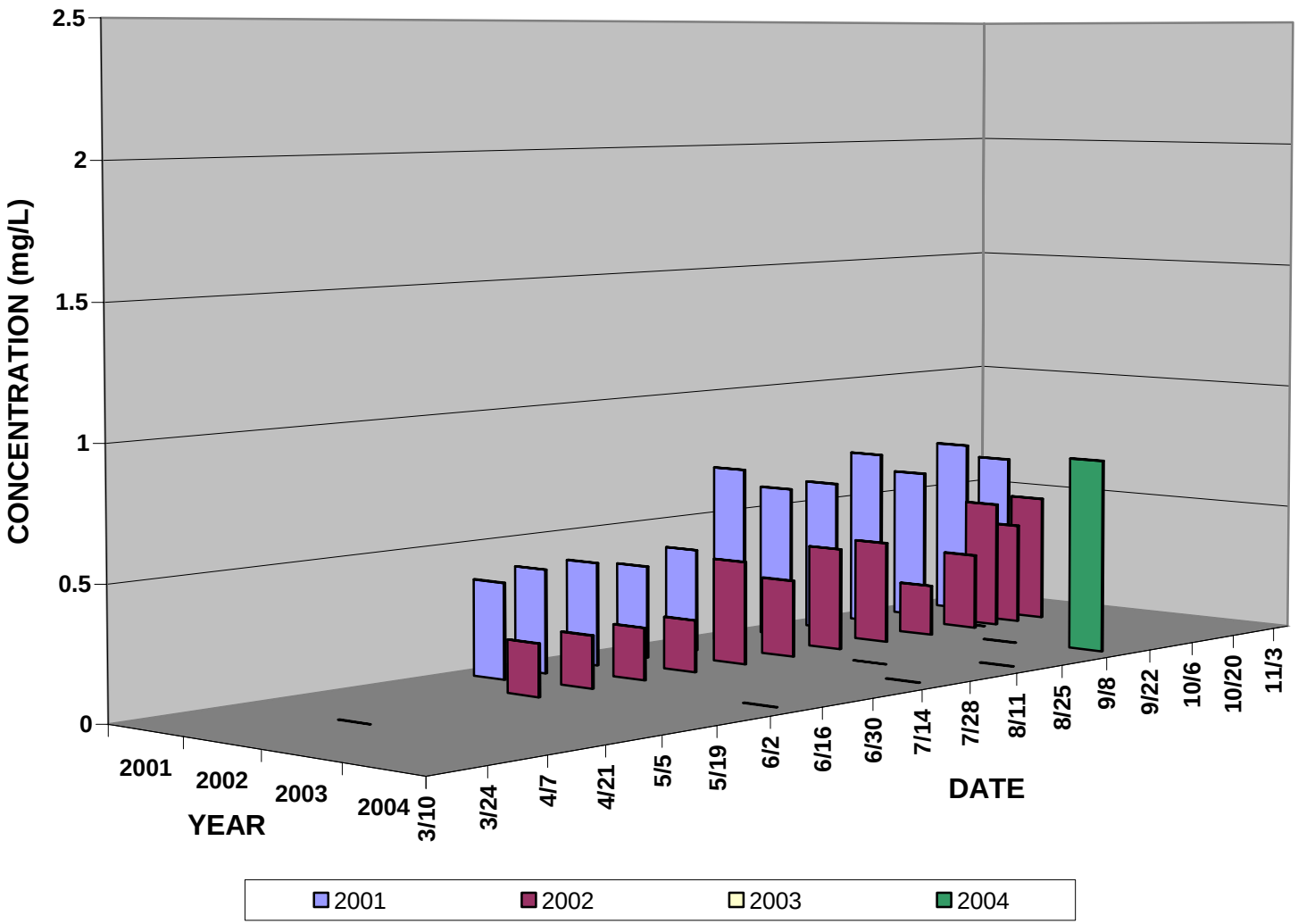
Total Kjeldahl Nitrogen (TKN) in the Shasta River near the mouth, 2001 to 2004



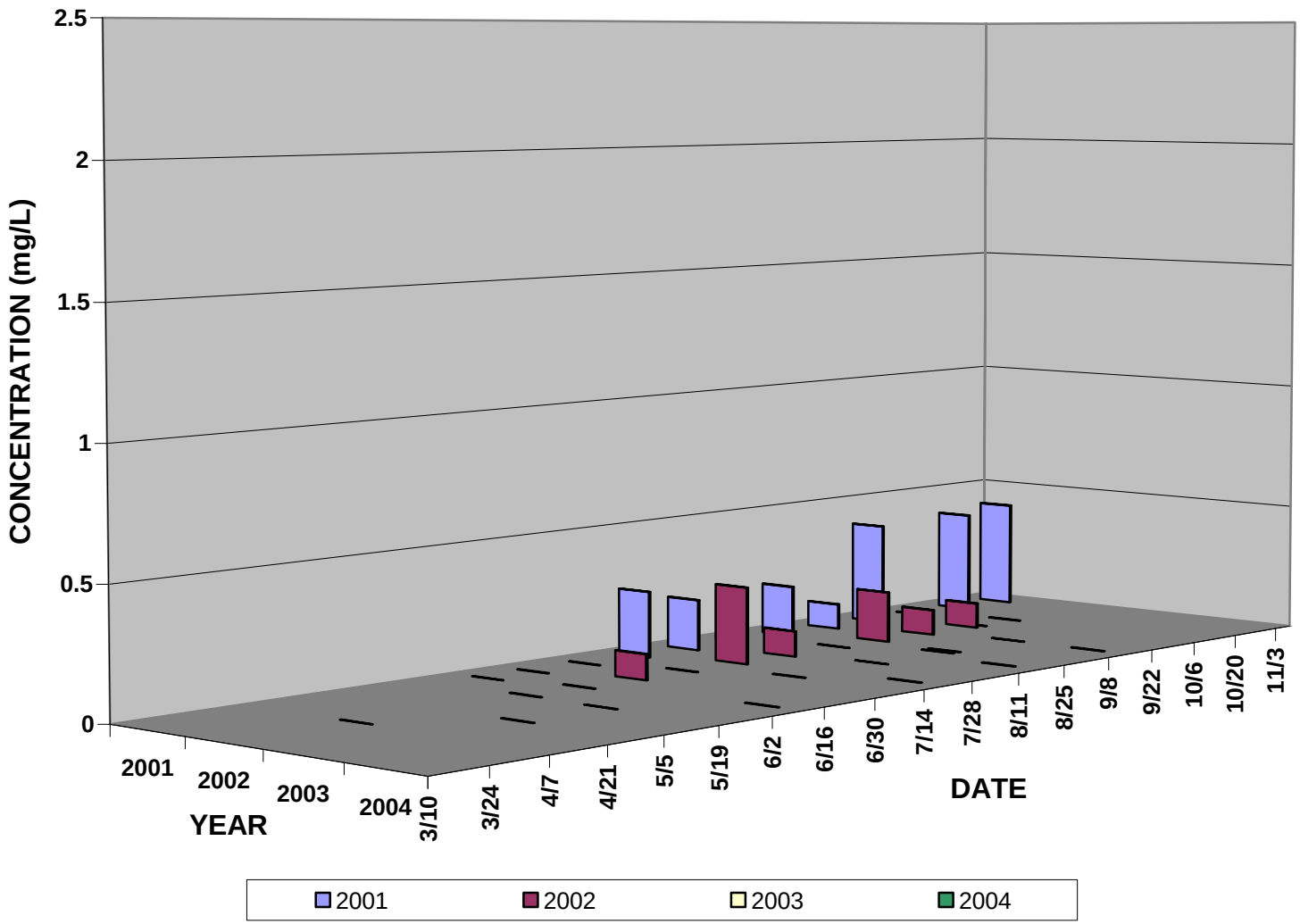
Total Kjeldahl Nitrogen (TKN) in the Klamath River at the Seiad Valley Gage, 2001 to 2004



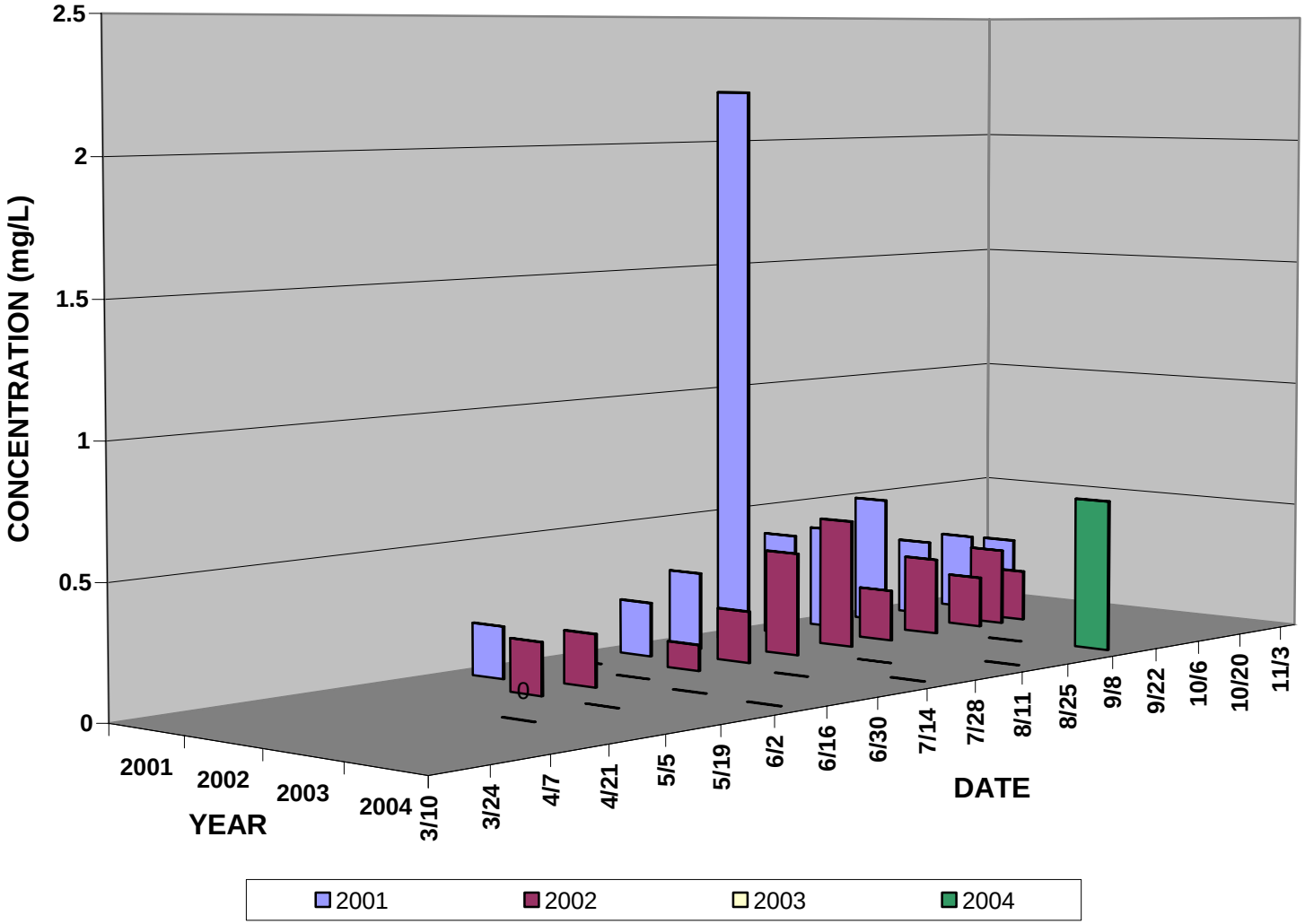
Total Kjeldahl Nitrogen (TKN) in the Klamath River at Orleans, 2001 to 2004



Total Kjeldahl Nitrogen (TKN) in the Trinity River near Weitchpec, 2001 to 2004

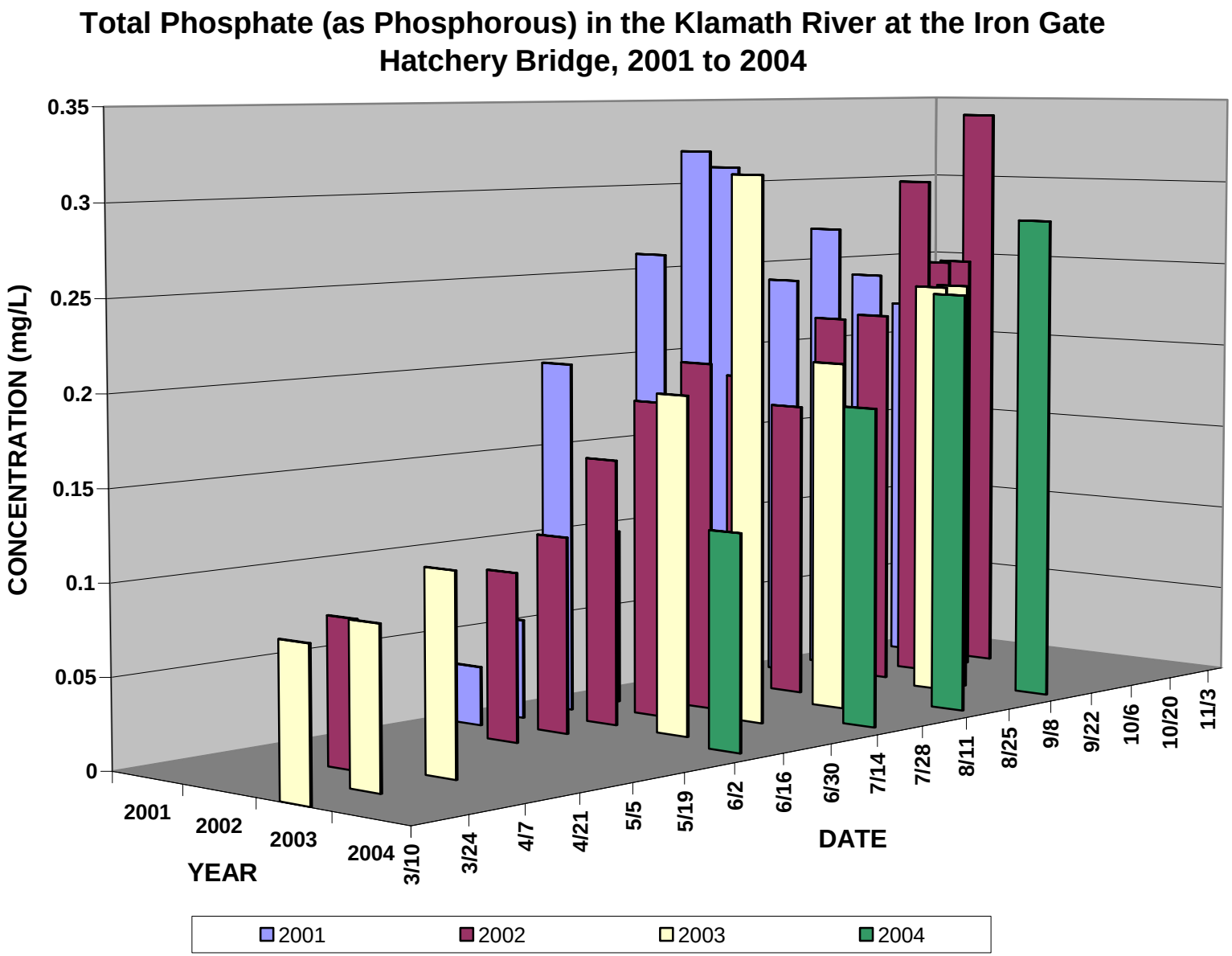


Total Kjeldahl Nitrogen (TKN) in the Klamath River at the Turwar Gage, 2001 to 2004

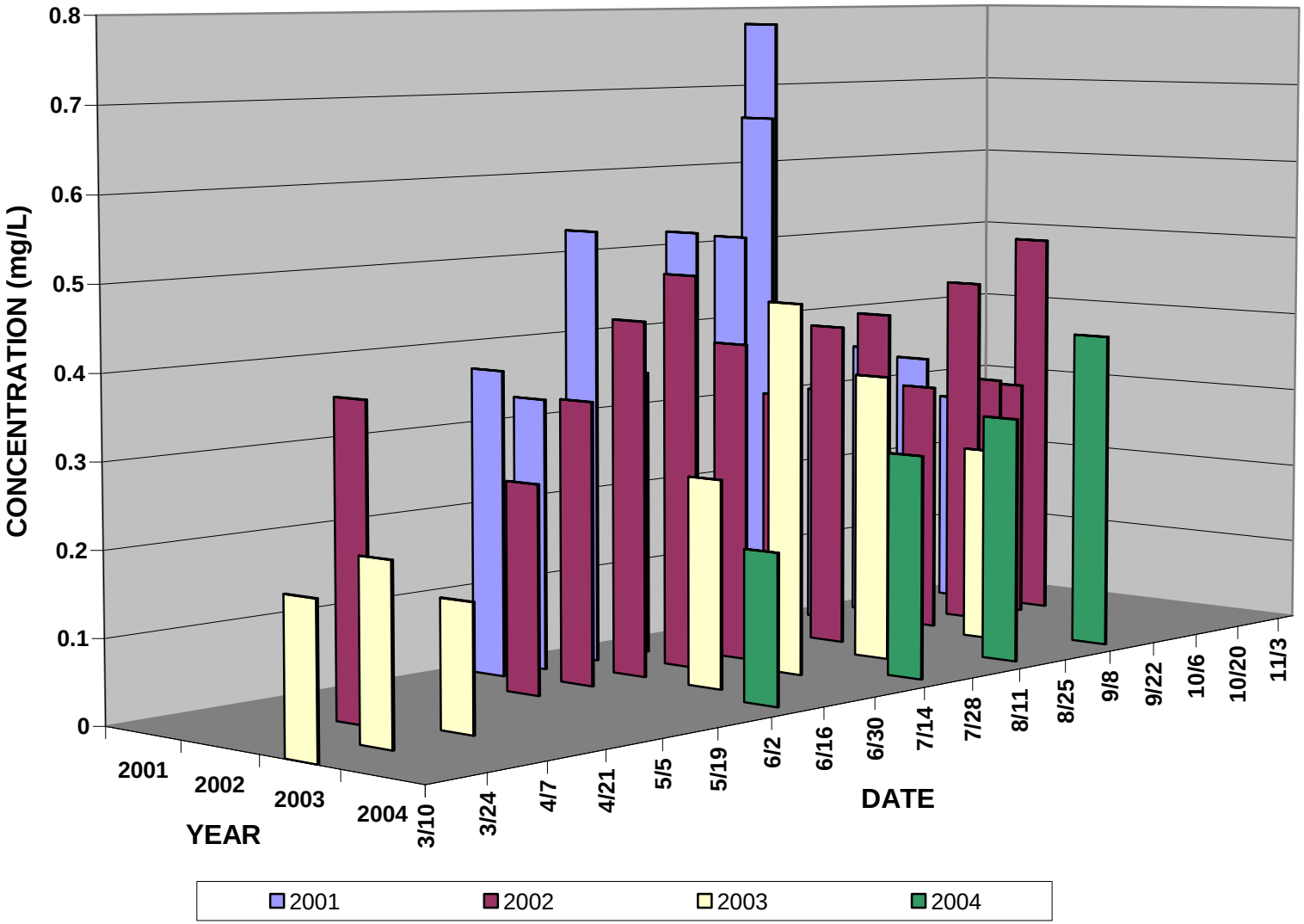


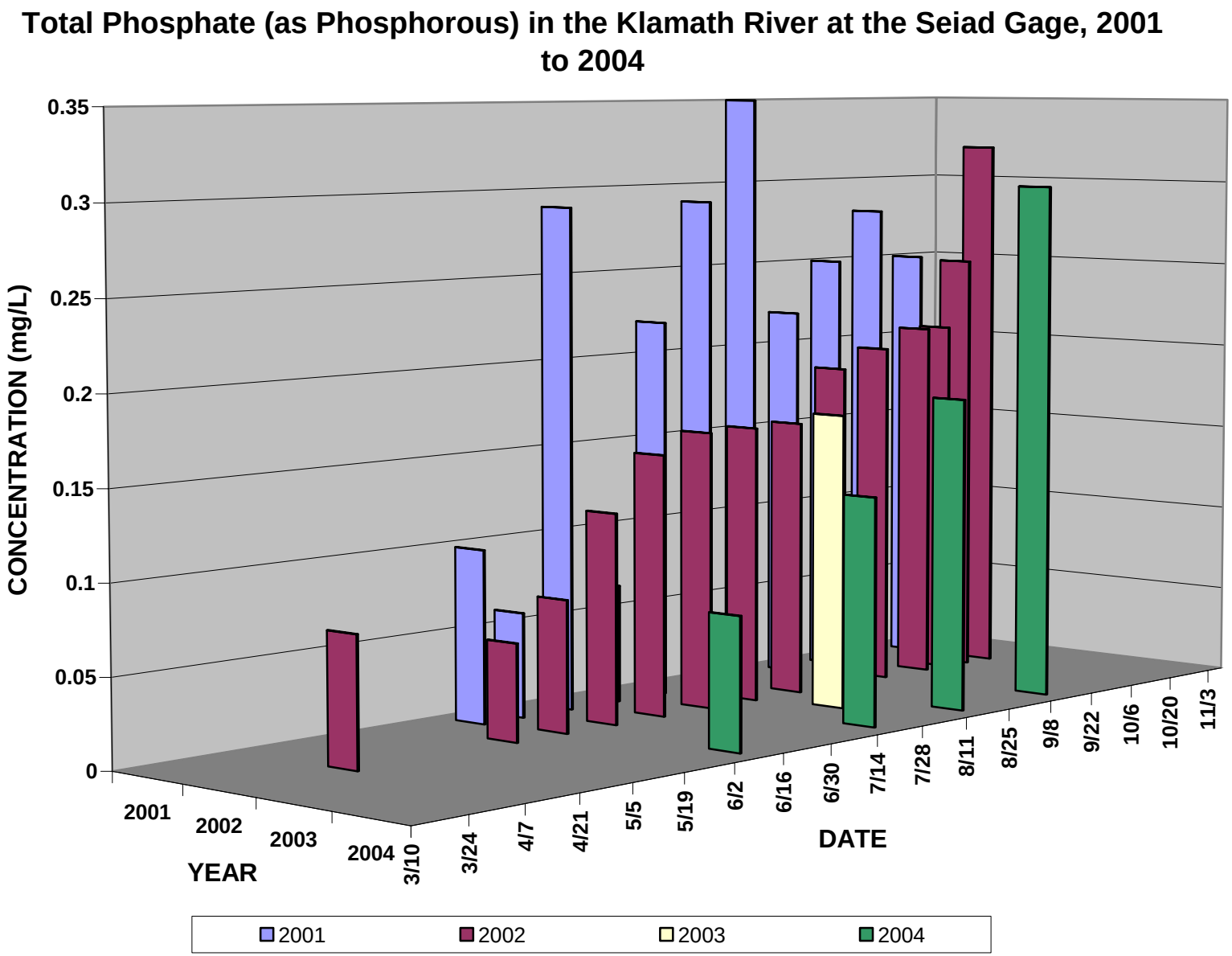
Organic Nitrogen - Summary

- Highest in 2001 and 2002 at Iron Gate and Shasta River
- Decreasing levels at downstream sites due to tributary accretion.


Total Phosphate (as Phosphorous) in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004
CONCENTRATION (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004

Total Phosphate (as Phosphorous) in the Shasta River near the mouth, 2001 to 2004




Total Phosphate (as Phosphorous) in the Klamath River at the Seiad Gage, 2001 to 2004
CONCENTRATION (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
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10/20
11/3
DATE
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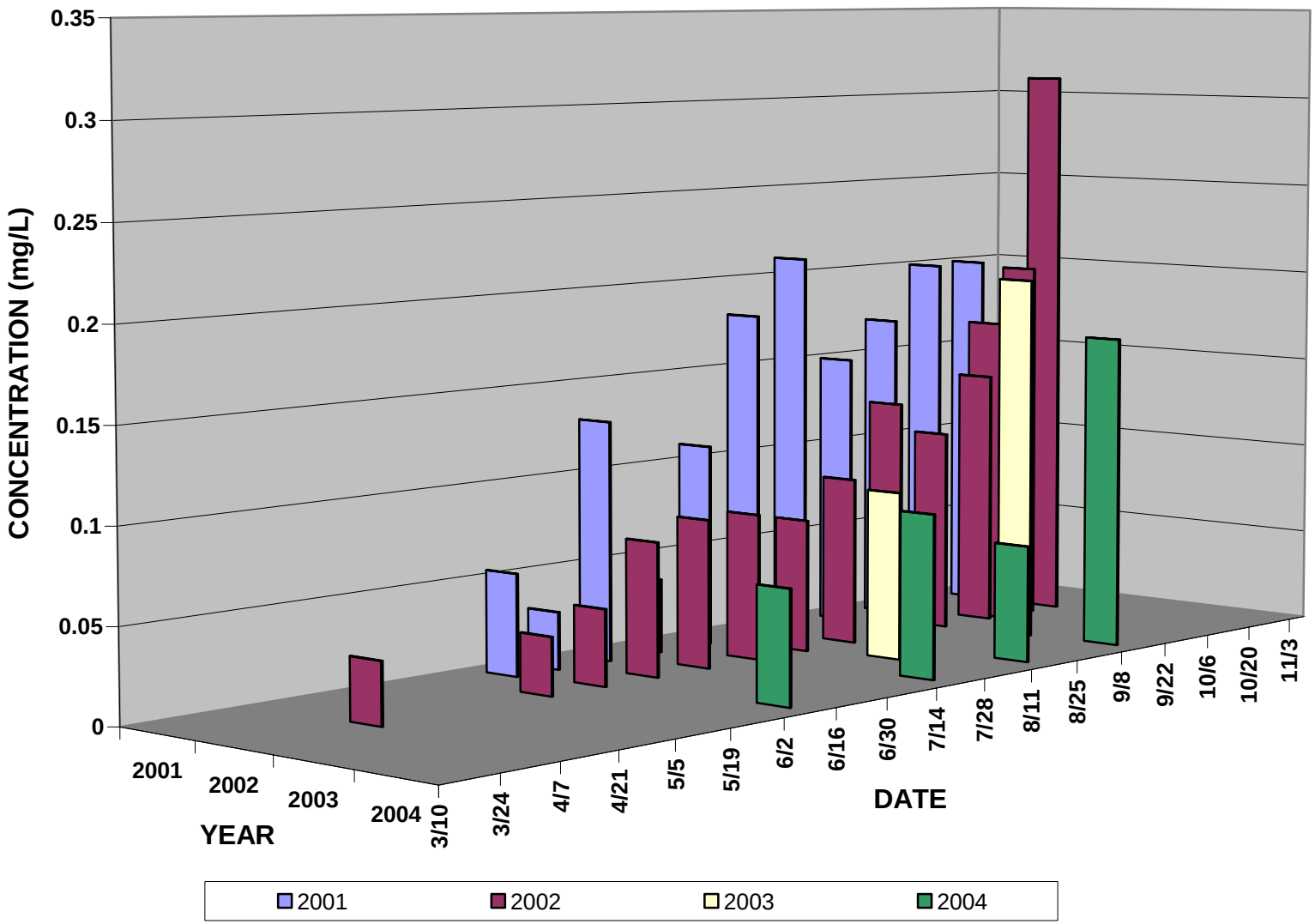
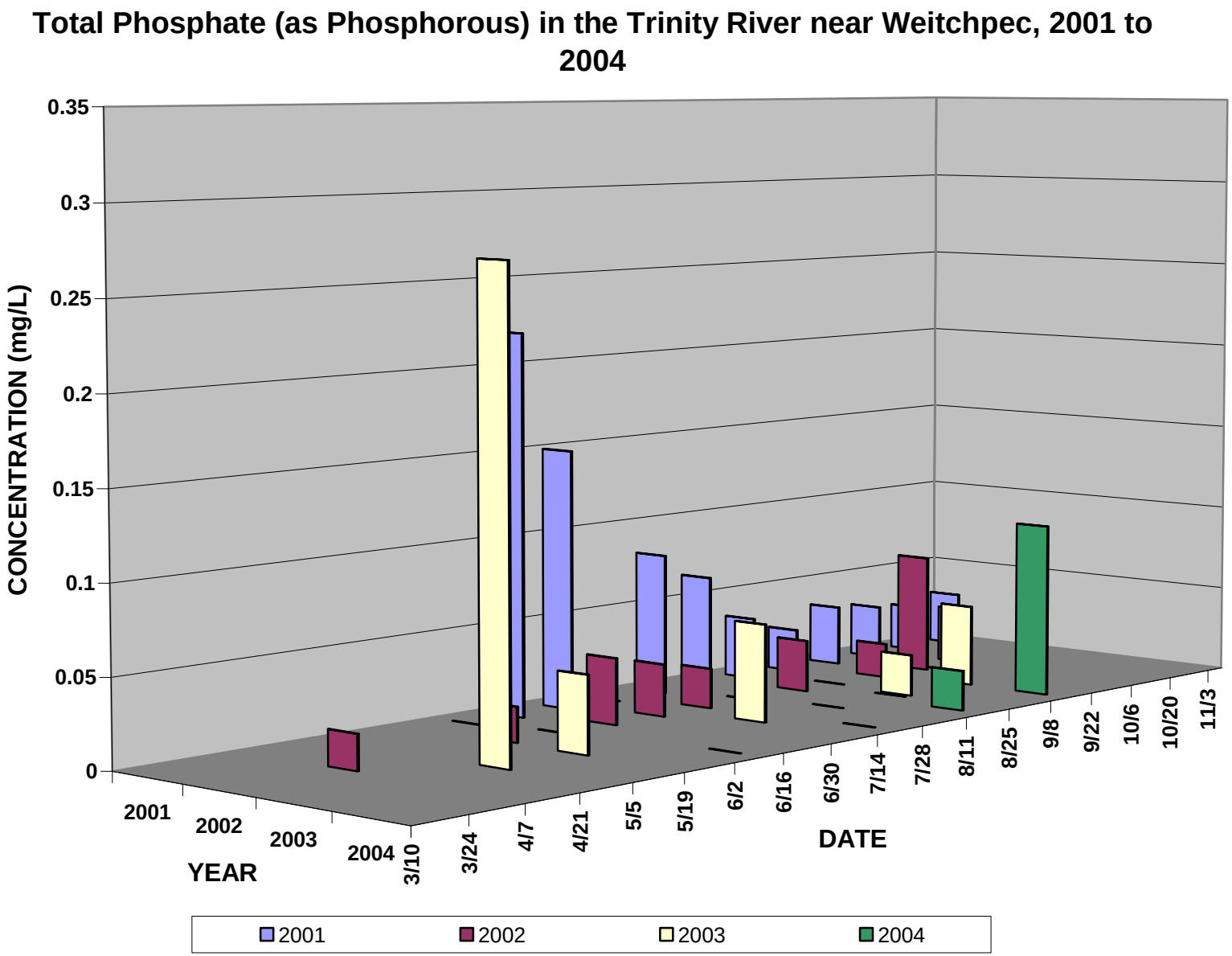
2002
2003
2004

Total Phosphate (as Phosphorous) in the Klamath River at Orleans, 2001 to 2004




Total Phosphate (as Phosphorous) in the Trinity River near Weitchpec, 2001 to 2004
CONCENTRATION (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001
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2003
2004
YEAR
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4/7
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5/5
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6/2
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11/3
DATE
2001
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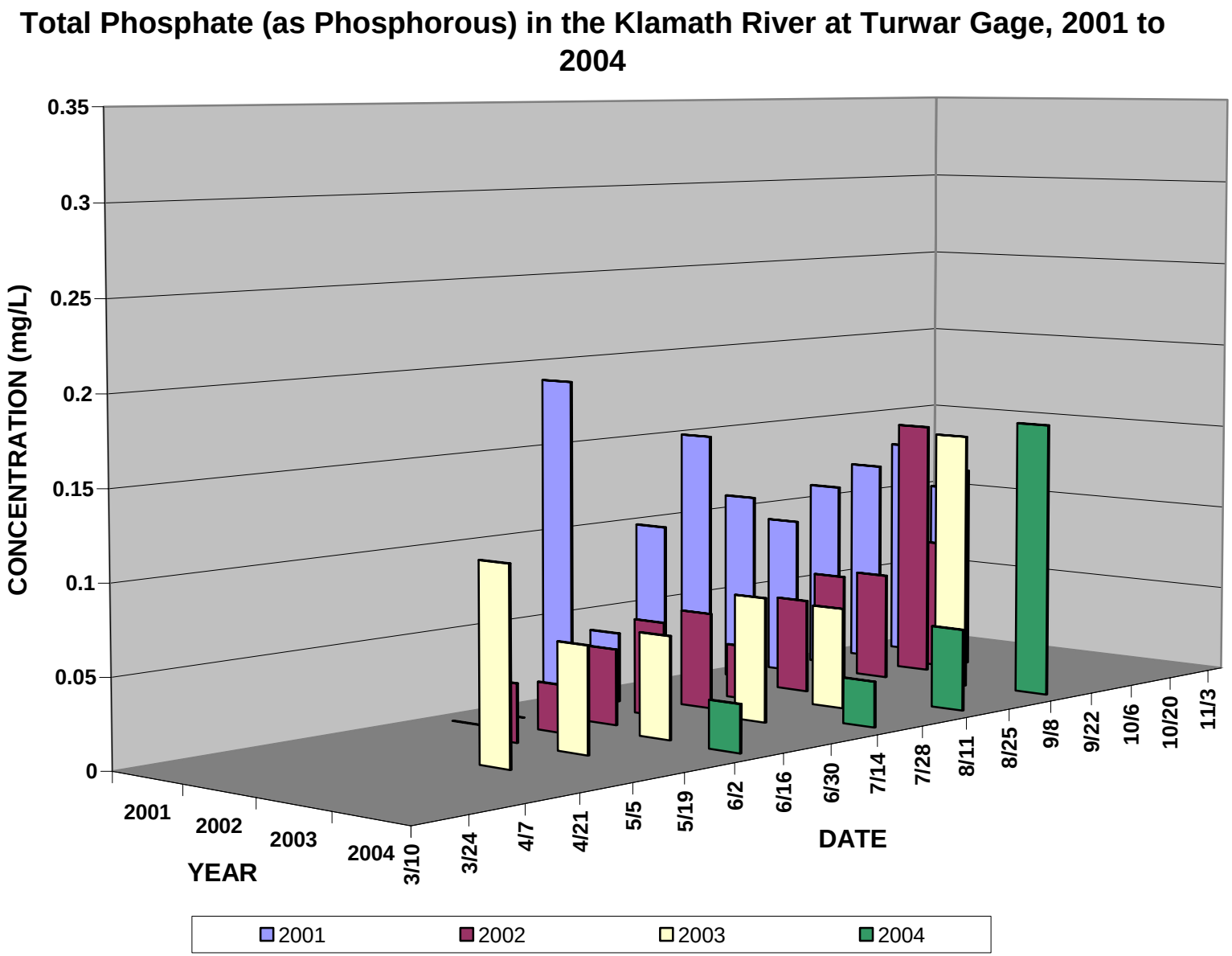
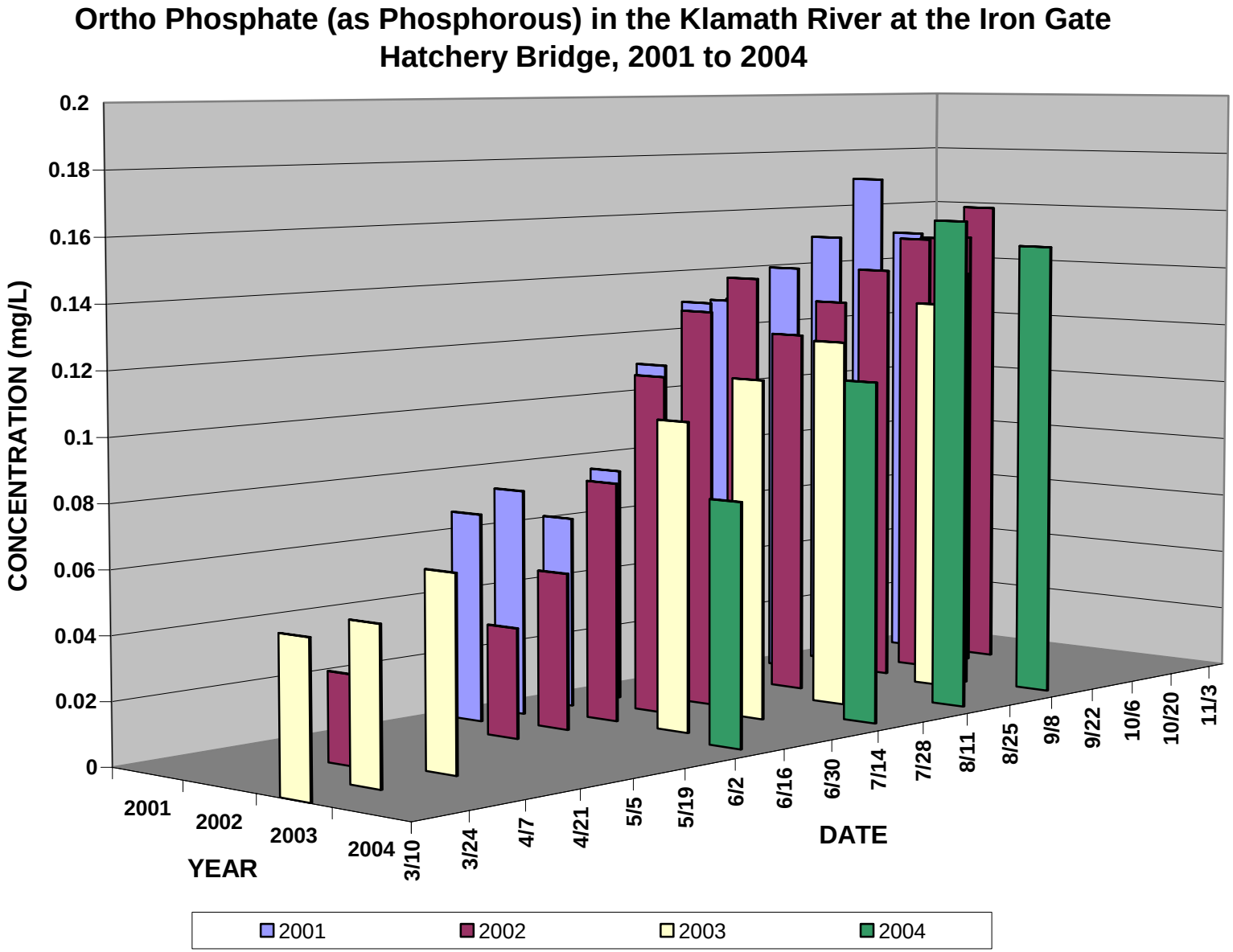
2003
2004


Total Phosphate (as Phosphorous) in the Klamath River at Turwar Gage, 2001 to 2004
CONCENTRATION (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004

Total Phosphorus - Summary

- Iron Gate and Shasta River highest contributors
- Concentrations increases from June through September
- Decreasing levels at downstream sites likely due to accretion of flow with low concentrations and assimilation from plants/algaes


Ortho Phosphate (as Phosphorous) in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004
CONCENTRATION (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2001
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2003
2004
YEAR
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4/7
4/21
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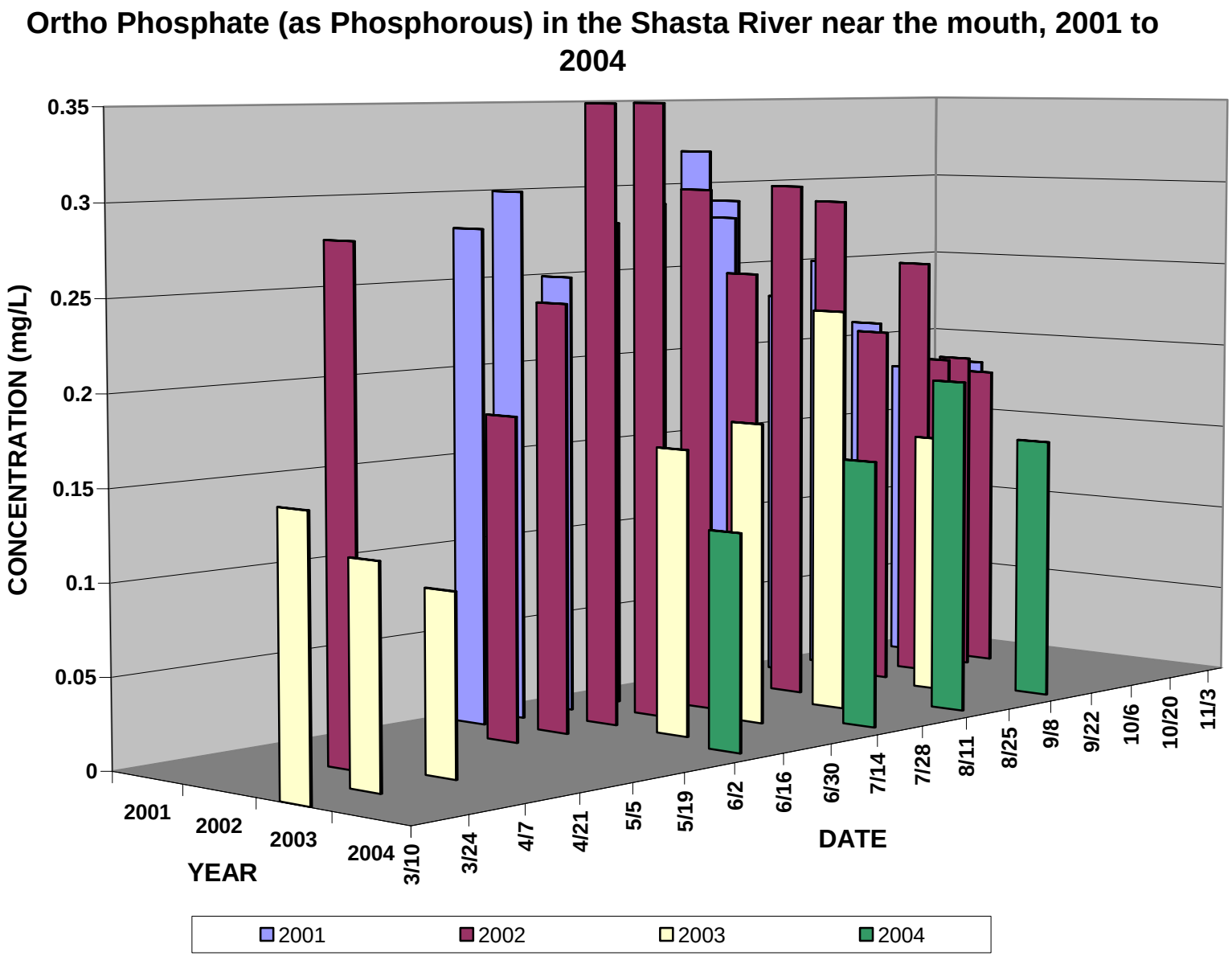
11/3
DATE
2001
2002
2003
2004


Ortho Phosphate (as Phosphorous) in the Shasta River near the mouth, 2001 to 2004
CONCENTRATION (mg/L)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
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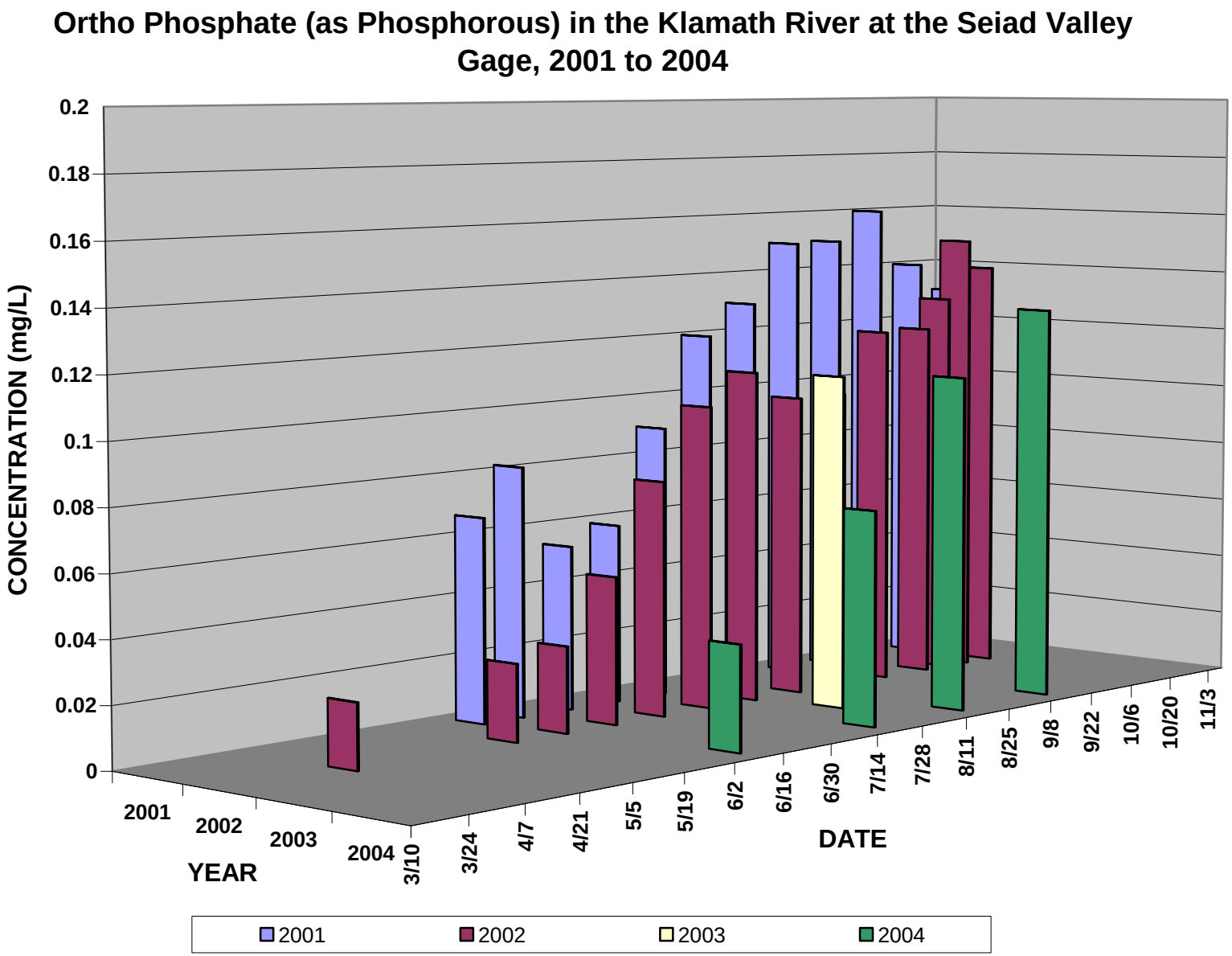
DATE
2001
2002
2003
2004


Ortho Phosphate (as Phosphorous) in the Klamath River at the Seiad Valley Gage, 2001 to 2004
CONCENTRATION (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2001
2002
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4/21
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DATE
2001
2002
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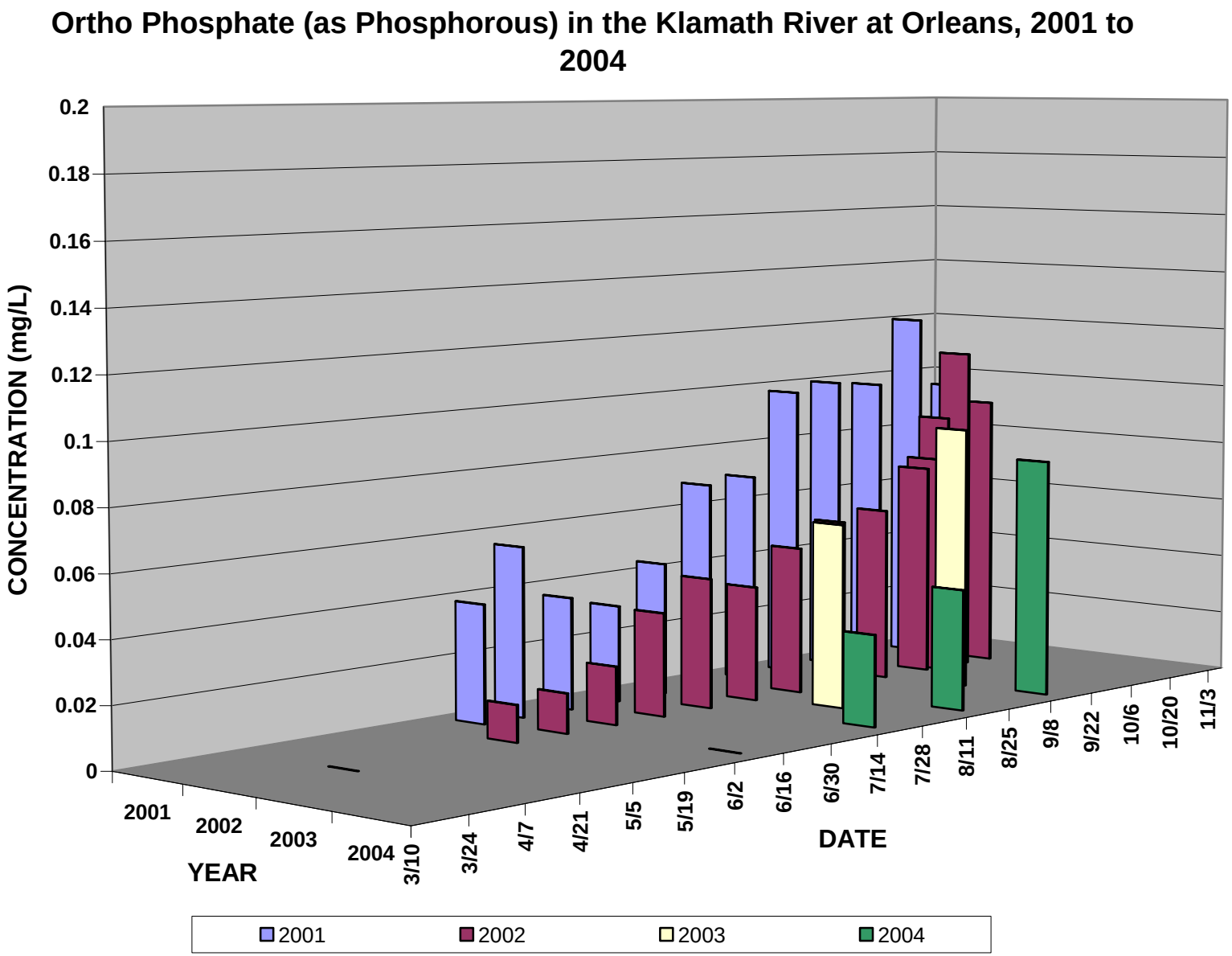
2004


Ortho Phosphate (as Phosphorous) in the Klamath River at Orleans, 2001 to 2004
CONCENTRATION (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2001
2002
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YEAR
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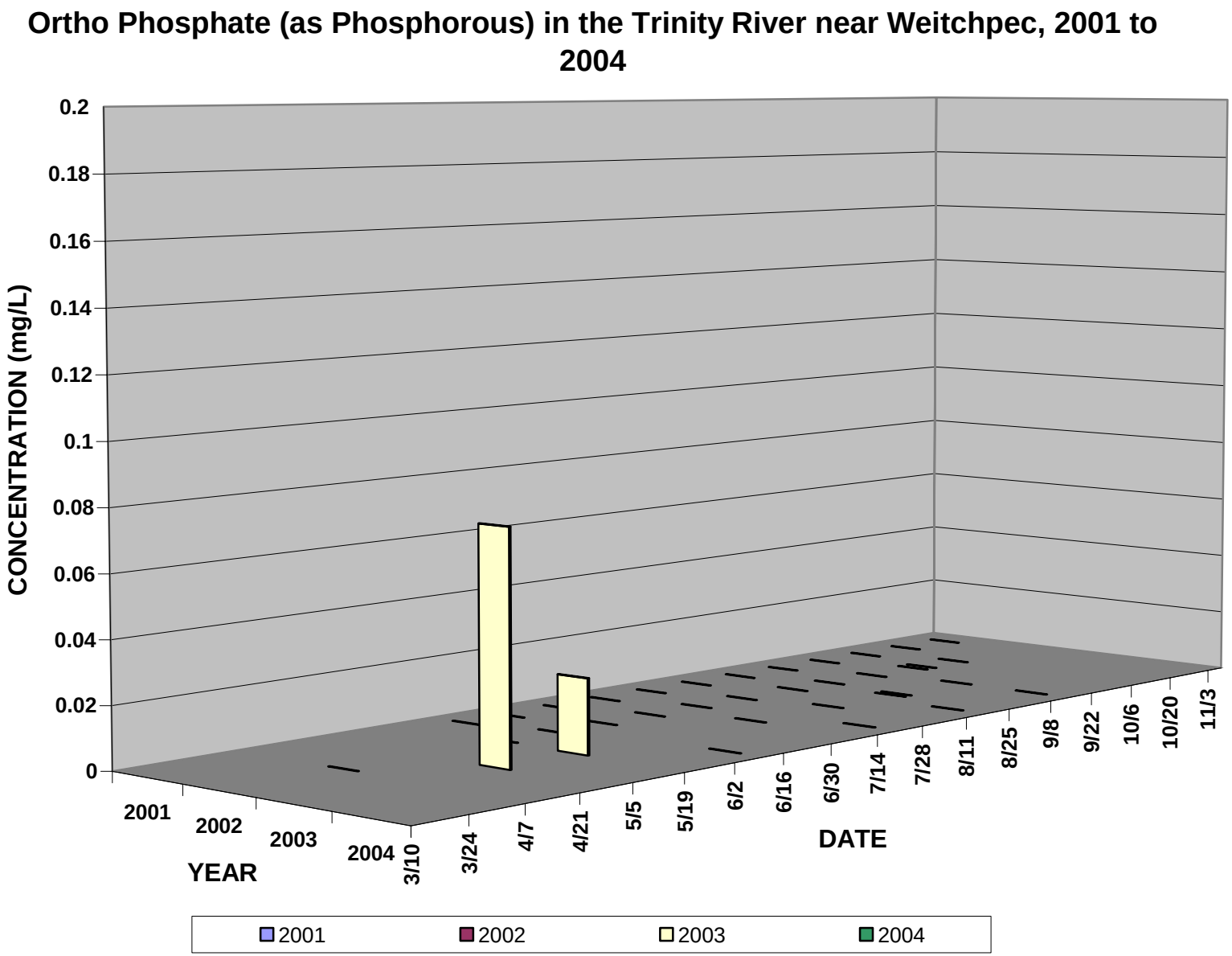
Ortho Phosphate (as Phosphorous) in the Trinity River near Weitchpec, 2001 to 2004
CONCENTRATION (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2001
2002
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2004
YEAR
3/10
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4/21
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5/19
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6/16
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DATE
2001
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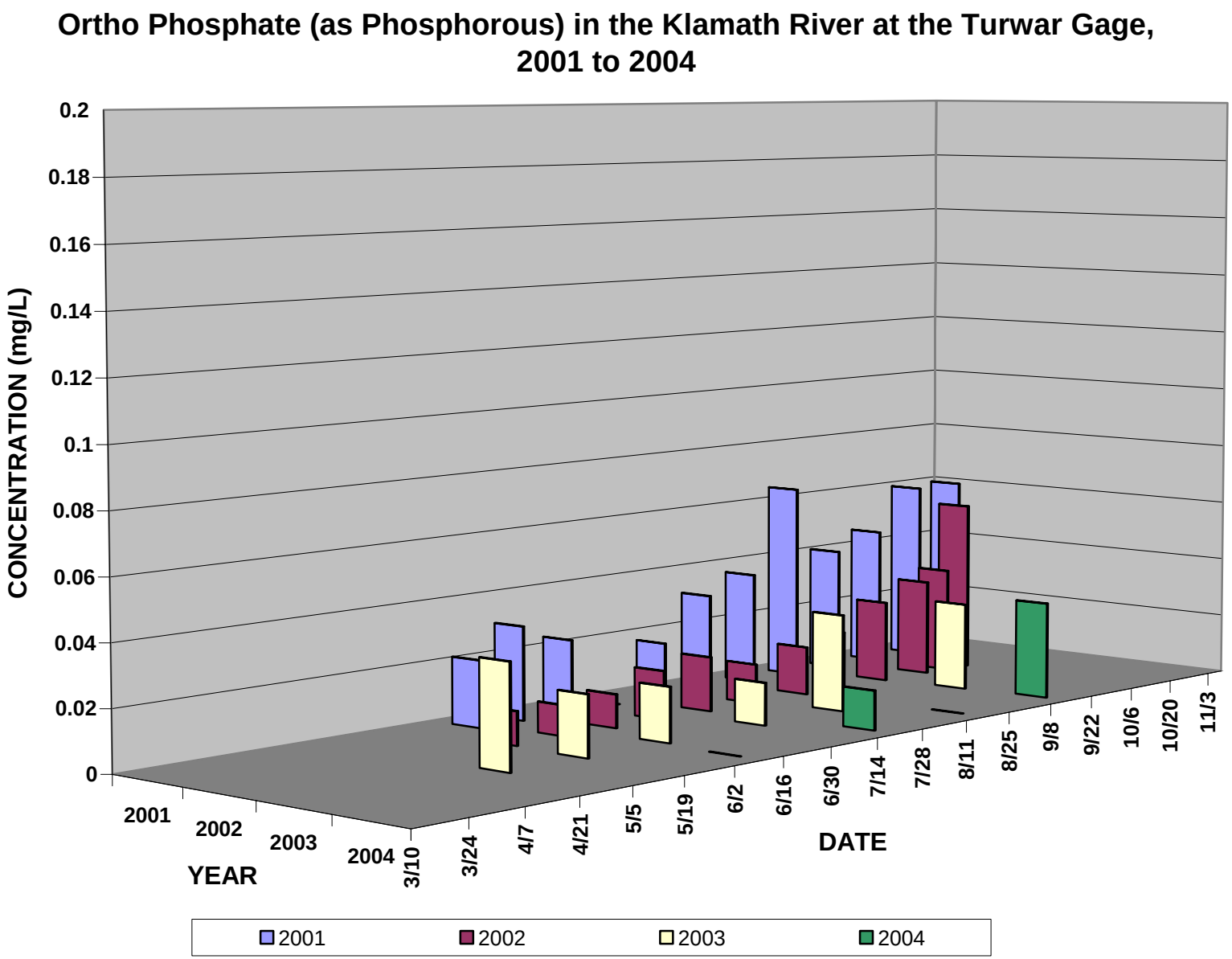
Ortho Phosphate (as Phosphorous) in the Klamath River at the Turwar Gage, 2001 to 2004
CONCENTRATION (mg/L)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
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2001
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YEAR
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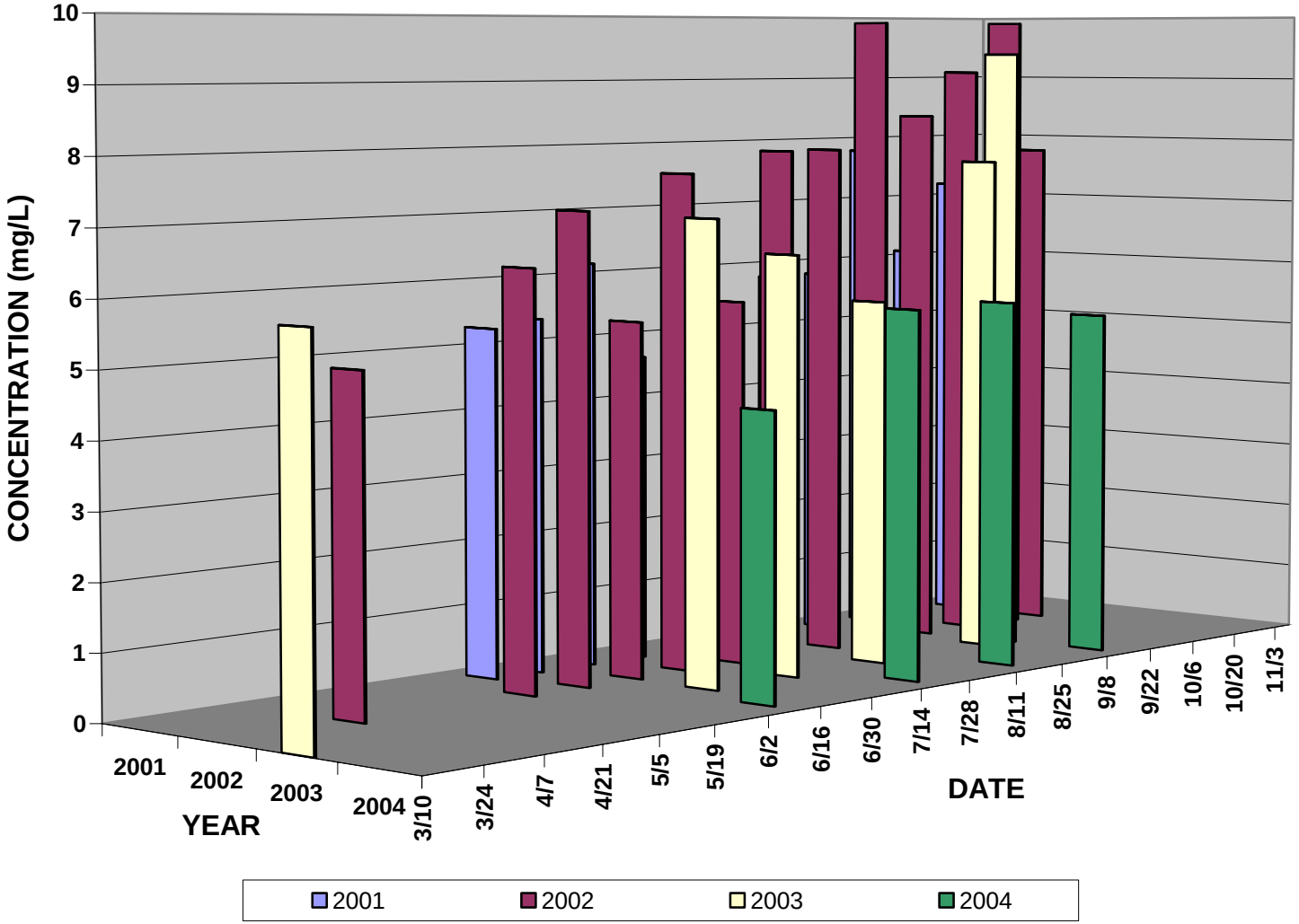
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004

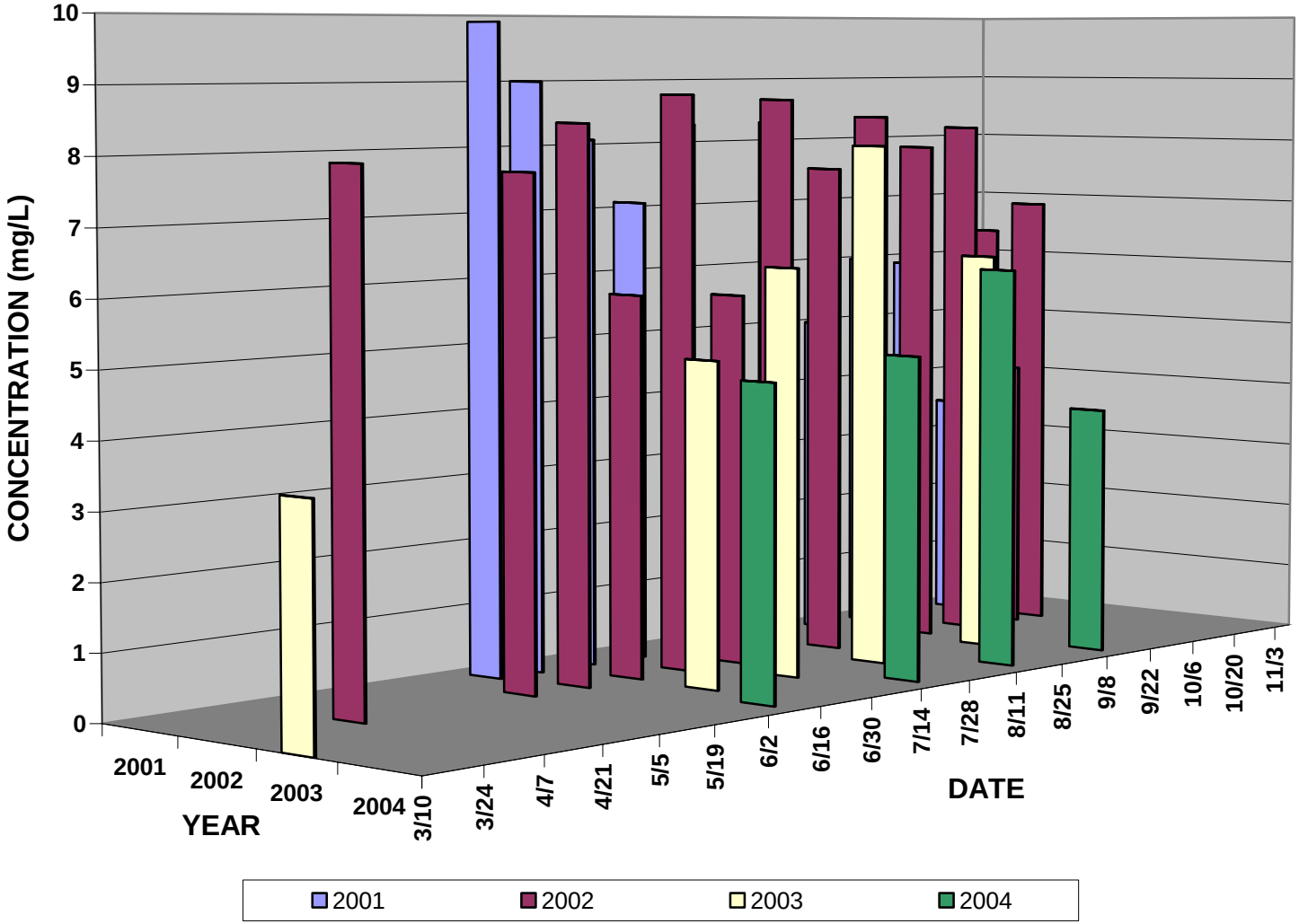
O-Phosphorus - Summary

- Shasta River highest concentration, but Iron Gate also high.
- Concentrations increases from June through September at IG, but peaks in July in the Shasta River
- Decreasing levels at downstream sites due to tributary accretion and transient nature of this form of phosphorus

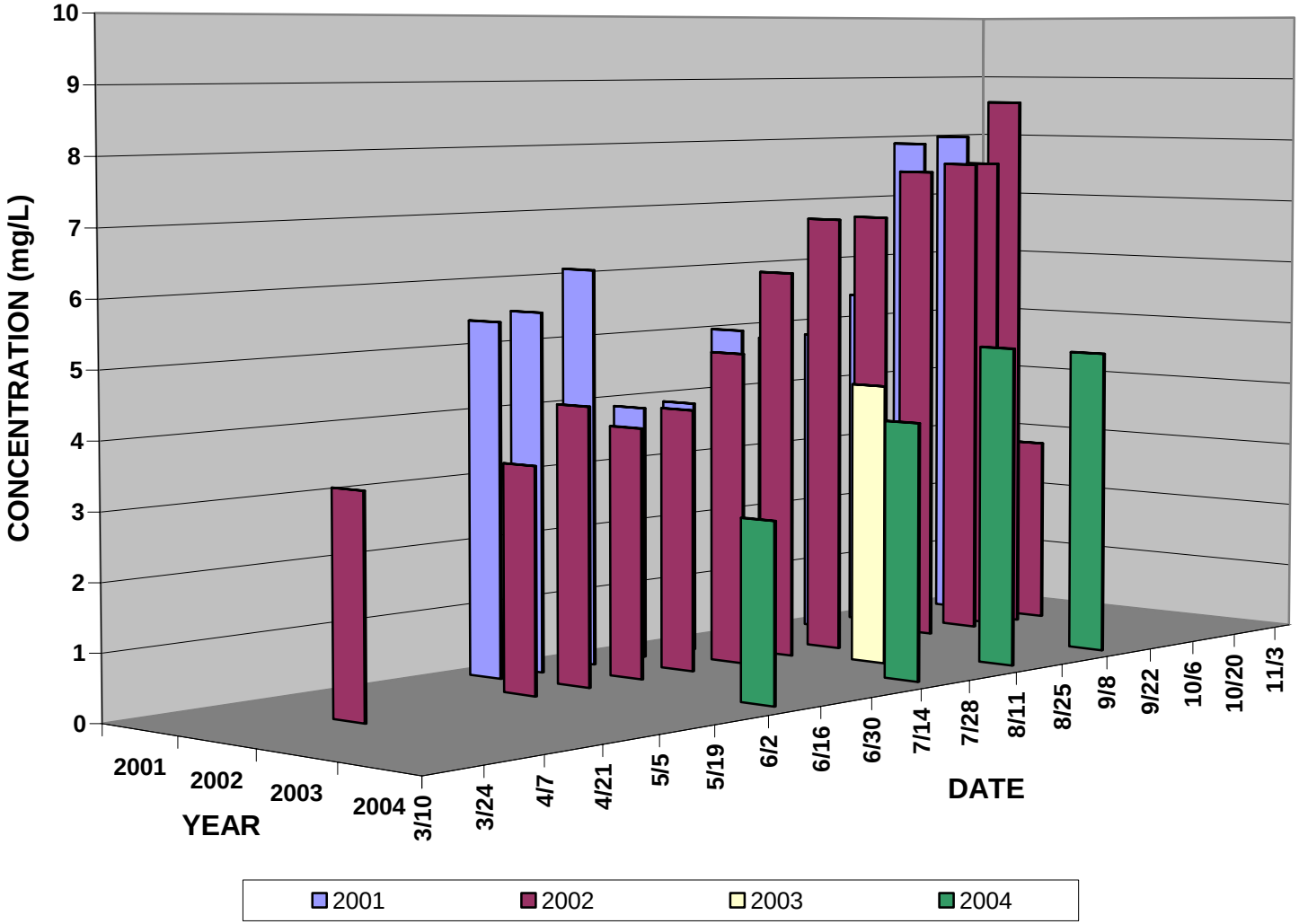
Total Organic Carbon in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004



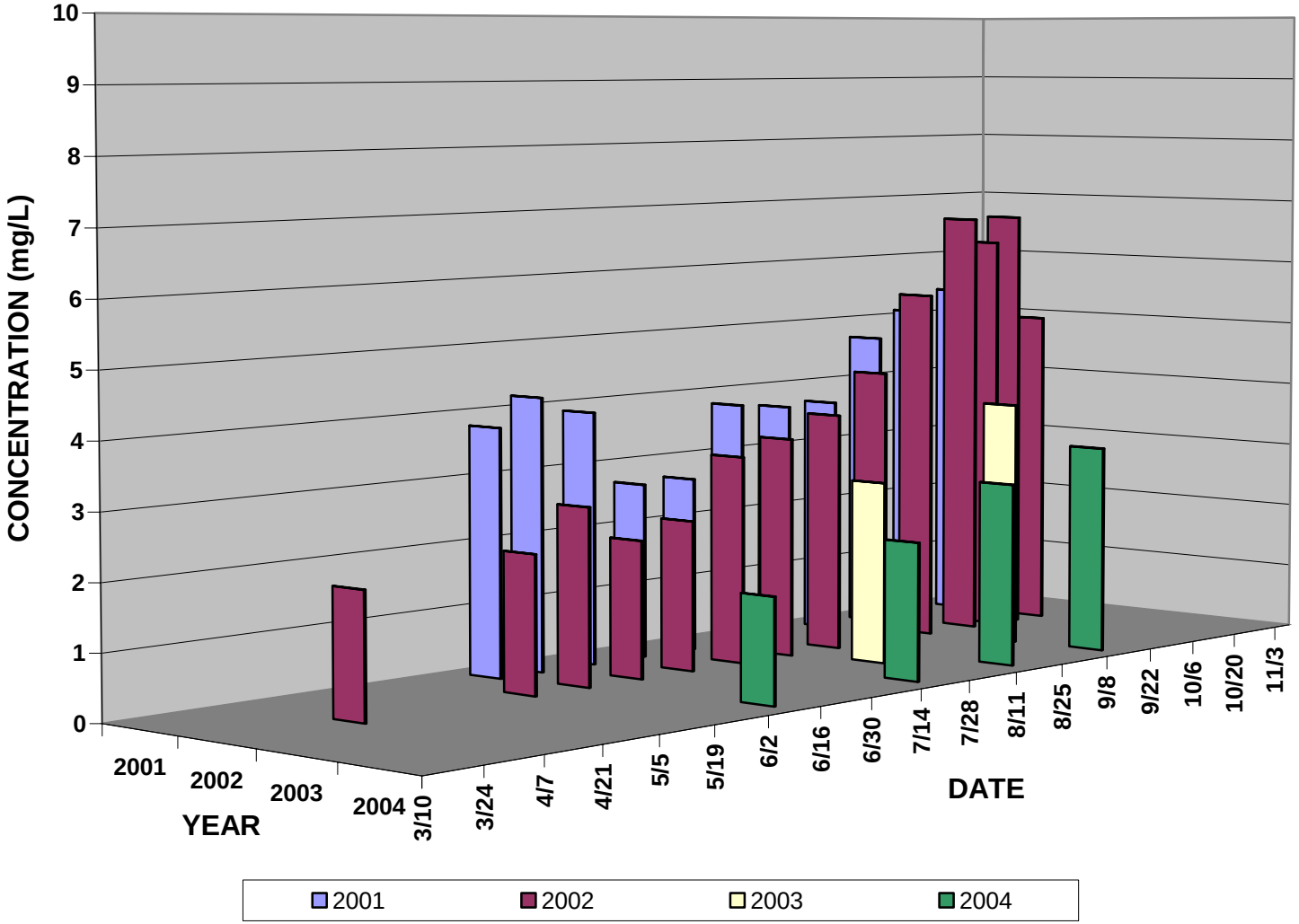
Total Organic Carbon in the Shasta River near the mouth, 2001 to 2004



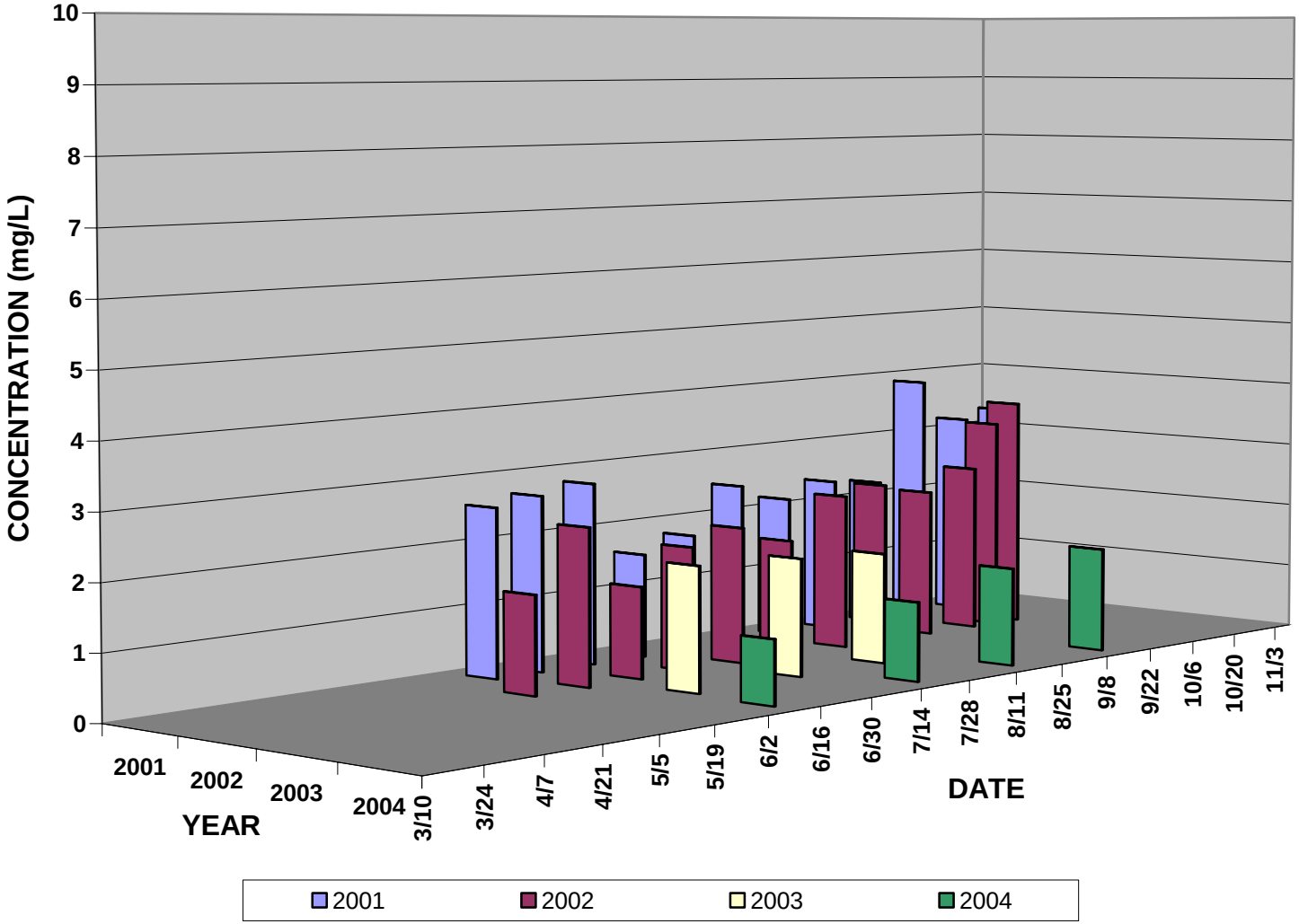
Total Organic Carbon in the Klamath River at the Seiad Valley Gage, 2001 to 2004



Total Organic Carbon in the Klamath River at Orleans, 2001 to 2004



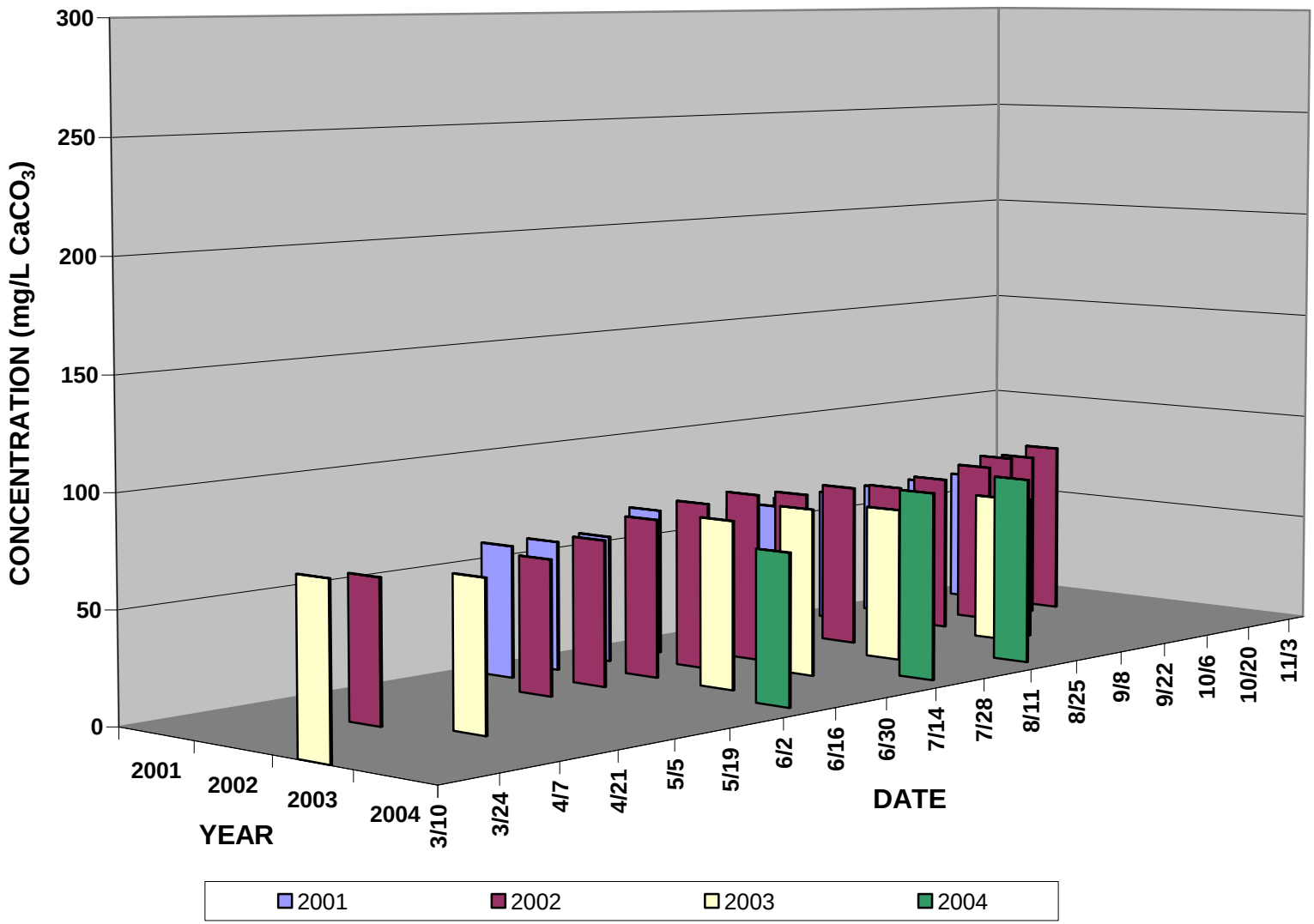
Total Organic Carbon in the Klamath River at the Turwar Gage, 2001 to 2004

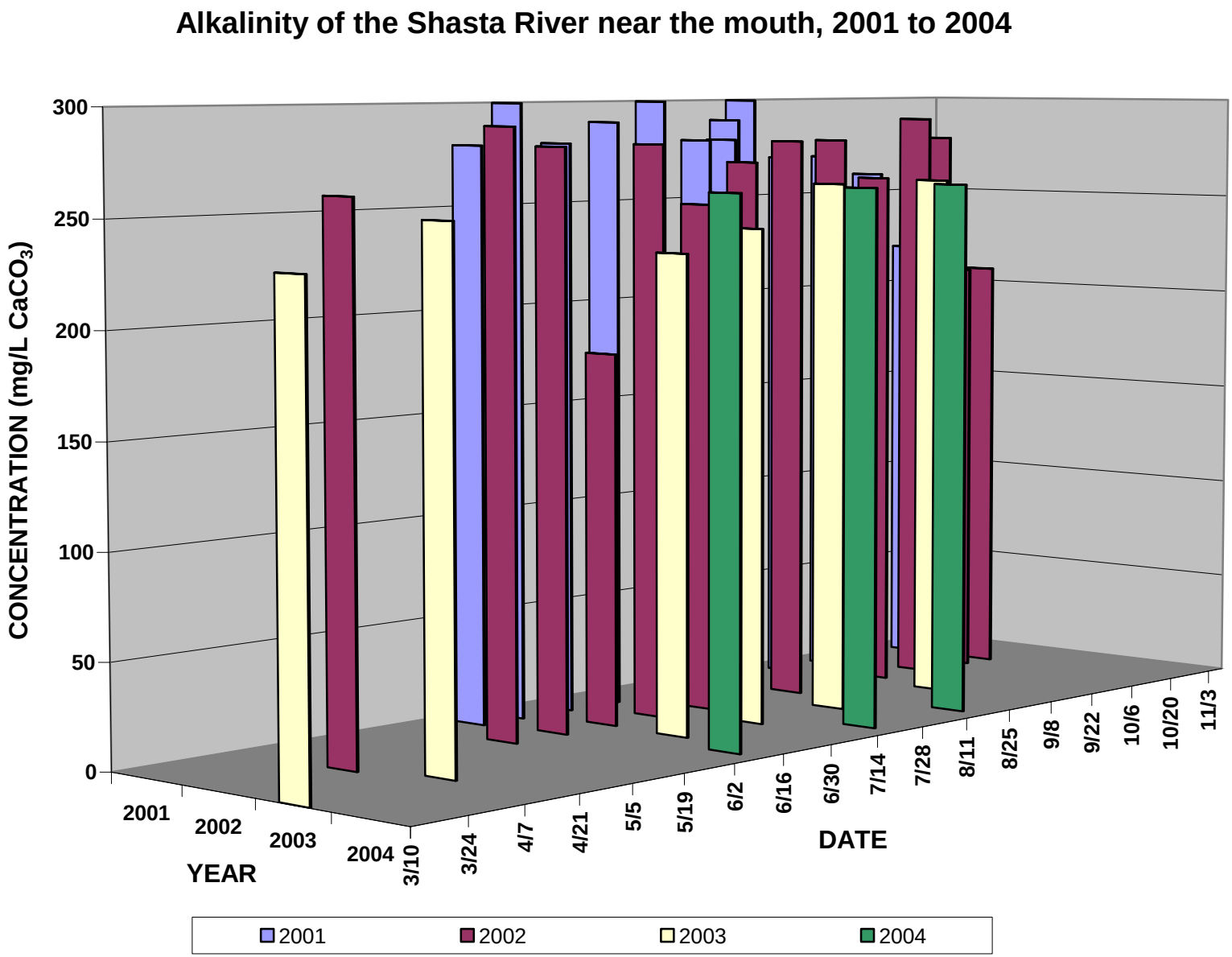


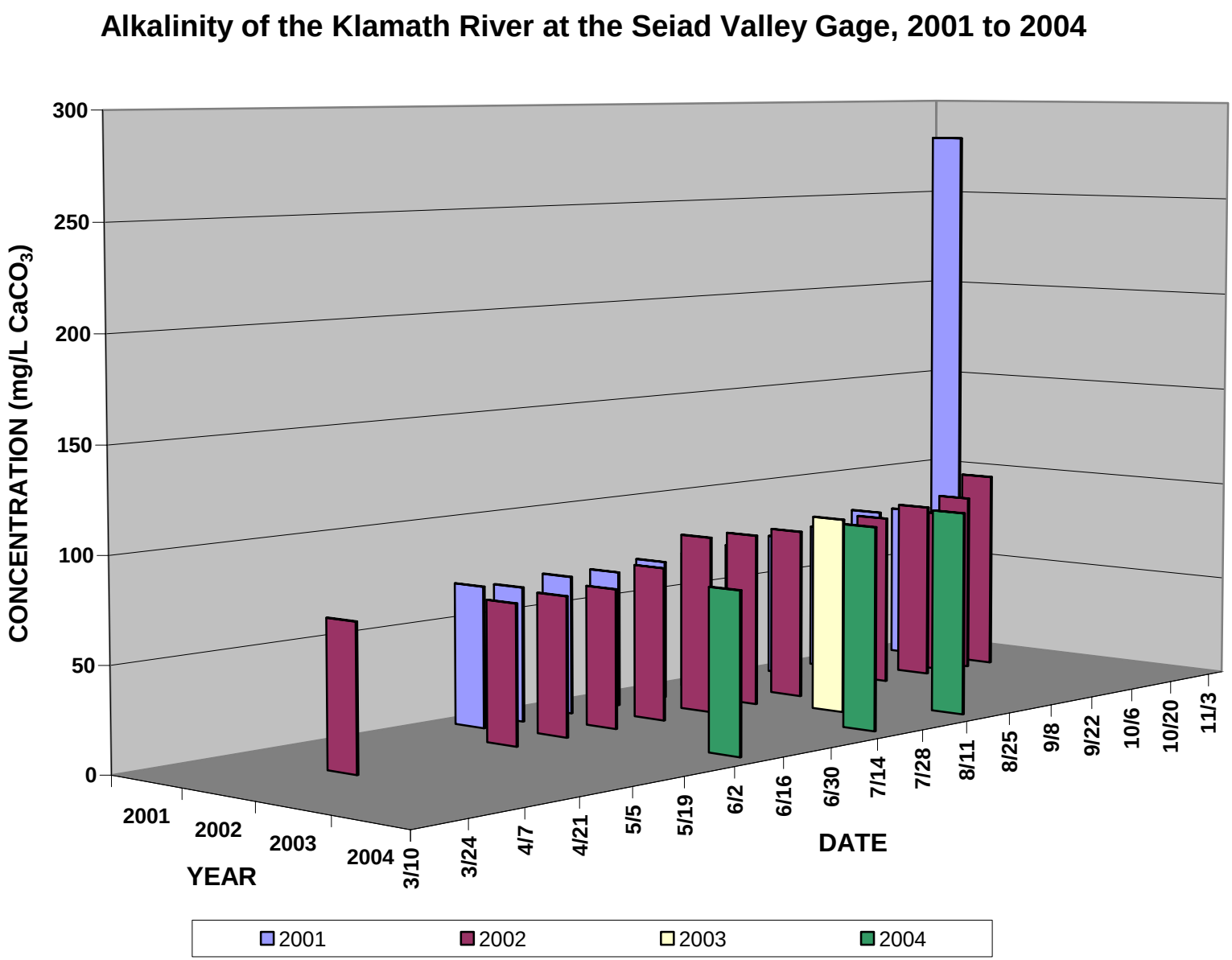
TOC - Summary

- Iron Gate and Shasta River highest concentrations
- Concentration increases from June through September at IG
- Decreasing concentrations at downstream sites due to tributary accretion.

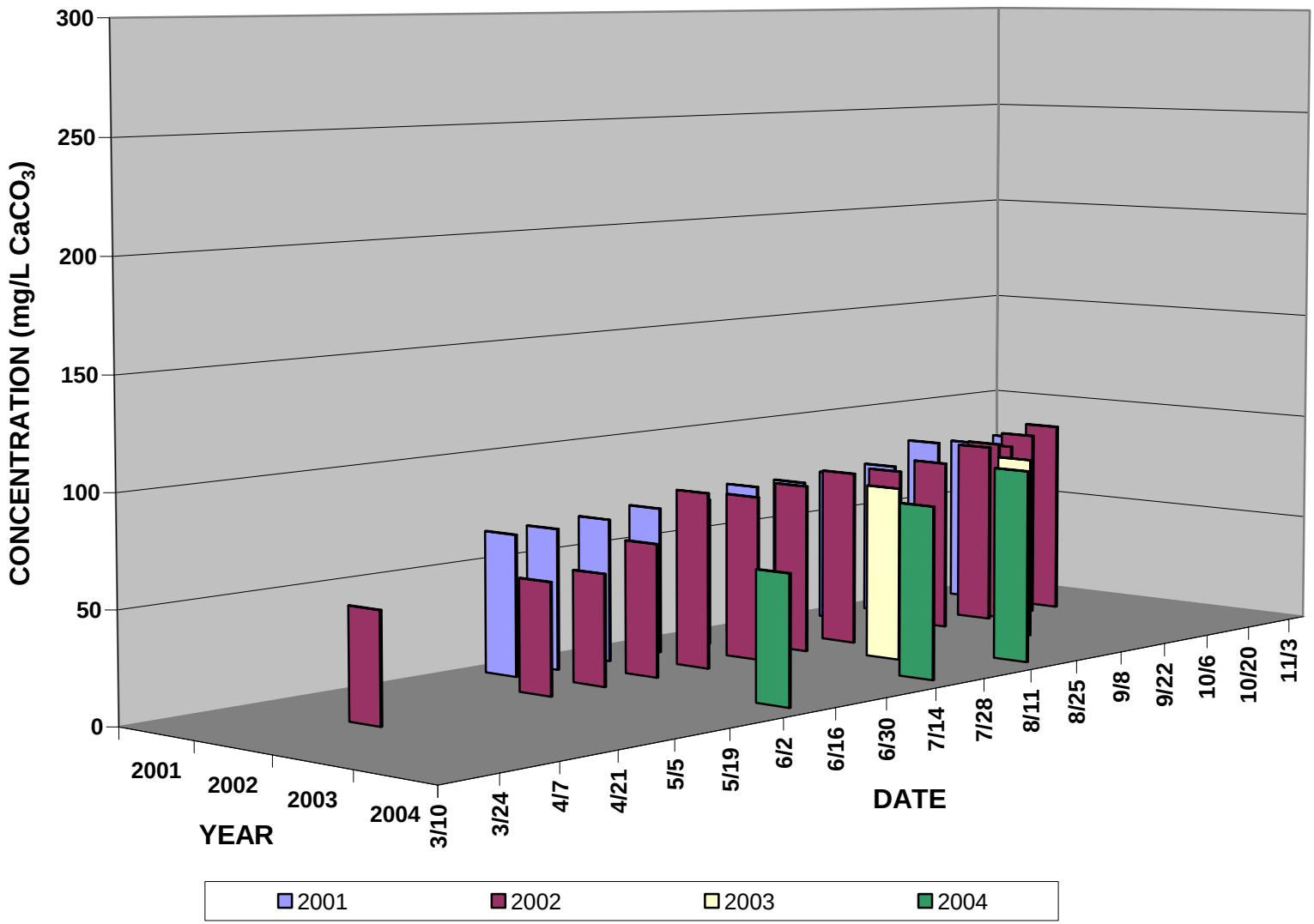
Alkalinity of the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004

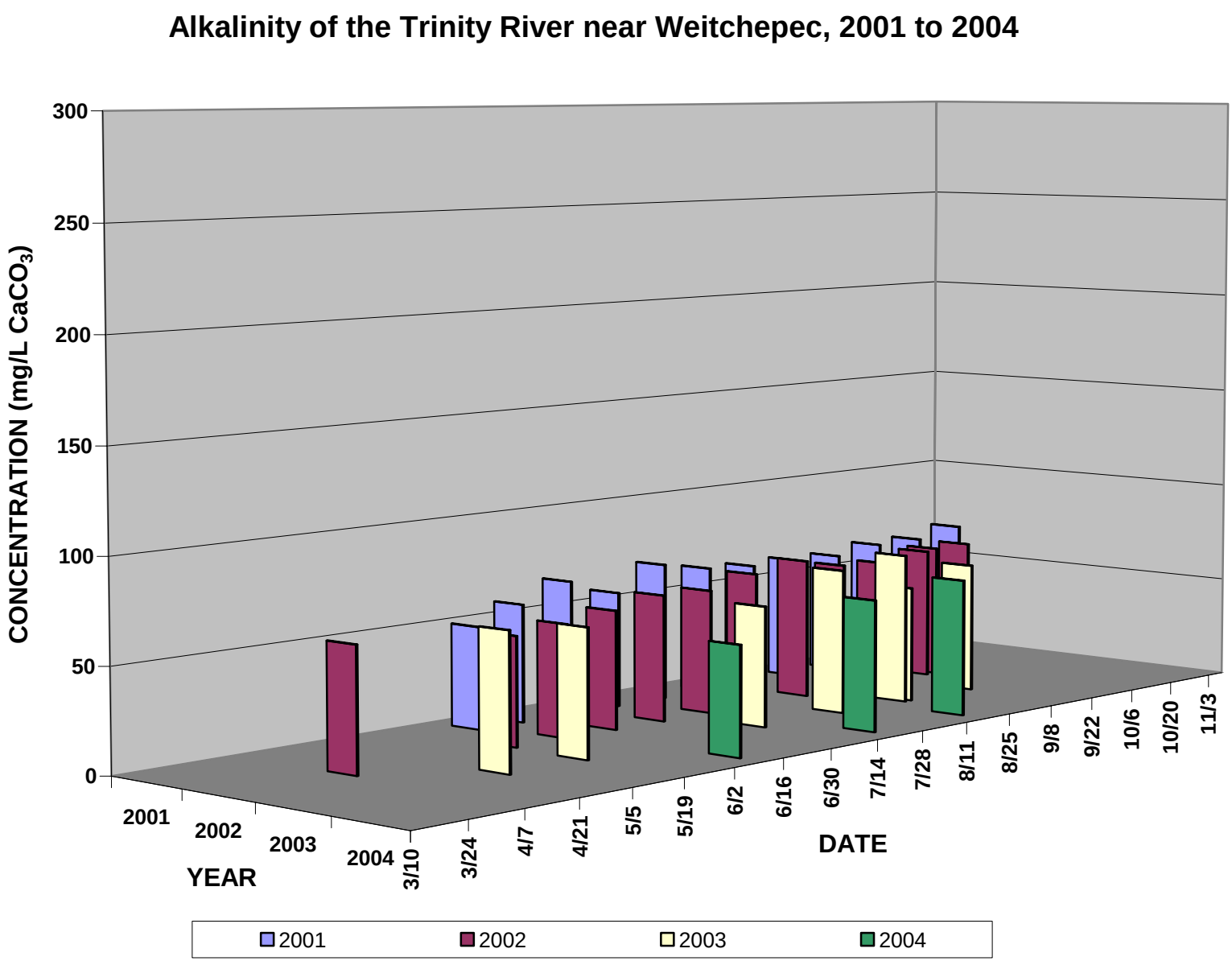


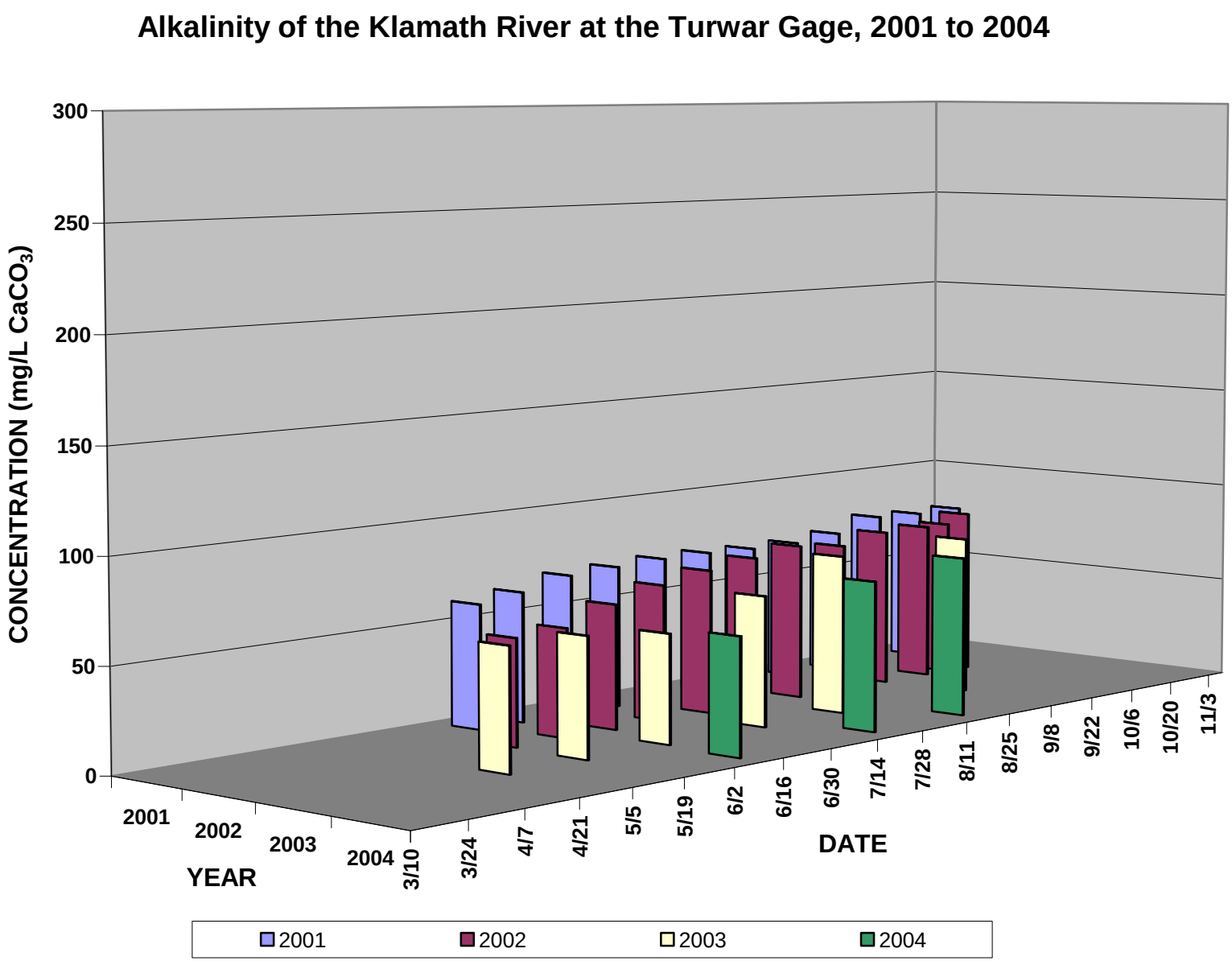

Alkalinity of the Shasta River near the mouth, 2001 to 2004
CONCENTRATION (mg/L CaCO3)
300
250
200
150
100
50
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004


Alkalinity of the Klamath River at the Seiad Valley Gage, 2001 to 2004
CONCENTRATION (mg/L CaCO3)
300
250
200
150
100
50
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004

Alkalinity of the Klamath River at Orleans, 2001 to 2004




Alkalinity of the Trinity River near Weitchepec, 2001 to 2004
CONCENTRATION (mg/L CaCO3)
300
250
200
150
100
50
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004


Alkalinity of the Klamath River at the Turwar Gage, 2001 to 2004
CONCENTRATION (mg/L CaCO3)
300
250
200
150
100
50
0
2001
2002
2003
2004
YEAR
3/10
3/24
4/7
4/21
5/5
5/19
6/2
6/16
6/30
7/14
7/28
8/11
8/25
9/8
9/22
10/6
10/20
11/3
DATE
2001
2002
2003
2004

Alkalinity - Summary

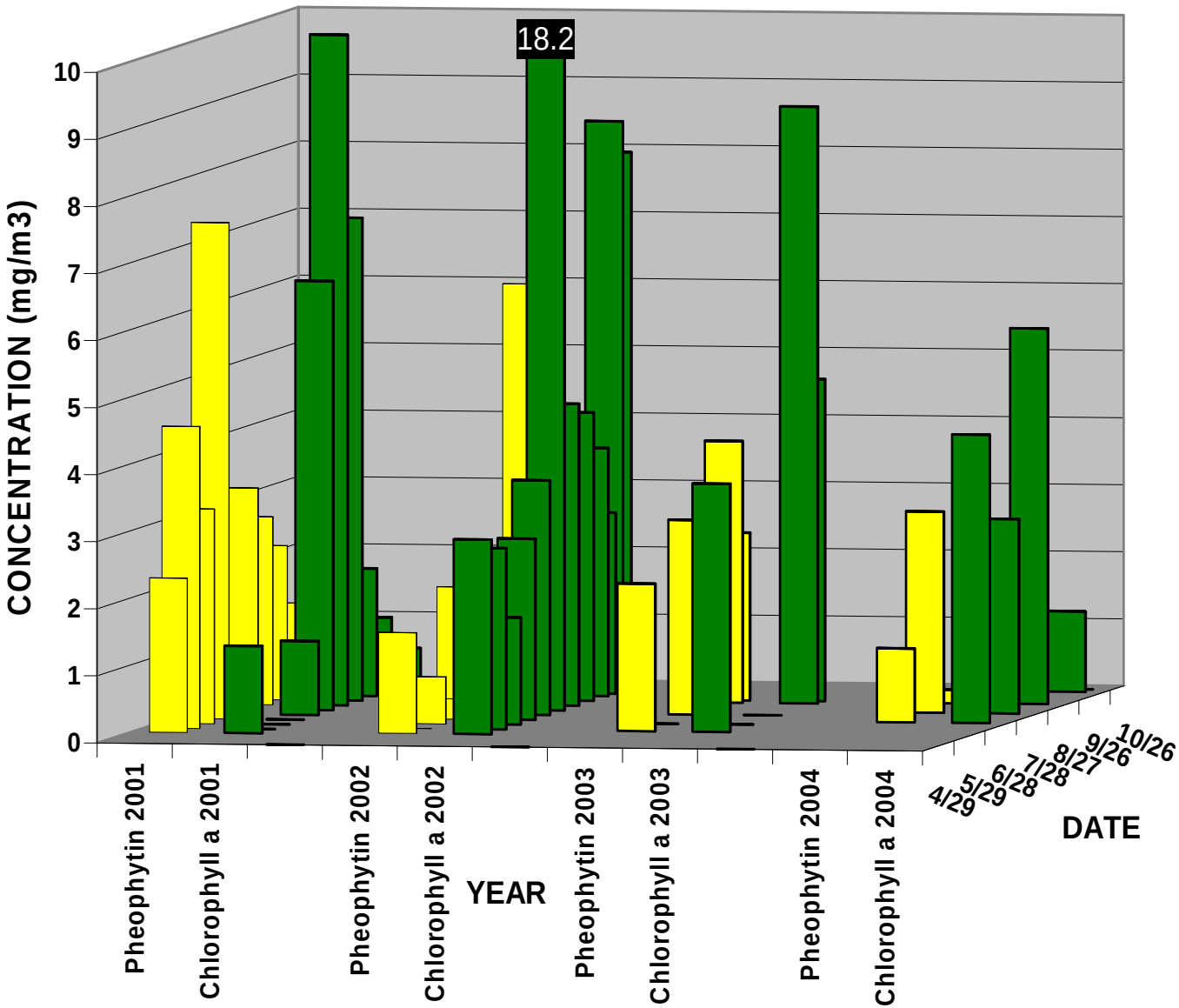
- Shasta River ~3x higher than IG Release
- Does not change appreciably through the year at any site

Chlorophyll a/ Pheophytin

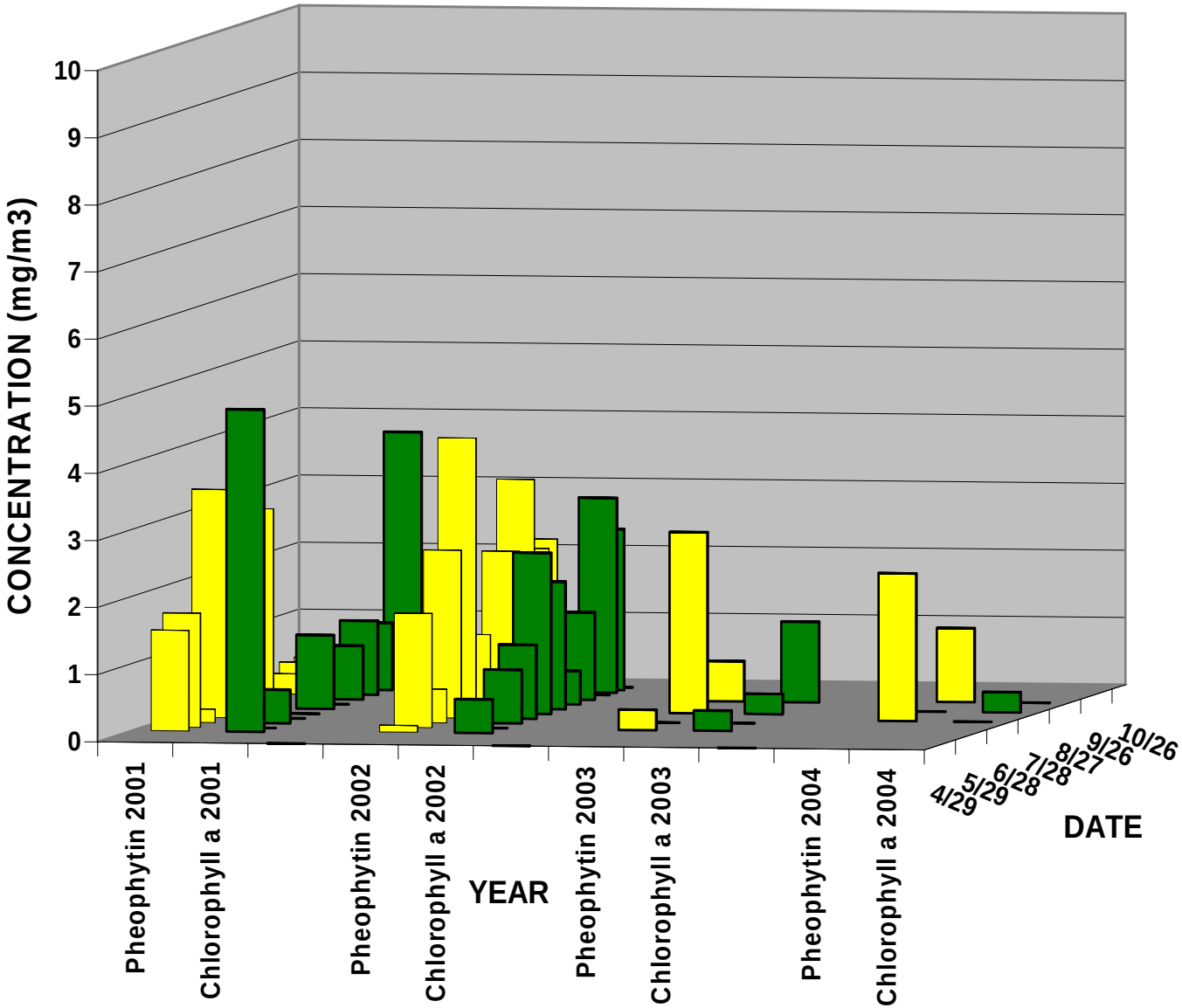
- Chlorphyll a - Measure of photosynthetic material in algae/water column, also a measure of algal biomass
- Pheophytin – The compliment to Chlorophyll a
- Ratios provide a description of environmental status of algaes

KR @ Orleans on August 28, 2004, USFWS

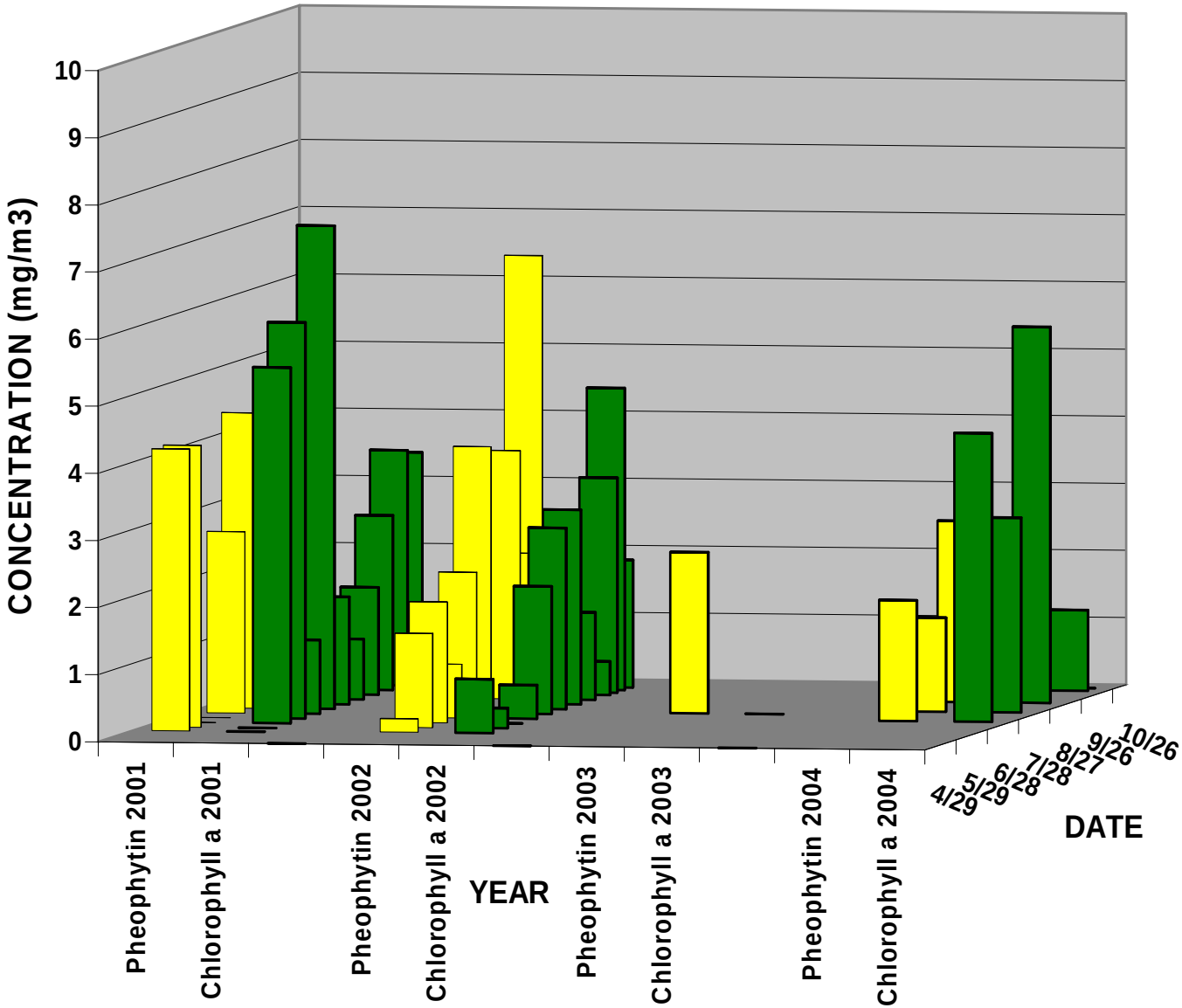
Chlorophyll a and Pheophytin in the Klamath River at the Iron Gate Hatchery Bridge, 2001 to 2004



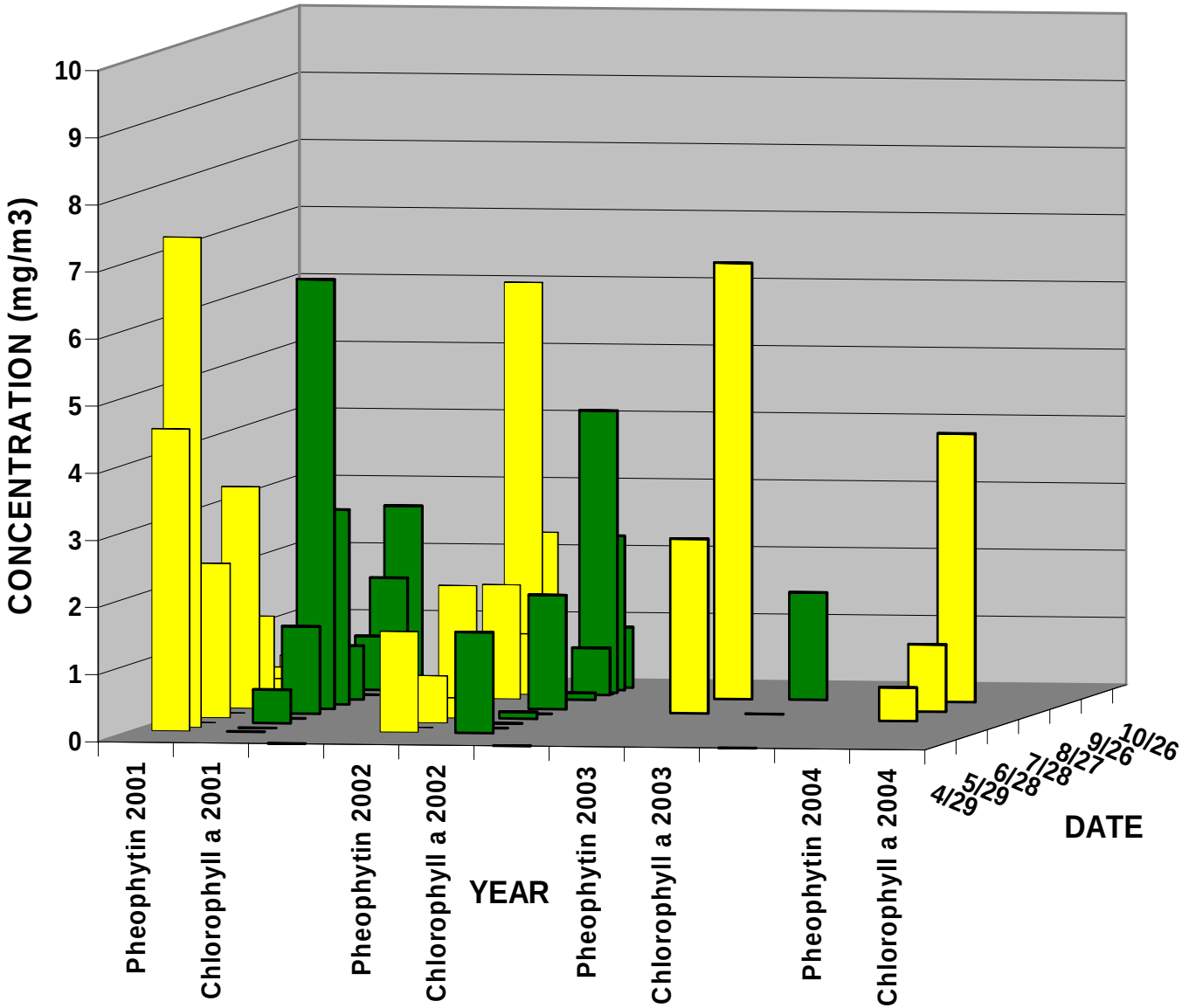
Chlorophyll a and Pheophytin in the Shasta River
2001 to 2004



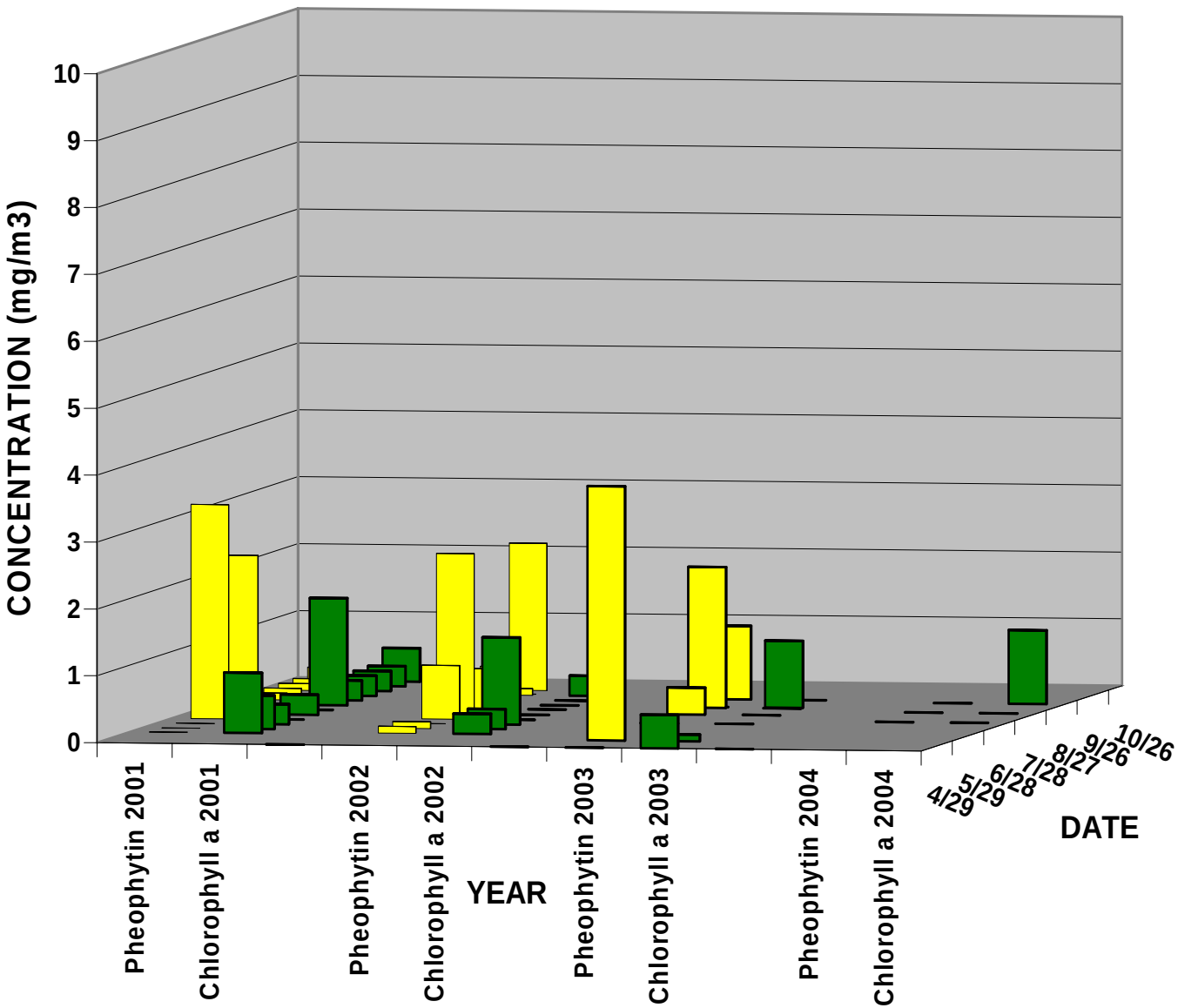
Chlorophyll a and Pheophytin in the Klamath River at Seiad Valley Gage 2001 to 2004



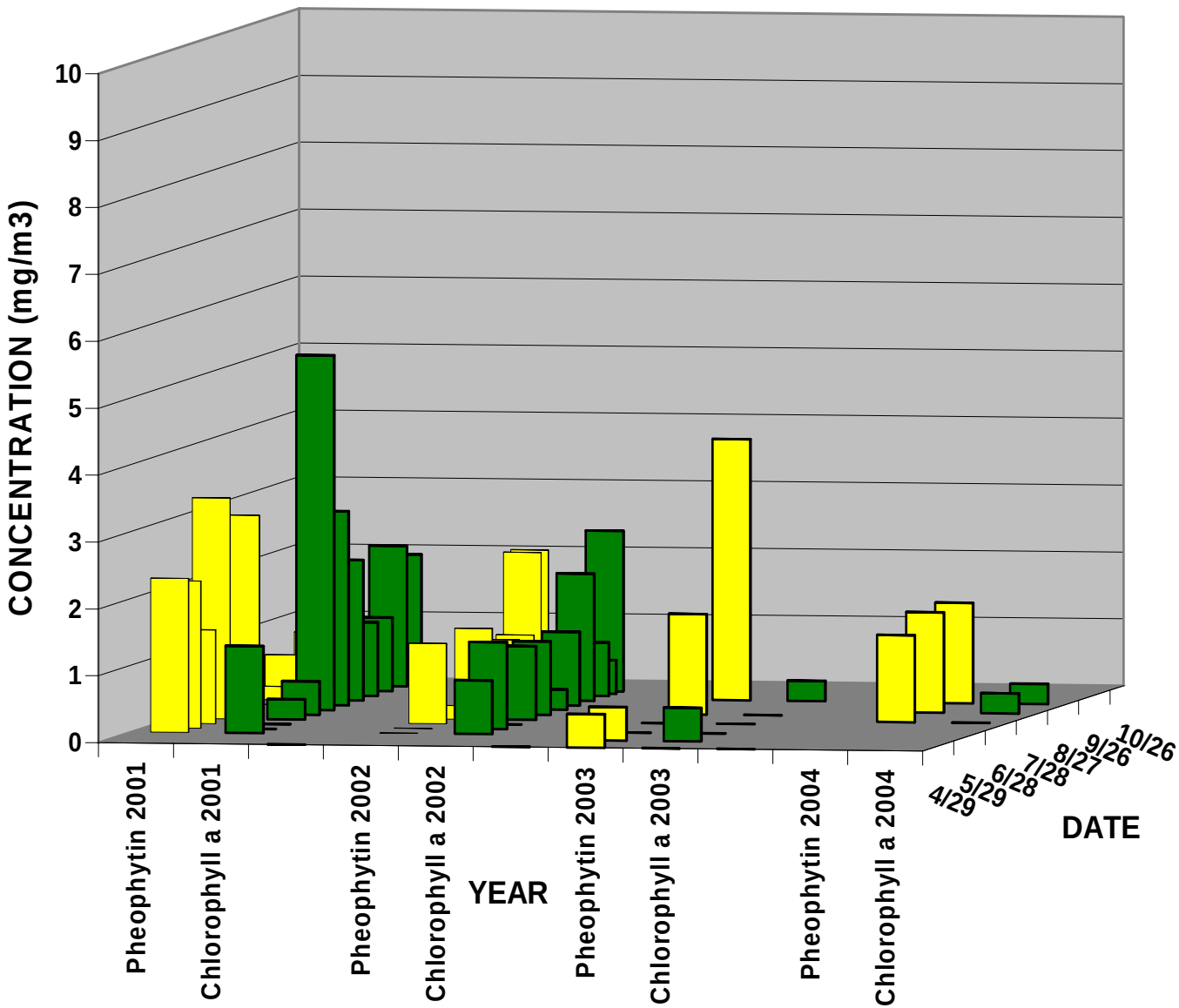
Chlorophyll a and Pheophytin in the Klamath River at Orleans
2001 to 2004



Chlorophyll a and Pheophytin in the Trinity River at Weitchpec
2001 to 2004



Chlorophyll a and Pheophytin in the Klamath River at Terwer Gage
2001 to 2004



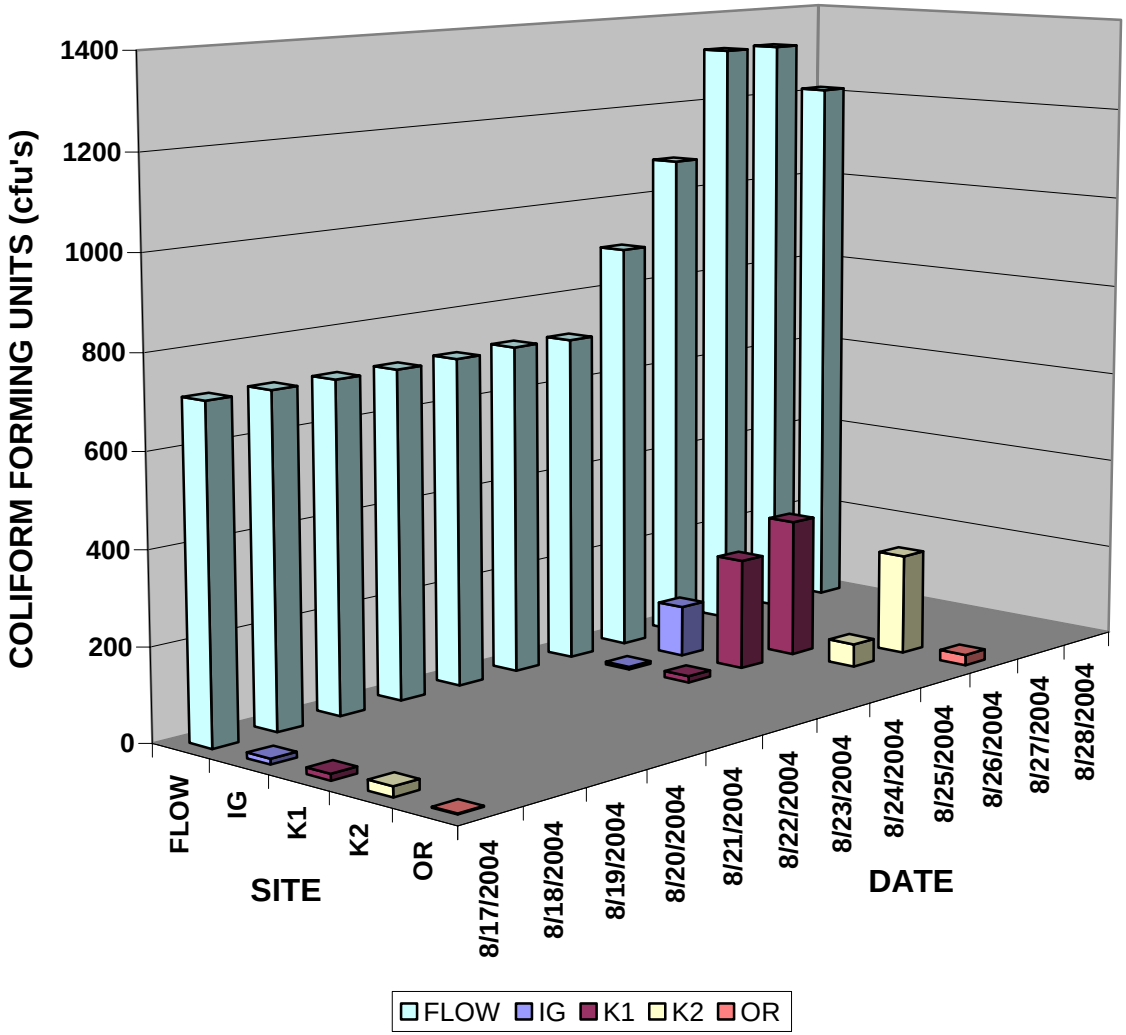
Summary:

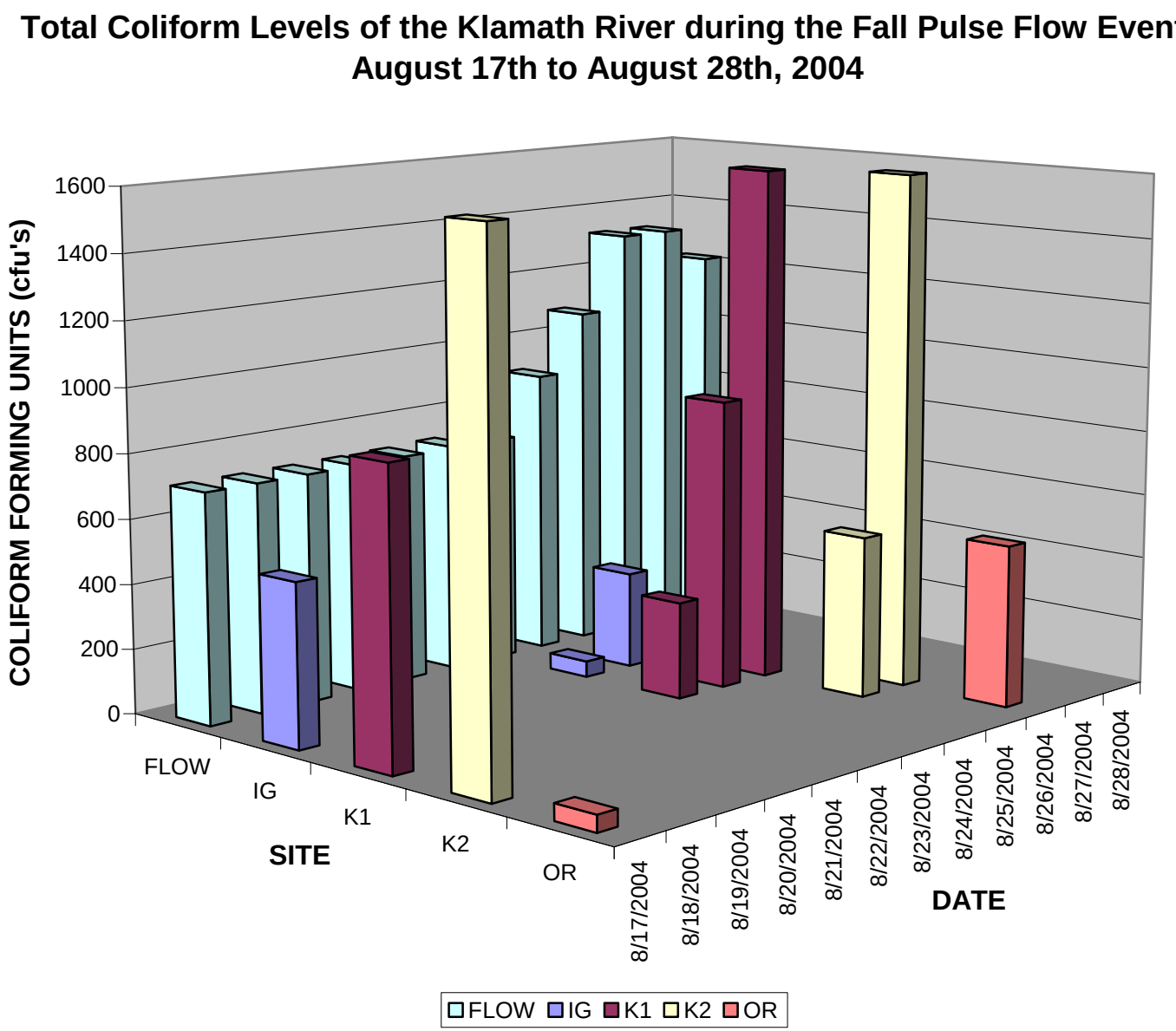
- Chlorophyll a and Pheophytin generally increase from spring to fall
- Chlorophyll a and Pheophytin is generally highest at Iron Gate Dam and decreases downstream
- Ratios have not yet been thoroughly examined

Special Study #1

- Evaluation of flow change at Iron Gate in late August of 2004 and its affects on downstream water quality.
- Question: Does a flow increase such as that which occurred affect downstream water quality?
- Methods: collection of grab samples before and during flow/stage changes (N, P, BOD, Colliform, Turbidity)

Fecal Coliform Levels of the Klamath River during the Fall Pulse Flow Event, August 17th to August 28th, 2004




Total Coliform Levels of the Klamath River during the Fall Pulse Flow Event, August 17th to August 28th, 2004
COLIFORM FORMING UNITS (cfu's)
1600
1400
1200
1000
800
600
400
200
0
FLOW
IG
K1
K2
OR
SITE
8/17/2004
8/18/2004
8/19/2004
8/20/2004
8/21/2004
8/22/2004
8/23/2004
8/24/2004
8/25/2004
8/26/2004
8/27/2004
8/28/2004
DATE
FLOW IG K1 K2 OR

Special Study #1 - Summary

- Nitrogen species – no appreciable change
- 2X increase in total P from above Shasta to above the Scott River; likely due to stirring up of sediments.
- BOD increased at K1 and K2, again likely due to stirred up organic material
- Chlor.a and pheophytin increase
- Fecal/total coliforms increased due to pulse

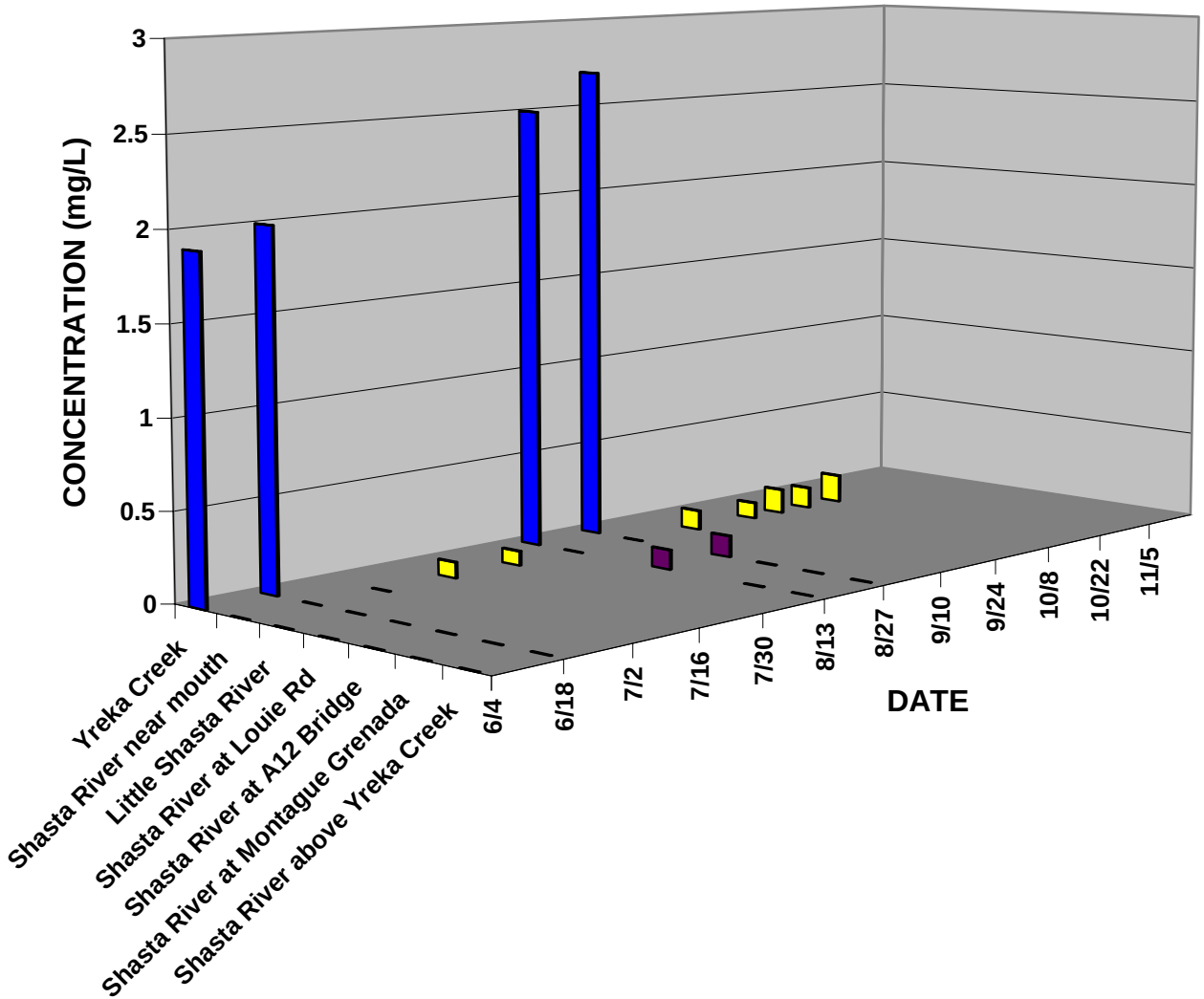
Special Study #2

- Evaluation of ammonia on a diurnal scale
- Methods: Seiad Valley and Happy Camp region (July 30-31; IG September 2-3; 4 hour intervals)
- Water temperatures were extremely warm during this time (Max ~ 28.3 °C = 83 °F)
- 0.14 mg/L at SV 15:00hrs
- 0.10 mg/L at Iron Gate: 22:00hrs

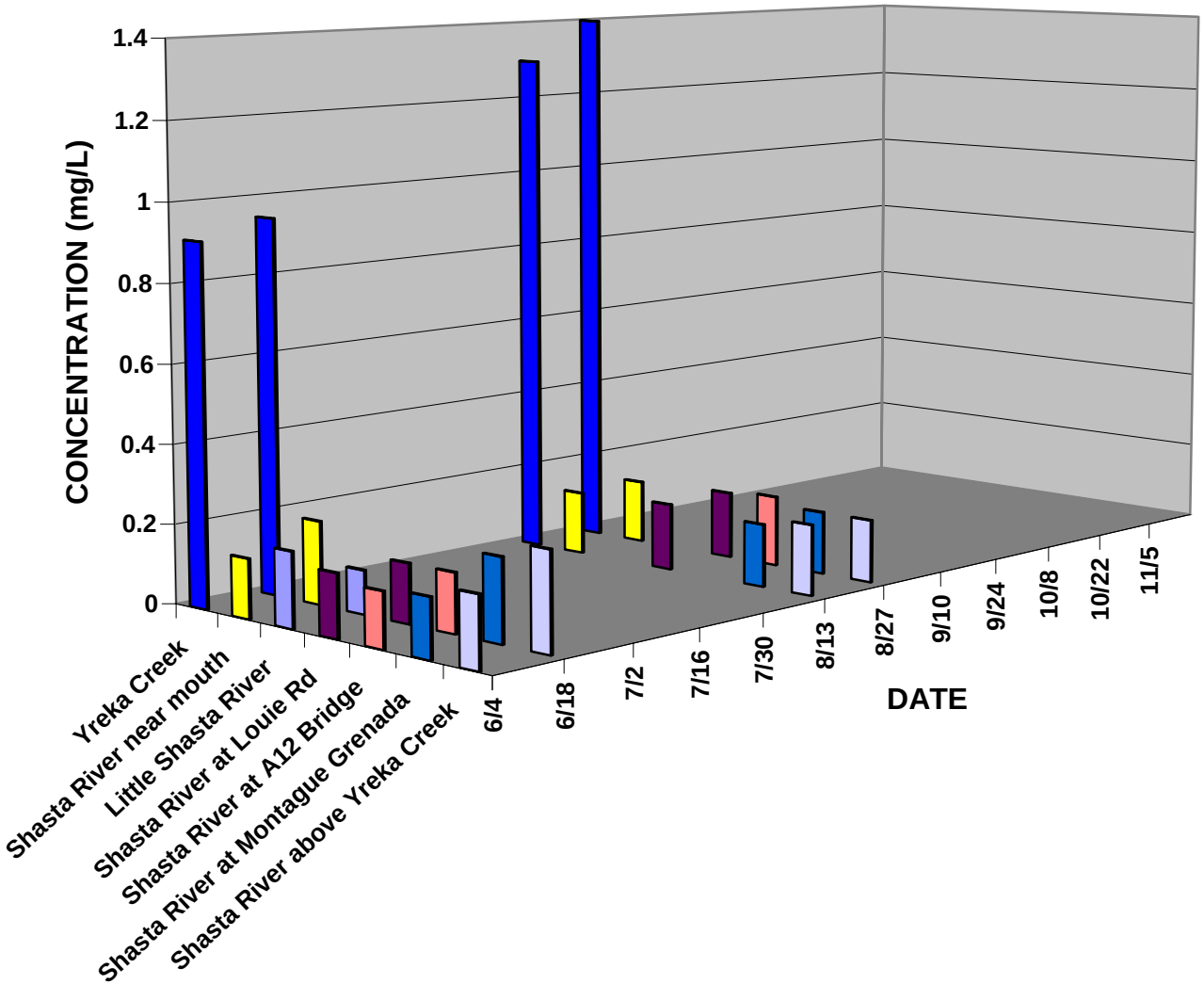
Special Study #3

- Evaluation of nutrient concentrations within the Shasta River basin: 2002 Study

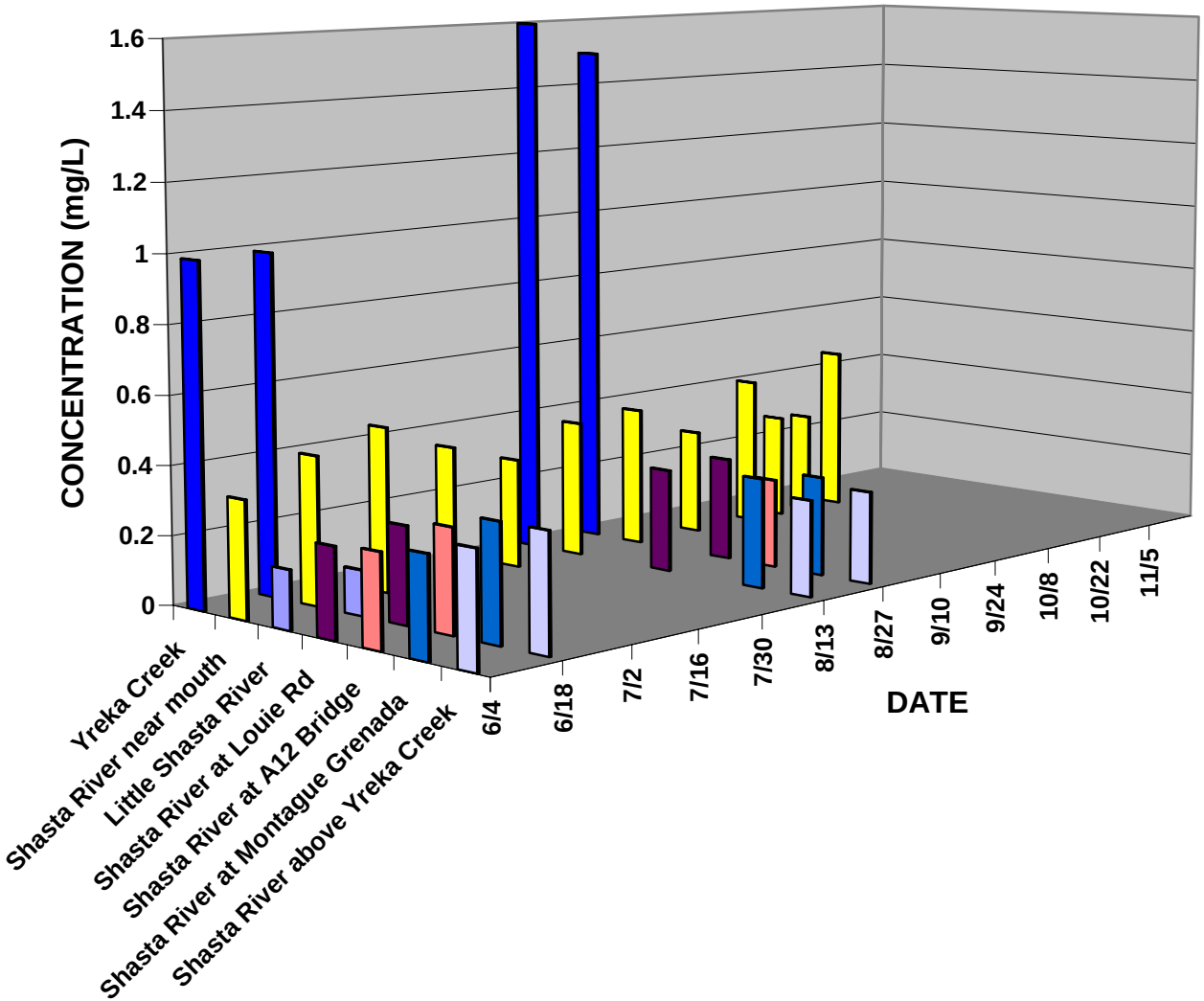
Nitrate in the Shasta River and Tributaries, 2002

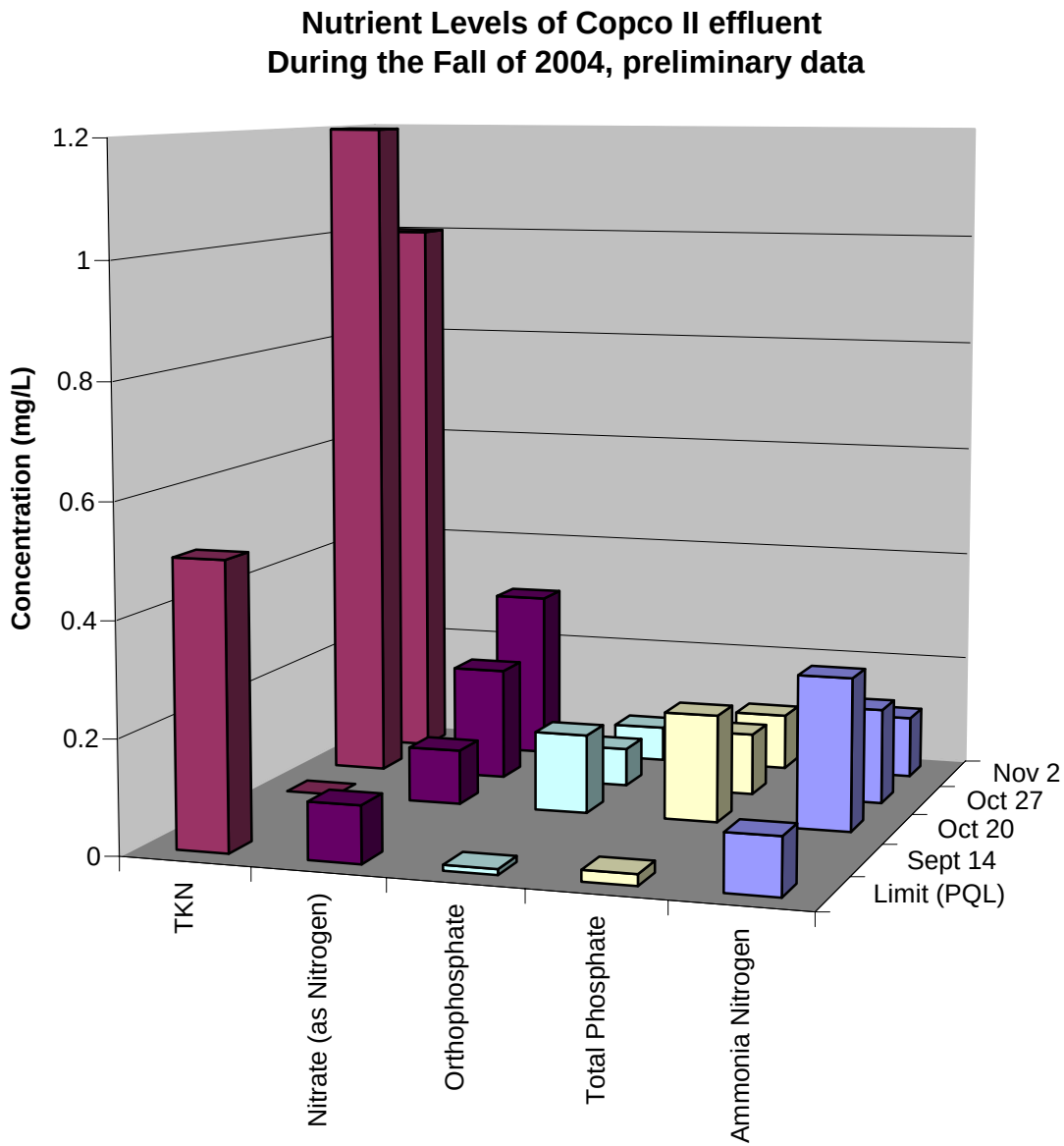


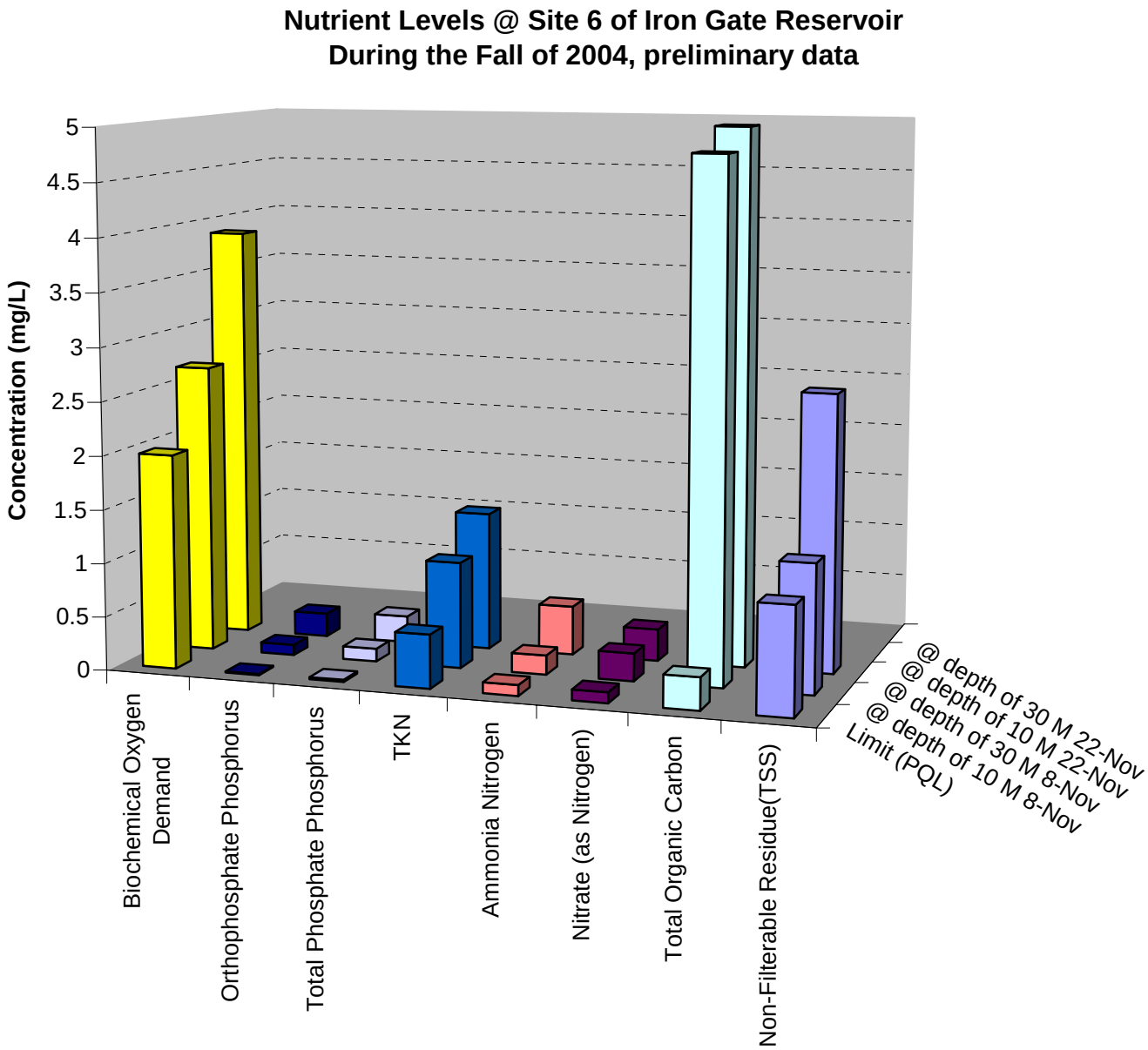
O- Phosphate in the Shasta River and Tributaries, 2002



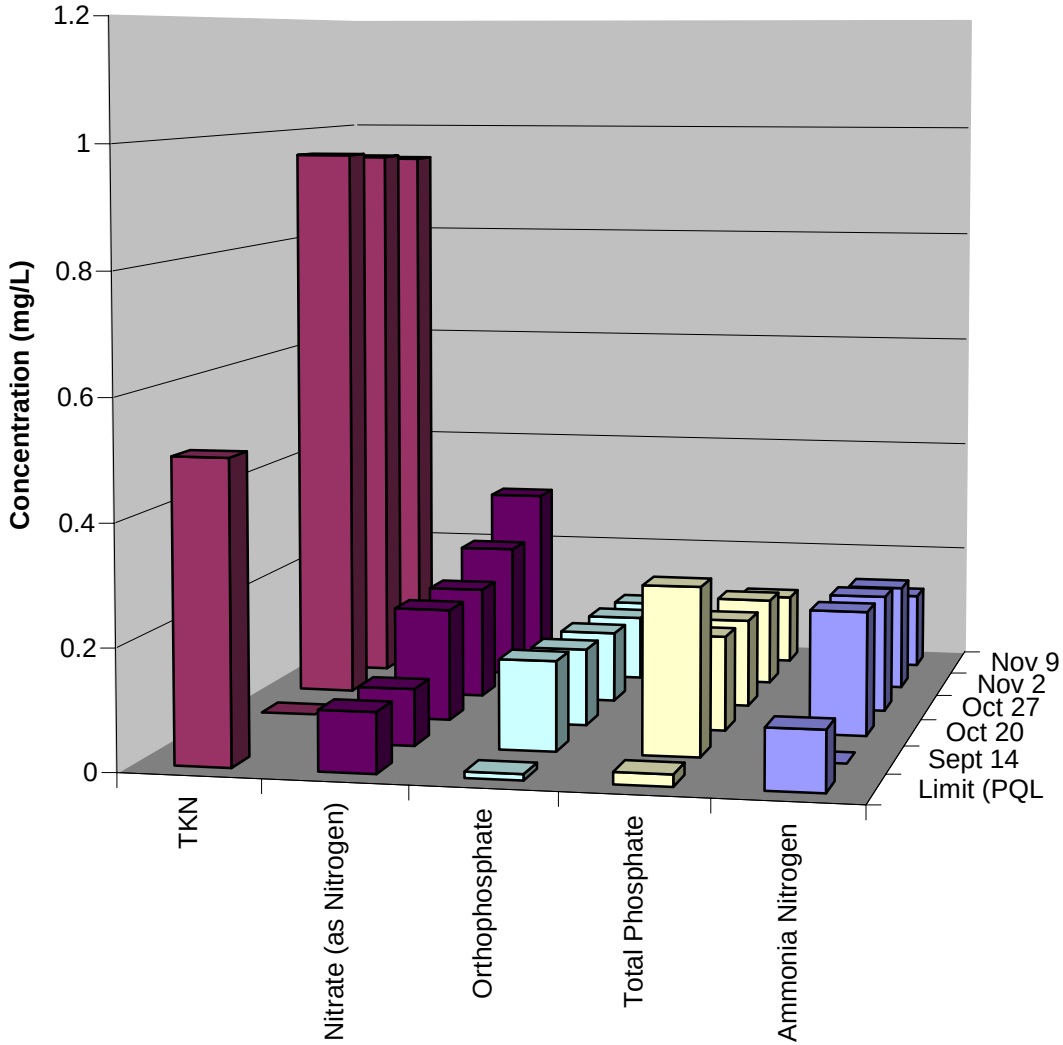
Total Phosphate in the Shasta River and Tributaries, 2002




Nutrient Levels of Copco II effluent
During the Fall of 2004, preliminary data
Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
TKN
Nitrate (as Nitrogen)
Orthophosphate
Total Phosphate
Ammonia Nitrogen
Nov 2
Oct 27
Oct 20
Sept 14
Limit (PQL)


Nutrient Levels @ Site 6 of Iron Gate Reservoir
During the Fall of 2004, preliminary data
Concentration (mg/L)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Biochemical Oxygen Demand
Orthophosphate Phosphorus
Total Phosphate Phosphorus
TKN
Ammonia Nitrogen
Nitrate (as Nitrogen)
Total Organic Carbon
Non-Filterable Residue(TSS)
@ depth of 30 M 22-Nov
@ depth of 10 M 22-Nov
@ depth of 30 M 8-Nov
@ depth of 10 M 8-Nov
Limit (PQL)

Nutrient Levels of IGD Releases
During the Fall of 2004, preliminary data



Special Study #4 - Summary

- Work in progress: waiting for more laboratory results
- Appears that turnover occurs very slow.
- Nutrient levels are changing but may not be able to detect significant differences in downstream water quality....stay tuned.

THE END