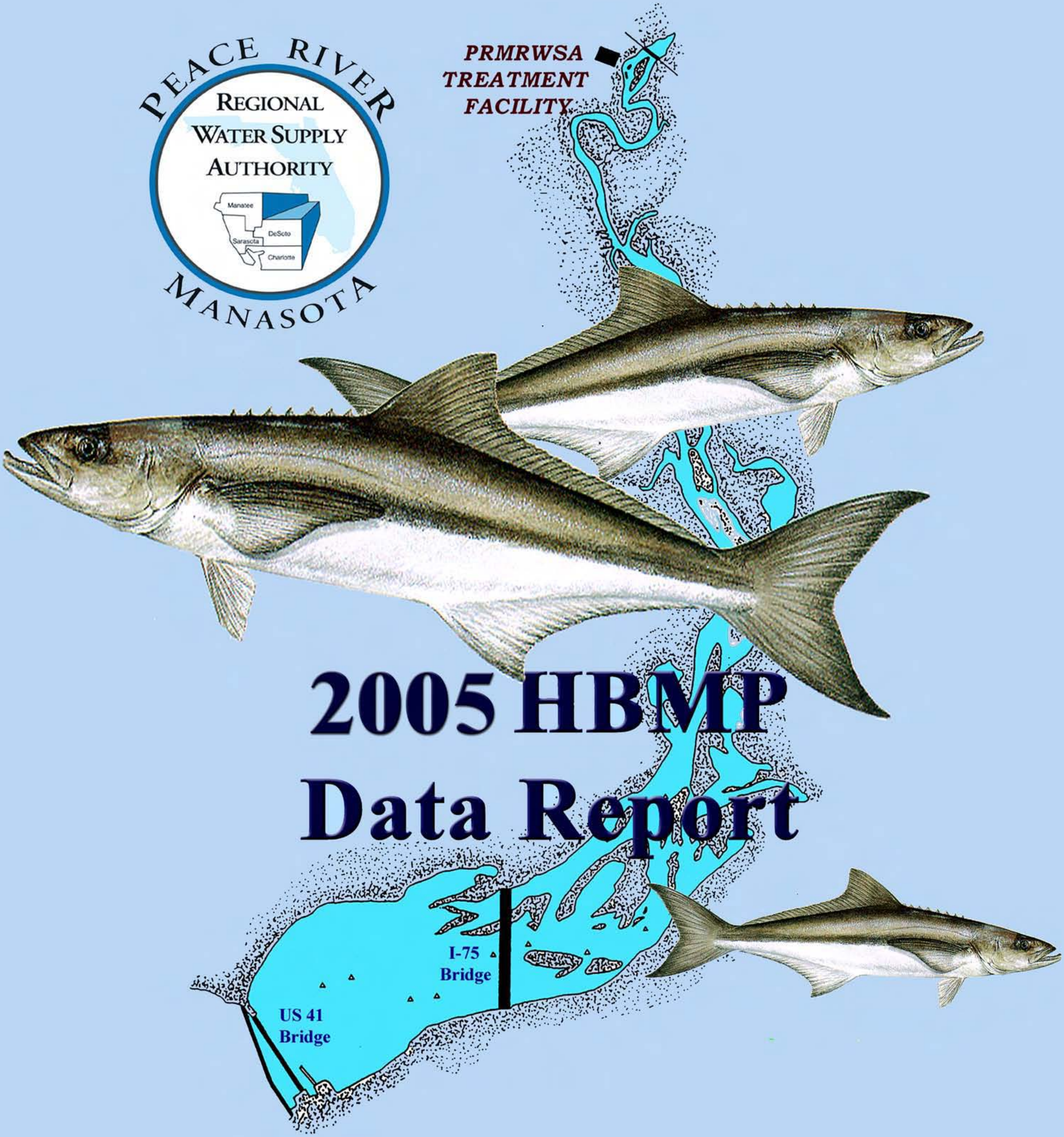
PEACE RIVER MANASOTA REGIONAL WATER SUPPLY AUTHORITY



2005 HBMP Data Report

Peace River Hydrobiological Monitoring Program 2005 Annual Data Report

Required by

Southwest Florida Water Management District
Water Use Permit 2010420.0004

Prepared for

Peace River Regional Water Supply Facility

Peace River / Manasota Regional Water Supply Authority

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Acknowledgments

The raw data, as well as the methods sections, presented in this report for the calendar year 2005 were provided by each of the contractors responsible for conducting specific elements of the Hydrobiological Monitoring Program.

- **EarthBalance (Florida Environmental)** – was responsible for all *in situ* water column physical measurements and the collection of water chemistry samples for both the "fixed" and "moving" station elements of the HBMP.

- **U.S. Geological Survey (Tampa Office) –** was responsible for all data collected at the two tide gages located in the lower Peace River that continuously collect data at 15 minute intervals. Measurements at each gaging location included measurements of: 1) surface and bottom conductivity; 2) surface and bottom water temperature; 3) and tide stage (water depth).

  Lower Peace River Continuous Recorders

  1. The Harbour Heights gage is designated by USGS as site 02297460, and it is located at the end of a private dock at River Kilometer 15.5.

  2. The second site is designated by USGS as 02297350 and it is located on a dock near Peace River Heights. This upstream monitoring site is located at River Kilometer 26.7.

  Gaged Stream Flow

  USGS also collects daily stream flow data at a wide number of gaging locations throughout southwest Florida. Flow data from a number of these sites are used by the HBMP program. Data for the period-of-record were obtained from the USGS web site: **(http://fl.water.usgs.gov/Tampa/index.html)**

  1. Peace River at Arcadia (02296750)
  2. Horse Creek near Arcadia (02297310)
  3. Joshua Creek near Nocatee (02297100)
  4. Shell Creek near Punta Gorda (02298202)
  5. Myakka River Near Sarasota (02298830)

- **Peace River/Manasota Regional Water Supply Authority** – provided measurements of daily withdrawals by the facility.

- **Benchmark Laboratory –** conducted all HBMP water chemistry analyses conducted during 2005.

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Historical Overview

On December 10, 1975, the Consumptive Use Permit #7500016 for the Peace River Regional Water Supply Facility was signed between General Development Utilities, Inc. and the Southwest Florida Water Management District (District). In conjunction with this agreement, a comprehensive Hydrobiological Monitoring Program (HBMP) was set forth to assess the responses of various physical, chemical and biological characteristics of the Charlotte Harbor Estuary to changes in Peace River flow. The program was designed to evaluate the impacts and significance of natural salinity changes on the aquatic fauna and flora in upper Charlotte Harbor, and to determine if freshwater withdrawals by the Peace River Regional Water Supply Facility could be shown to alter these patterns.

Between 1979 and 2005, an ongoing series of individual reports have been submitted to the District, documenting the results of the HBMP during the period from January 1976 through December 2005. These reports include summarizations (findings) of data collected during the first four years of baseline monitoring, prior to the start of freshwater withdrawals, as well as comparisons of these data to the results obtained from the HBMP during subsequent years of water treatment plant operation. The period covered within this *2005 Annual Data Report* follows directly upon that contained within the preceding *2004 Annual Data Report* submitted in May 2005, as well as the *2002 Comprehensive Summary Report* finalized in September 2004. This current data report includes unreported HBMP data collected over the period from January through December 2005, and represents the sixteenth year of data collection for the Peace River / Manasota Regional Water Supply Authority (PRMRWSA), the owner/operator of the Peace River Regional Water Supply Facility.

In 1976 the initial monitoring elements of the HBMP were designed to provide answers to specific questions raised by District staff during the original permitting process. These questions raised concerns regarding the potential for negative impacts that might be associated with possible salinity changes in Charlotte Harbor resulting from freshwater withdrawals. The primary findings and conclusions reached by the most recent *2002 Comprehensive Summary Report* (named for the period through which HBMP data were analyzed) were:

- Analyses of HBMP data collected between 1976-2002 indicates that Facility withdrawals have had, and are expected to cause, small changes in salinity gradients. However, these changes are within the normal natural range of tidal and seasonal ranges of variability found in the lower Peace River/upper Charlotte Harbor estuarine system. To date, the detected and predicted changes in salinity and/or spatial locations of isohalines resulting from Facility freshwater withdrawals have not been found to cause any pronounced or systematic changes in the salinity structure, water quality, or biological integrity of the affected estuarine communities of the lower Peace River/upper Charlotte Harbor estuarine system.

- The results and findings of the continuous recorder models supported the conclusions of previous statistical modeling efforts, which indicated that the maximum expected salinity increases due to Facility withdrawals are expected to be difficult to detect within the normal daily range of tidal salinity variations. As long as salinity changes attributable to Facility withdrawals remain a fraction of the normal typical range of daily salinity variations along the lower Peace River/upper Charlotte Harbor transect, no significant environmental changes in the estuarine system are expected as a result of increased salinity.

- The 130 cfs low flow cutoff criteria established by District staff in 1988 was based on plots of conductivity versus Peace River at Arcadia flow from HBMP data gathered at fixed monitoring sites located near the Facility's point of withdrawal. Analogous updated plots using data through 2002 indicated that the existing 130 cfs low flow threshold for withdrawals represents a conservative estimate to ensure minimal impacts to the lower Peace River/upper Charlotte Harbor estuary during periods of low freshwater inflow.

- The existing withdrawal schedule elements, which combines a 130 cfs low flow Arcadia gaged flow, with the requirement that diversions cannot exceed ten percent of the previous day's gaged flow, have been and are expected to continue to be extremely effective in preventing Facility withdrawals from having any apparent adverse harm on the lower Peace River estuarine system

An updated *2004 Comprehensive Summary Report* is currently under progress and will be submitted as a draft to the District later in 2006.

Current Hydrobiological Monitoring Program

Based on the results of the 1993 and 1995 Summary HBMP Reports and additional analyses requested by District staff during the 1996 permit renewal process, an expanded HBMP was approved by the District in March 1996 as a part of Water Use Permit (WUP) #2010420.004 for implementation in 1996 and subsequent years. This 20 year Water Use Permit continues to require the submission of both Annual Data Reports as well as Comprehensive Summary Documents after data collection for the 3rd and 5th years of each five-year period. Specific conditions within the permit include major expansions of both the physical and biological elements of the Hydrobiological Monitoring Program.

USGS Continuous Recorders –The primary goal of this HBMP study element was to develop an extensive database of short-term changes in surface and near-bottom salinity in the lower Peace River. In 1996 the U.S. Geological Survey (USGS) installed an automated 15-minute interval water level conductivity and stage recorder approximately 15.5 kilometers upstream of the river's mouth at Harbour Heights. In November 1997 a similar recorder was installed at approximately River Kilometer (RK) 26.7 just downstream of the Peace River Treatment Facility. Summary 2005 results from these continuous recorders shows that both surface and bottom conductivities at the downstream Harbour Heights site (River Kilometer 15.5) are very strongly influenced by tide (water stage) during periods when river flows are relatively low. During May, in the dry-season, it was not uncommon for surface and bottom conductivities to vary 1000 to 17000 uS/cm (roughly from .3 to 10.0 ppt salinity) over a tidal cycle. During June, in the wet-season, this lower reach of the Peace River was characteristically far fresher and daily variations in both surface and near bottom conductivities resulting from tidal influences are greatly reduced. At the more upstream continuous USGS gage at Peace River Heights (River Kilometer 26.7), the conductivity data indicated naturally hard water (high specific conductance) conditions often predominate, with only small, infrequent differences in conductivity (usually less than 100 uS/cm) resulting from tidal variations during the May 2005 dry-season. During the wet-season (in early June), conductivities were low and showed no variations due to normal daily tidal cycles in water levels.

Additional PRMRWSA Continuous Recorders – During 2005, the PRMRWSA evaluated a number of both possible alternative sites and deployment methodologies to be utilized in the deployment of additional continuous conductivity monitoring devices downstream of the Facility. These additional monitoring sites will be used as part of an expanded HBMP study element directed specifically toward measuring Facility withdrawal impacts under lower flow conditions. Ultimately, analyses of conductivity data from these new monitoring locations will be used to extend the graphical and statistical results previously conducted and presented as part of the *2002 HBMP Comprehensive Summary Report* with regard to directly measuring the salinity changes due to withdrawals.

Water Chemistry and Water Column Physical Profiles – The primary focus of the HBMP program extends along the monitoring transect centerline extending from south below the mouth of the river (which follows an imaginary line between Punta Gorda Point and Hog Island) to just north of the 761 Bridge, which is located upstream of the Peace River Facility. Two separate HBMP study elements incorporate both *in situ* water column profile physical measurements combined with the collection of chemical water quality sampling along the monitoring transect. Several goals are associated with both the individual and combined findings of these water quality HBMP study elements. A principal goal of both monitoring efforts is to assess the overall "health of the harbor" by collecting sufficient long-term data to statistically describe spatial and seasonal variability of the water quality characteristics of the lower Peace River/upper Charlotte Harbor Estuary, and test for significant changes over time (trends). A further goal of these HBMP elements is to determine whether significant relationships exist between freshwater inflows and the seasonal/spatial variability of key selected water quality parameters. If such relationships can be shown, then the ultimate goal becomes to determine the potential magnitude of change that might result from both existing permitted withdrawals and projected future increases, and compare such predicted changes due to withdrawals with the normal ranges of observed natural seasonal and annual variability.

Similar and comparable physical and chemical water quality parameter measurements along the upper Charlotte Harbor/lower Peace River estuarine monitoring transect are collected under these two different HBMP study elements.

1. During the first week of each month, water quality measurements (physical and chemical) are conducted at four "moving" salinity-based isohaline locations (0, 6, 12

and 20 ppt) along a river kilometer centerline running from the imaginary "mouth" of the Peace River upstream to above its junction with Horse Creek, and downstream to Boca Grande Pass. The relative monthly location of each sampling is based on the first occurrence of these specific isohalines (± 0.5 ppt), with freshwater being defined as the first occurrence of conductivities less than 500 ms. Historically, this isohaline sampling effort was undertaken in conjunction with other long-term phytoplankton elements of the HBMP (see Phytoplankton Studies described below.)

2. Approximately two weeks after the collection of the "moving" isohalines, water column physical profiles are conducted, near high tide, at sixteen "fixed" locations along a transect running from just below the river's mouth upstream to a point just above the Peace River Facility. In addition, chemical water quality samples are taken at five of these locations.

Both of these water quality study HBMP elements include physical *in situ* water column profile measurements of characteristic parameters (temperature, dissolved oxygen, pH, conductivity and salinity) at 0.5 meter intervals from the surface to the bottom. In addition both efforts measure the penetration of photosynthetically active radiation (PAR) to determine ambient extinction coefficients at specific sampling locations. Both studies also include the analyses of an extensive list of chemical water quality parameters. The only difference is that at the "fixed" sampling stations both sub-surface and near-bottom samples are collected at each of the five sites, while only sub-surface water chemistry samples are taken as part of the "moving" isohaline based HBMP study element.

Summary of 2005 Results

The following summarizes and compares data collected during 2005 with similar HBMP information previously compiled during various elements of the ongoing long-term monitoring programs. Such key elements include:

1. Peace River freshwater inflows and facility withdrawals.

2. Physical measurements such as water temperature, color and extinction coefficients.

3. Water quality characteristics such as nitrate/nitrite, ortho-phosphorus, nitrogen to phosphorus ratios, and reactive silica.

4. Biological measurements of phytoplankton biomass (chlorophyll *a*.)

In making comparisons of the 2005 data with averages of similar data collected over the preceding twenty-two year period (1983-2004), it should be noted that the very wet winter/spring El Niño of 1997/1998 was followed by very dry La Niña conditions that influenced southwest Florida and the entire Peace River watershed between 1999 and mid-2002. A weaker El Niño occurred at the end of 2002, and freshwater flows during 2003, 2004 and 2005 were generally above average.

- **Flows –** Average mean daily Peace River flow at the Arcadia gage during 2005 was 1858 cfs, which was slightly more than the daily mean flow of 1853 cfs during 2003 and 1740 in 2004. However the average mean daily flow of 1858 cfs during 2005 was approximately thirteen times greater than the daily average mean flow of only 139 cfs that occurred in 2000 during the past drought. The extremely low average mean flow during 2000 was the lowest that has occurred during the twenty-nine year period of HBMP monitoring. Overall, gaged Peace River at Arcadia freshwater mean flows during 2005 was approximately two hundred and two percent the average daily flow for the preceding long-term period 1976-2004. The sum of average daily flows from the Peace River at Arcadia, Horse Creek, Joshua Creek, and Shell Creek during ~~2004~~ 2005 was roughly one hundred and eighty-seven percent of the average daily flows for the period 1976-2004.

- **Withdrawals –** The Facility's mean average daily withdrawal during 2005 was 18.8 cfs. Overall withdrawals comprised 1.01 percent of the annual Arcadia gaged flow, and 0.64 percent of the combined lower Peace River gaged flow (Peace, Arcadia, Horse Creek, Joshua Creek and Shell Creek). Facility withdrawals during 2005 never exceeded ten percent of the gaged Peace River at Arcadia flows. Historically, such excendances of the permitted ten percent withdrawal have resulted from subsequent revisions by USGS of the provisional daily flow information available to the PRMRWSA at the time of actual withdrawals. Often there are extended periods each year when the Peace River Facility does not withdraw any water from the river due to either the 130 cfs cutoff (as measured at the USGS Arcadia gage) and/or Facility operations. During 2005, the facility did not withdraw any water approximately nine percent of the time. As indicated, maximum withdrawals increased notably during the later half of 2002 due to the recently completed facility expansion, which resulted in an increase in the PRMRWSA's ability to divert, treat and store larger daily amounts of freshwater when river flows are within the existing permit schedule.

- **Temperature –** Median water temperatures during 2005 at each of the three higher salinity isohalines were slightly greater than corresponding values measured over the preceding twenty-two year period (1982-2004). The warm water temperatures in the freshwater isohaline during the spring of 2005 were slightly higher than those observed at the other three salinity zones, possibly reflecting the increased heating of the more highly colored water. It should be noted, that the water temperatures measured during both January and December 2005 were much warmer than usual in comparison to values measured during the 1983-2004 period.

- **Water Color –** The average color levels throughout the estuary during 2003, 2004 and 2005 were markedly different than those recently observed during the 1999-2002 drought. Color levels in 2005 were well above the long-term averages within each of the four isohalines as a result of the higher than average freshwater inflows during much of 2005. Somewhat surprisingly, the peak very high color levels typically observed during the summer wet-season within the freshwater isohaline was not observed during 2005. This may reflect the higher than usual flows during both the winter and spring of 2005 and that the washout of tannins from uplands and wetlands were distributed over a much longer period, rather than being flushed out simply during the summer period.

- **Extinction Coefficient –** The rates of measured light attenuation at each of the four isohaline stations reflect both ambient color and phytoplankton biomass (chlorophyll *a*). Comparisons among the mean 2005 extinction values at the four isohalines indicate that even though water color throughout the estuary was higher than average during 2005 due to greater than average freshwater inflows, light extinction coefficients at all four isohalines were below historical annual averages. It is possible that in 2003, 2004 and 2005 higher than average freshwater inflows resulted in higher than average water color, which in turn suppressed normal spring levels of phytoplankton production (chlorophyll *a*), resulting in lower than average measurements of extinction coefficients.

- **Nitrite/Nitrate Nitrogen** - During 2005, the average concentrations of this major inorganic form of nitrogen were lower in the upper freshwater reach of the estuary than the long-term (1983-2004), historical annual average and higher at each of the three higher salinity isohalines. Typically monthly comparisons among the isohalines indicate nitrite/nitrate inorganic nitrogen concentrations in the lower Peace River/upper Charlotte Harbor Estuary are characterized by a distinct spatial gradient. Concentrations typically decrease rapidly with increasing salinity, with inorganic nitrogen levels within the 20 o/oo isohaline often being near method detection limits. Normally, estuarine inorganic nitrogen concentrations usually decline to their lowest levels during the relatively drier, late spring as phytoplankton populations increase, while responding to increasing water temperatures and light. This increased primary production removes available inorganic nitrogen. However, the higher than normal freshwater flows during winter and spring of 2005 resulted in differences in the characteristic annual patterns of inorganic nitrogen concentrations in the estuary.

- **Ortho-phosphorus** - Estuarine inorganic phosphorus concentrations in the lower Peace River and upper Charlotte Harbor are heavily influenced by the unusually "very" high natural levels found in the Peace River watershed. As a result, the observed differences in concentrations among the four isohalines simply reflect conservative dilution by Gulf waters. Unlike inorganic nitrogen, seasonal observed changes in phosphorus concentrations in the estuary are for the most part unaffected by biological uptake. Since the late 1970s there has been marked historical declines in inorganic phosphorus levels in the lower Peace River/upper Charlotte Harbor estuarine system due to declines in the combined influence of reductions in phosphate mining and processing discharges in the upper reaches of the basin. Inorganic phosphorus concentrations entering the estuary system from the Peace River watershed are typically lower during wetter periods, when a higher proportion of flow results from surface flow (rather than coming from groundwater, which is naturally richer in phosphorus). Average inorganic phosphorus concentrations during 2005 were higher than the long-term averages (1983-2004) at each of the four isohalines. Such higher than average phosphorus levels in these salinity zones reflects the overall results of higher than average freshwater inflows, which was also reflected in higher color and nitrogen levels in these areas of the estuary.

- **Nitrogen to Phosphorus Atomic Ratios** – Calculated atomic inorganic nitrogen to phosphorus ratios for ambient measured concentrations in 2005, as indicated by the long-term averages, show nitrogen to always be the limiting macronutrient at each of the four isohalines.

- **Silica** – Although the observed seasonal peaks of dissolved reactive silica in the lower Peace River/upper Charlotte Harbor estuarine system during 2005 were below those observed in 2003 and 2004, overall concentrations reflected a continuation of the previously noted increasing pattern of higher values at all four isohalines. This increasing pattern was slightly interrupted by the extended drought during 2000-2002, but seems to have accelerated starting late in 2002. Comparisons of long-term (1983-2004) annual average silica concentrations indicated that levels during 2005 were notably higher than the long-term historic levels within all four salinity zones.

- **Chlorophyll *a*** – The seasonal patterns of freshwater inflows to the estuary during 2005 reflect both much wetter than average conditions during the typically dry winter/spring and wetter than average conditions both during the early and late summer wet-season. The resulting seasonal flow patterns combined to produce both higher than average inputs of inorganic nutrients, as well as higher than average levels of water color (resulting in greater light attenuation). Overall, phytoplankton production (chlorophyll *a*) levels in the lower Peace River/upper Charlotte estuary were above the long-term (1983-2004) averages within each of the four salinity zones. As in previous years, phytoplankton blooms were more common within the intermediate (6 and 12 o/oo) isohalines. Somewhat surprisingly, the highest chlorophyll level ever recorded by any of the HBMP monitoring programs occurred during October 2005 at the 12 o/oo isohaline. The actual recorded value was based on a calculation using a very high dilution and therefore represents only a relative estimate. However, this isolated unusual estimated level was nearly double the previous highest measurement. During previous years, taxonomic counts indicated that such "bloom" events within these intermediate salinity zones were typically characterized by high numbers of dinoflagellates (Dinophyceae) or diatoms (Bacillariophycae).

Conclusions

This document represents the tenth Annual Data Report submitted under the expanded Hydrobiological Monitoring Program (HBMP) initiated in 1996 in compliance with Water Use Permit 2010420.004. The graphical and summary analyzes presented in this document do not indicate any substantial changes, or atypical events in either the physical or biological data collected during 2005, other than those previously noted. These include:

- Freshwater inflows during 2005 were characterized by a much wetter than normal flows during the winter (January and February), unusually high flows during the typical spring dry-season (especially during March and May), much higher than normal flow through the first part of the summer wet-season (June, July and August), and seasonally very high flows from the end of October through mid November.

- A continuation of the previously noted long-term increase in reactive silica concentrations in the lower Peace River.

- Some indications that inorganic phosphorus concentrations in the freshwater entering the estuary has increased slightly in recent years, following decades of major declines that began in the late 1970s.

The "limited" analyzes presented in the annual data report do not suggest that there have been any long-term changes resulting from either current or historic water withdrawals by the Peace River Regional Water Supply Facility. To date, none of the conducted HBMP data analyses have shown that facility withdrawals have had, or are expected to cause, measurable negative physical or biological adverse impacts within the lower Peace River estuarine system. The analyses and evaluations of the 2005 HBMP data neither indicated any potential "Significant Environmental Changes", nor were any changes observed that required administrative action as per the PRMRWSA's Management Response Plan

Permanent Data

This Executive Summary provides a brief over view of the HBMP project and the recent findings from the 2005 annual report. The complete *HBMP 2005 Annual Report* and all historic project water quality data is available in electronic format on a CD titled *HBMP 2005 Annual Report*. This CD is available upon request by contacting the Southwest Florida Water Management District or the Peace River / Manasota Regional Water Supply Authority. All historic water quality and *in situ* data collected during the fixed and moving station elements of the HBMP are provided on the *HBMP 2005 Annual Data Report* CD in a separate directory labeled 2005 Data Sets, as files in ASCII, Excel and/or SAS formats.

1.0 Introduction/Summary

1.1 Previous Studies and Reports

On December 10, 1975, the Consumptive Use Permit #7500016 for the Peace River Regional Water Supply Facility was signed between General Development Utilities, Inc. and the Southwest Florida Water Management District (District). In conjunction with this agreement, a comprehensive Hydrobiological Monitoring Program (HBMP) was set forth to assess the responses of various physical, chemical and biological characteristics of the Charlotte Harbor Estuary to changes in Peace River flow. The program was designed to evaluate the impacts and significance of natural salinity changes on the aquatic fauna and flora in upper Charlotte Harbor, and to determine if freshwater withdrawals by the Peace River Regional Water Supply Facility could be shown to alter these patterns. The area of study is shown in **Figure 1.1**.

Between 1979 and 2005, an ongoing series of individual reports have been submitted to the District, documenting the results of the HBMP during the period from January 1976 through December 2005. These reports include summarizations (findings) of data collected during the first four years of baseline monitoring, prior to the start of freshwater withdrawals, as well as comparisons of these data to the results obtained from the HBMP during subsequent years of water treatment plant operation. The period covered within this *2005 Annual Data Report* follows directly upon that contained within the preceding *2004 Annual Data Report* submitted in May 2005, as well as the *2002 Comprehensive Summary Report* finalized in September 2004. This current data report includes unreported HBMP data collected over the period from January through December 2005, and represents the sixteenth year of data collection for the Peace River / Manasota Regional Water Supply Authority (PRMRWSA), the owner/operator of the Peace River Regional Water Supply Facility.

In 1976 the initial monitoring elements of the HBMP were designed to provide answers to specific questions raised by District staff during the original permitting process. These questions raised concerns regarding the potential for negative impacts that might be associated with possible salinity changes in Charlotte Harbor resulting from freshwater withdrawals. Analysis of data from pre- and post-water treatment plant operation, presented in the August 1982 Summary Report, indicated the need to revise the monitoring program. These revisions would better evaluate possible changes in the Charlotte Harbor system due to natural variations in freshwater inflows. Further modifications to the HBMP were made in 1985 and again in conjunction with the renewal of the Water Use Permit in November 1988. Under the 1988 permit, data reports were required to be submitted annually for the first through fifth years of the monitoring program. In addition, two expanded Comprehensive Summary Reports were submitted which included various comparative analyses of the data reported over the preceding periods of data. The first Comprehensive Summary Report was finalized in December 1993 and included analyses of long-term data collected between 1983 and 1991. The next Comprehensive Summary Report was filed in draft form in 1994, and as a final report in April 1995. This second Summary Report statistically summarized and evaluated the results of the HBMP elements conducted between 1976 and 1993. The most recent *2002 Comprehensive Summary Report* (named for the period through which HBMP data were analyzed) both extended previous selected analyses of study elements undertaken in conjunction with the preceding summary reports of long-term HBMP data, as well as presented new analyses of a number of program study elements. The primary findings and conclusions reached in the 2002 Comprehensive Summary Report were:

- That the analyses of HBMP data collected between 1976-2002 have shown that Facility withdrawals have had, or are expected to cause, small changes in salinity gradients and that these changes are within the normal natural range of tidal and seasonal ranges of variability found in the lower Peace River/upper Charlotte Harbor estuarine system. To date, the detected and predicted changes in salinity and/or spatial locations of isohalines resulting from Facility freshwater withdrawals have not been found to cause any pronounced or systematic changes in the salinity structure, water quality, or biological integrity of the affected estuarine communities of the lower Peace River/upper Charlotte Harbor estuarine system.

- The results and findings of the continuous recorder models presented in this report support the overall conclusions of previous reported statistical modeling efforts. These efforts have concluded that the maximum expected increases in salinity due to Facility withdrawals are expected to be difficult to detect within the normal daily range of tidal salinity variations during those periods when the Facility is potentially having its greatest influence. As long as salinity changes attributable to Facility withdrawals remain a fraction of the normal typical range of daily (let alone seasonal) salinity variations along the lower Peace River/upper Charlotte Harbor transect, no significant environmental changes in the estuarine system are expected as a result of increased salinity.

- The 130 cfs low flow cutoff criteria established by District staff in 1988 was based on plots of conductivity versus Peace River at Arcadia flow from HBMP data gathered at fixed monitoring sites located near the Facility's point of withdrawal. Analogous updated plots using data through 2002 indicate that the existing 130 cfs low flow threshold for withdrawals represents a conservative estimate to ensure minimal impacts to the lower Peace River/upper Charlotte Harbor estuary during periods of low freshwater inflow.

- The existing withdrawal schedule elements, which combines a 130 cfs low flow Arcadia gaged flow, with the requirement that diversions cannot exceed ten percent of the previous day's gaged flow, have been and are expected to continue to be extremely effective in preventing Facility withdrawals from having any apparent adverse harm on the lower Peace River estuarine system

The *2004 Comprehensive Summary Report* is currently under progress and will be submitted as a draft to the District later in 2006.

1.2 Current Hydrobiological Monitoring Program

Based on the results of the 1993 and 1995 Summary HBMP Reports and additional analyses requested by District staff during the1996 permit renewal process, an expanded HBMP was approved by the District in March 1996 as a part of Water Use Permit (WUP) #2010420.004 for implementation in 1996 and subsequent years. This 20 year Water Use Permit continues to require the submission of both Annual Data Reports as well as Comprehensive Summary Documents after data collection for the 3rd and 5th years of each five-year period. Specific conditions within the permit include major expansions of both the physical and biological elements of the Hydrobiological Monitoring Program.

The analyses of long-term HBMP data provided in both the initial *2000 Midterm Interpretive Report* (finalized in 2002) and the recent *2002 Comprehensive Summary Report* (September 2004) further support previous monitoring program findings regarding the potential magnitude of the changes that might be attributed directly to facility withdrawals. The primary goals and objectives of these summary documents have been to provide the District with sufficient analyses to:

- Determine key relationships between ecological characteristics and freshwater inflows, and determine whether the biological health and productivity of the estuary are showing signs of stress related to natural periods of low freshwater inflow or potential negative influences of facility withdrawals.
- Assess the presence or absence of long-term trends for important HBMP variables.
- Evaluate the overall HBMP design and make recommendations regarding implementing modifications.
- Assess the presence or absence of adverse ecological impacts and determine the influence facility withdrawals may have contributed.
- Evaluate the environmental considerations that may be associated with additional future increased withdrawals from the river and the feasibility of increased water supplies.
- Assess and evaluate the effectiveness of the withdrawal schedule for preventing adverse environmental impacts.

The overall findings of these recent summary documents submitted to the District in conjunction with the 1996 permit requirements have indicated that:

- In response to increasing potable water demands, Peace River Facility withdrawals have steadily and progressively increased since being initiated in 1980. However, the magnitude of withdrawals has remained extremely small when compared to the natural seasonal variability of rates of freshwater inflow to the estuary. Currently average yearly Peace River Facility withdrawals comprise less than 1 percent of total freshwater flow at the mouth of the Peace River.
- Since its inception in 1976, the HBMP has incorporated numerous physical, chemical, and biological study elements directed toward assessing both the overall "health of the harbor" as well as direct and indirect adverse impacts potentially associated with

facility withdrawals. To date, none of these monitoring efforts have been able to detect any significant impacts associated with facility withdrawals.

- The summary results of developed statistical salinity models have indicated that, on average, the influences of facility withdrawals on the salinity structure of the Lower Peace River between the U.S. 41 Bridge and the Peace River Facility has historically resulted in maximum changes of less than 0.3 ppt.

- Statistical models were also used to predict what the potential magnitude of salinity changes might be under the maximum permitted daily withdrawals during Arcadia flows between 200 and 1,000 cfs. Model results predict that a maximum salinity change of < 0.5 ppt would occur between River Kilometers 14 and 18 when Arcadia flows range between 400 and 1000 cfs. With Arcadia flows of 200 cfs, the results predict that similar changes in salinity (< 0.5 ppt) would occur further upstream.

- The results and findings of similar statistical models developed using data from the two HBMP continuous recorders concluded that the maximum expected increases in salinity due to facility withdrawals would be difficult to actually measure within the normal daily range of tidal salinity variations during the periods when the facility is potentially having its greatest influence.

- Long-term comparisons of upstream and downstream occurrences of selected indicator plant species along the lower Peace River have indicated that the distributions of the selected indicator species have not indicated any signs of systematic progressive changes over time. The indicator riparian vegetation element of the HBMP was therefore deleted from the program.

As long as salinity changes attributable to facility withdrawals remain a fraction of the normal typical range of daily (and seasonal) salinity variations along the lower Peace River/upper Charlotte Harbor HBMP study monitoring transect, no significant measurable environmental changes in the estuarine system would be expected. To date, none of the conducted HBMP data analyses have shown that facility withdrawals have had, or are expected to cause, measurable negative physical or biological adverse impacts within the lower Peace River estuarine system.

1.2.1 Ongoing HBMP Program Study Elements

An explicit element of the updated HBMP was the development of standardized station descriptors to be applied across all program elements (**Figure 1.2**). As part of the required morphometric study, the "mouth" of the Peace River was defined using USGS standardized protocols as an imaginary line extending from Punta Gorda Point to Hog Island. **Figure 1.3** and **Table 1.1** provide a summary of the locations of all ongoing long-term fixed study elements and a cross-reference to previous station identifications. The following briefly outlines each of the current HBMP study elements.

1.2.2 USGS Continuous Recorders

The primary goal of this element of the HBMP was to develop an extensive database of short-term (daily or more frequent) changes in surface and near-bottom salinity in the lower Peace River. These data, combined with corresponding gage height, freshwater flows and withdrawals, would then be used to develop detailed spatial and temporal relationships. A secondary goal was to assess potential long-term changes in river salinity, which might be explained by predicted increases in sea level.

In 1996 the U.S. Geological Survey (USGS) installed automated 15-minute interval water level recorders at the following two locations:

1. At Boca Grande, which is the estuary's largest opening to the Gulf of Mexico.

2. Approximately 15.5 kilometers upstream of the river's mouth at Harbour Heights. The gaging station at Harbour Heights also measures surface and bottom conductivity at 15-minute intervals.

In November 1997 a third gage was installed at approximately River Kilometer (RK) 26.7 just downstream of the Peace River Facility. This gage also measures water level as well as surface and bottom conductivity at 15-minute intervals.

Based on consultation with USGS staff, the water level recorder information from the gage at Boca Grande was discontinued at the end of 2004. The original purpose of this gage was to assess potential increase in salinity that might be naturally occurring due to projected gradual increases in sea level expected to occur over time. However, USGS staff felt that any conclusions regarding sea level rises at this site would be compromised due to the gages location near the mouth of the pass. As a result, the PRMRWSA (after consultation with the Scientific Review Panel) decided to delete this water level information from the HBMP monitoring program. The relative locations of each of these USGS gages are depicted in **Figure 6.1** and **Figure 6.7**.

Summary results of 2005 information for the continuous USGS recorders located at Harbour Heights (River Kilometer 15.5) and Peace River Heights (River Kilometer 26.7) are further presented in Section 5 of this document.

1.2.3 Additional PRMRWSA Continuous Recorders

During 2005, the PRMRWSA evaluated a number of both possible alternative sites and deployment methodologies to be utilized in the deployment of additional continuous conductivity monitoring devices downstream of the Facility. These additional monitoring sites would be used as part of an expanded HBMP study element directed specifically toward measuring Facility withdrawal impacts under lower flow conditions. Ultimately, analyses of conductivity data from these new monitoring locations would be used to extend the graphical and statistical results previously conducted and presented as part of the *2002 HBMP Comprehensive Summary Report* with regard to directly measuring the salinity changes due to withdrawals.

The initial first step to deploying additional continuous recorders was to determine the potential spatial distribution of arraying such new continuous recorders downstream of the Facility in order to maximize their ability to detect salinity changes (impacts) that could be directly attributed to Facility freshwater withdrawals. Existing statistical models and graphical analyses of salinity/flow relationships were reviewed from the long-term HBMP fixed stations and USGS continuous recorders in this reach of the lower Peace River. These results were next evaluated in relationship to potential existing physical structures (docks, pilings, etc.) to which additional continuous recorders might be attached. A series of potential new monitoring sites located between the two existing USGS continuous recorders were selected for evaluation

One option considered was to locate a third land based gage similar in design to the two existing USGS continuous recorders on one of the single family docks located just upstream (between River Kilometers 24.5 and 25.0) of the entrance to Navigator Marina. However, a series of other potential sites exist further downstream, due to the recent placement of Manatee Speed Zone markers along the river. The PRMRWSA was able to receive permission from US Fish and Wildlife to establish continuous recorders using these markers. Three of these Manatee Speed Zone markers were chosen for the initial deployment of the new PRMRWSA HBMP continuous recorders, the locations of which are indicated by the light-green arrows in **Figure 6.7**. The methodologies used for deployment of the three new continuous recorders are depicted in **Figure 6.8** and **Photographs 6.1** through **6.4.**

1.2.4 Water Chemistry and Water Column Physical Profiles

The primary focus of the HBMP program extends along the monitoring transect centerline extending from south below the mouth of the river (which follows an imaginary line between Punta Gorda Point and Hog Island) to just north of the 761 Bridge, which is located upstream of the Peace River Facility (see **Figure 1.2**). Two separate HBMP study elements incorporate both *in situ* water column profile physical measurements combined with the collection of chemical water quality sampling along the monitoring transect. Several goals are associated with both the individual and combined findings of these water quality HBMP study elements. A principal goal of both monitoring efforts is to assess the overall "health of the harbor" by collecting sufficient long-term data to statistically describe spatial and seasonal variability of the water quality characteristics of the lower Peace River/upper Charlotte Harbor Estuary, and test for significant changes over time (trends). A further goal of these HBMP elements is to determine whether significant relationships exist between freshwater inflows and the seasonal/spatial variability of key selected water quality parameters. If such relationships can be shown, then the ultimate goal becomes to determine the potential magnitude of change that might result from both existing permitted withdrawals and projected future increases, and compare such predicted changes due to withdrawals with the normal ranges of observed natural seasonal and annual variability.

Similar and comparable physical and chemical water quality parameter measurements along the upper Charlotte Harbor/lower Peace River estuarine monitoring transect are collected under these two different HBMP study elements.

1. During the first week of each month, water quality measurements (physical and chemical) are conducted at four "moving" salinity-based isohaline locations (0, 6, 12

and 20 ppt) along a river kilometer centerline running from the imaginary "mouth" of the Peace River upstream to above its junction with Horse Creek, and downstream to Boca Grande Pass. The relative monthly location of each sampling is based on the first occurrence of these specific isohalines (± 0.5 ppt), with freshwater being defined as the first occurrence of conductivities less than 500 ms. Historically, this isohaline sampling effort was undertaken in conjunction with other long-term phytoplankton elements of the HBMP (see Phytoplankton Studies described below.)

2. Approximately two weeks after the collection of the "moving" isohalines, water column physical profiles are conducted, near high tide, at sixteen "fixed" locations along a transect running from just below the river's mouth upstream to a point just above the Peace River Facility (see **Figure 1.3** and **Table 1.1**). In addition, chemical water quality samples are taken at five of these locations.

Both of these water quality study HBMP elements include physical *in situ* water column profile measurements of characteristic parameters (temperature, dissolved oxygen, pH, conductivity and salinity) at 0.5 meter intervals from the surface to the bottom. In addition both efforts measure the penetration of photosynthetically active radiation (PAR) to determine ambient extinction coefficients at specific sampling locations. Both studies also include the analyses of an extensive list of chemical water quality parameters (**Table 1.2**). The only difference is that at the "fixed" sampling stations both sub-surface and near-bottom samples are collected at each of the five sites, while only sub-surface water chemistry samples are taken as part of the "moving" isohaline based HBMP study element.

During 2005, EarthBalance, Inc. (formerly Florida Environmental) conducted all fieldwork (physical water column profile measurements and water chemistry parameter sampling) associated with both the "moving" and "fixed" station HBMP monitoring elements. Benchmark EnviroAnalytical, Inc. was responsible for conducting all 2005 water chemistry analyses.

In response to the recommendations contained within the 2000 HBMP Midterm Interpretive Report, the number of water chemistry parameters associated with both the "moving and "fixed" HBMP study elements was decreased from those originally specified in the 1996 monitoring conditions. These changes were made only after extensive consultation with both the HBMP Scientific Review Panel and District staff. As a result of this consultation, a revised/ reduced long-term water quality sampling parameter list was implemented in March 2003 (**Table 1.2**).

Further descriptions, as well as complete summaries of the 2005 monitoring results and historical comparisons of the "isohaline" and "fixed" location based HBMP monitoring study elements are presented respectively in Section 4 and Section 5 of this report.

1.2.5 HBMP Study of Long-Term Changes in Vegetation

At selected intervals between 1976 and 2004, three different HBMP study elements were conducted to assess variations in emergent and riparian vegetation along the lower Peace River. The overall objective of these monitoring programs was to determine the magnitude of annual and longer term changes caused by natural river flow differences between extended wet and dry periods, and then using this information assess the potential magnitude of changes that might be expected to occur due to current and projected Facility withdrawals.

The identification of potential adverse effects to emergent vegetation and riverine wetlands caused by freshwater withdrawals initially requires determining the magnitude of the spatial and temporal responses of these vegetative communities to the natural variation resulting from extended periods of drought and flood. This step involves developing methodologies that allow differentiating between long-term natural changes in riverine vegetative patterns and withdrawal induced changes. The vegetative monitoring elements of the HBMP provided information for determining relationships between vegetation patterns and freshwater flows by observing the positions of the freshwater and salt-tolerant plant communities, especially in the salinity transitional zone of the river. A permanent shift of more salt-tolerant plants upriver could be an indication that withdrawals were impacting the river corridor wetlands, as long as natural variability (drought) or man-made causes could be eliminated.

Photointerpretation - This long-term element of the HBMP initially began in 1976. Initially aerial infra-red photography of the vegetative communities were taken yearly along the lower Peace River, starting at the U.S. 41 Bridge (River Kilometer 6.6) and extending upstream above the Peace River Facility to near the area where Horse Creek enters the river (river kilometer 39.5). Under the 1996 HBMP permit modifications, such aerial surveys continued to be conducted at two year intervals. All post-1996 aerial photography was taken in a corrected, GIS compatible format, thus allowing for accurate quantification of any observed changes. Photointerpretation of these images, in conjunction with field observations, was then used to develop maps of the river's vegetation associations. Both qualitative and quantitative data were applied to assess potential changes associated with extended natural periods of both low (1999-2001) and high (2002-2004) freshwater inflows.

First and Last Occurrence of Indicator Plant Species – At approximately two year intervals between 1976 and 2004, the first and last occurrence of a large number of indicator plant species was recorded along the banks of the Peace River downstream of the Peace River Facility. As part of this vegetation HBMP study element, detailed maps using the standardized river kilometer scale were made, identifying the first and last occurrences of individual and substantial populations of key indicator species. Since 1997, detailed photographic records were compiled in conjunction with this effort. These data were then used in conjunction with the aerial photography to assess the influences of long-term natural variations in river flow.

Vegetation Transition Sites – This portion of the HBMP study extended and expanded the detailed monitoring begun in 1977 of plant communities along the river's banks at fixed locations. The vegetative communities at three permanent transect sites (see **Figure 1.4** and **Table 1.1**) were sampled at approximately two-year intervals between 1976 and 2004. At each monitoring location, transects from the top of the bank to the water's edge were surveyed. The vegetation one meter to each side of the transects were identified, and the location and density recorded. Long-term data from these transition sites were then used to further assess the response of the riverine vegetative communities to natural variations in freshwater flows.

Complete and thorough analyses of the long-term results of these vegetation studies were presented in both the 2002 HBMP Comprehensive Summary Report and the 2004 HBMP Annual Data Report. These analyses indicated that vegetation patterns along the lower tidal Peace River have remained relatively stable over long periods of time, and show little in the way of consistent responses to natural periods of either high or low freshwater river flow. As a result, based on discussions with both the Scientific Review Panel and District staff, it was determined to suspend these HBMP study elements and potentially continue aerial photography at much longer intervals.

1.2.6 Phytoplankton Studies

Sub-surface samples are collected in conjunction with the "moving" isohaline sampling of physical and chemical water quality characteristics described above.

Carbon Uptake – From June 1983 through December 1999, replicate (5) rates of carbon uptake were determined for each of three separate phytoplankton size fractions: 1) greater than 20 microns; 2) less than 20 microns and greater than 5 microns; and 3) those cells less than 5 microns at each of the four "moving" isohalines (0, 6, 12 and 20 ppt). Based on the extensive nature of the database gathered, further *in situ* carbon uptake measurements were deleted from the HBMP in 2000.

Species Composition - Between 1989 and 2004, monthly sub-surface phytoplankton samples were collected, preserved and identified to the lowest practical taxon in conjunction with the carbon uptake measurements at each of the four isohalines. After sixteen years of sampling, the phytoplankton species identification element of the HBMP was deleted at the end of 2004 in conjunction with implementation of program modifications proposed in the *2002 Comprehensive Summary Report* and recommended by the Scientific Review Panel.

Chlorophyll *a* Biomass – Although direct carbon uptake measurements and species identifications have both been deleted from the HBMP, sub-surface samples for the measurement of chlorophyll *a* continue to be taken with regard to the estimation of phytoplankton biomass. However, the relative levels of chlorophyll *a* within each of three size fractions: 1) greater than 20 microns; 2) less than 20 microns and greater than 5 microns; and 3) those cells less than 5 microns was deleted from the HBMP monitoring program in 2002.

The 2005 chlorophyll *a* phytoplankton biomass estimates are presented for "isohaline" based monitoring in Section 4 and the "fixed" station locations in Section 5. In both sections, the 2005 chlorophyll results are compared in context with previous historical information.

1.3 Special Studies Associated with the HBMP

In addition to the current, ongoing elements of the HBMP outlined above, the revised HBMP program implemented in 1996 also required the PRMRWSA to conduct and/or contribute to a number of duration-limited studies designed to answer specific research questions. Comprehensive summaries of these special HBMP studies as well as other recent relevant reports by other research programs in the lower Peace River/upper Charlotte Harbor estuarine system were presented in Section 3 of the *2002 Comprehensive Summary Report*.

1.4 Summary of 2005 Results

The following text and tables compare data collected during 2005 with similar average values for key parameters previously compiled during various elements of the ongoing long-term monitoring programs. Such key elements, include:

1. Peace River freshwater inflows and facility withdrawals.

2. Physical measurements such as water temperature, color and extinction coefficients.

3. Water quality characteristics such as nitrate/nitrite, ortho-phosphorus, nitrogen to phosphorus ratios, and reactive silica.

4. Biological measurements of phytoplankton biomass (chlorophyll *a*.)

In making comparisons of the 2005 data with averages of similar data collected over the preceding twenty-two year period (1983-2004), it should be noted that the very wet winter/spring El Niño of 1997/1998 was followed by very dry La Niña conditions that influenced southwest Florida and the entire Peace River watershed between 1999 and mid-2002 (see **Figures 2.3** and **2.4**). A weaker El Niño occurred at the end of 2002, and freshwater flows during 2003, 2004 and 2005 were generally above average.

- **Flows** – Average mean daily Peace River flow at the Arcadia gage during 2005 was 1858 cfs, which was slightly more than the daily mean flow of 1853 cfs during 2003 and 1740 in 2004. However the average mean daily flow of 1858 cfs during 2005 was approximately thirteen times greater than the daily average mean flow of only 139 cfs that occurred in 2000 during the past drought. The extremely low average mean flow during 2000 was the lowest that has occurred during the twenty-nine year period of HBMP monitoring. Overall, gaged Peace River at Arcadia freshwater mean flows during 2005 was approximately two hundred and two percent the average daily flow for the preceding long-term period 1976-2004 (see **Table 2.4**). The sum of average daily flows from the Peace River at Arcadia, Horse Creek, Joshua Creek, and Shell Creek during 2004 was roughly one hundred and eighty-seven percent of the average daily flows for the period 1976-2004.

- **Withdrawals** – The Facility's mean average daily withdrawal during 2005 was 18.8 cfs. Overall withdrawals comprised 1.01 percent of the annual Arcadia gaged flow, and 0.64 percent of the combined lower Peace River gaged flow (Peace, Arcadia, Horse Creek, Joshua Creek and Shell Creek). Facility withdrawals during 2005 never exceeded ten percent of the gaged Peace River at Arcadia flows. Historically, such excendances of the permitted ten percent withdrawal have resulted from subsequent revisions by USGS of the provisional daily flow information available to the PRMRWSA at the time of actual withdrawals. Often there are extended periods each year when the Peace River Facility does not withdraw any water from the river due to either the 130 cfs cutoff (as measured at the USGS Arcadia gage) and/or Facility operations. During 2005, the facility did not withdraw any water approximately nine percent of the time. As indicated, maximum withdrawals increased notably during the later half of 2002 due to the recently completed facility expansion, which resulted in an increase in the PRMRWSA's ability to divert, treat and store larger daily amounts of freshwater when river flows are within the existing permit schedule.

Comparisons of means between 2005 and long-term averages for the following selected physical, chemical and biological water quality characteristics measured in conjunction with the "moving" and "fixed" HBMP study elements are presented in **Tables 3.8** and **4.5**.

- **Temperature** – Median water temperatures during 2005 at each of the three higher salinity isohalines were slightly greater than corresponding values measured over the preceding twenty-two year period (1982-2004). The warm water temperatures in the freshwater isohaline during the spring of 2005 were slightly higher than those observed at the other three salinity zones, possibly reflecting the increased heating of the more highly colored water. It should be noted, that the water temperatures measured during both January and December 2005 were much warmer than usual in comparison to values measured during the 1983-2004 period.

- **Water Color –** The average color levels throughout the estuary during 2003, 2004 and 2005 were markedly different than those recently observed during the 1999-2002 drought. Color levels in 2005 were well above the long-term averages within each of the four isohalines as a result of the higher than average freshwater inflows during much of 2005. Somewhat surprisingly, the peak very high color levels typically observed during the summer wet-season within the freshwater isohaline was not observed during 2005. This may reflect the higher than usual flows during both the winter and spring of 2005 and that the washout of tannins from uplands and wetlands were distributed over a much longer period, rather than being flushed out simply during the summer period.

- **Extinction Coefficient –** The rates of measured light attenuation at each of the four isohalines reflect both ambient color and phytoplankton biomass (chlorophyll *a*). Comparisons among the mean 2005 extinction values at the four isohalines indicate that even though water color throughout the estuary was higher than average during 2005 due to greater than average freshwater inflows, light extinction coefficients at all four isohalines were below historical annual averages. It is possible that in 2003, 2004 and 2005 higher than average freshwater inflows resulted in higher than average water color, which in turn suppressed normal spring levels of phytoplankton production (chlorophyll *a*), resulting in lower than average measurements of extinction coefficients.

- **Nitrite/Nitrate Nitrogen** - During 2005, the average concentrations of this major inorganic form of nitrogen were lower in the upper freshwater reach of the estuary than the long-term (1983-2004), historical annual average and higher at each of the three higher salinity isohalines. Typically monthly comparisons among the isohalines indicate nitrite/nitrate inorganic nitrogen concentrations in the lower Peace River/upper Charlotte Harbor Estuary are characterized by a distinct spatial gradient. Concentrations typically decrease rapidly with increasing salinity, with inorganic nitrogen levels within the 20 o/oo isohaline often being near method detection limits. Normally, estuarine inorganic nitrogen concentrations usually decline to their lowest levels during the relatively drier, late spring as phytoplankton populations respond to increasing water temperatures and light, and increased primary production removed available inorganic nitrogen. However, the higher than normal freshwater flows during winter and spring of 2005 resulted in differences in the characteristic annual patterns of inorganic nitrogen concentrations in the estuary.

- **Ortho-phosphorus** - Estuarine inorganic phosphorus concentrations in the lower Peace River and upper Charlotte Harbor are heavily influenced by the unusually "very" high natural levels found in the Peace River watershed. As a result, the observed differences in concentrations among the four isohalines simply reflect conservative dilution by Gulf waters. Unlike inorganic nitrogen, seasonal observed changes in phosphorus concentrations in the estuary are for the most part unaffected by biological uptake. Since the late 1970s there has been marked historical declines in inorganic phosphorus levels in the lower Peace River/upper Charlotte Harbor estuarine system due to declines in the combined influences reductions in phosphate mining and processing discharges in the upper reaches of the basin. Inorganic phosphorus concentrations entering the estuary system from the Peace River watershed are typically lower during wetter periods, when a higher proportion of flow results from surface flow (rather than coming from groundwater, which is naturally richer in phosphorus). Average inorganic phosphorus concentrations during 2005 were higher than the long-term averages (1983-2004) at each of the four isohalines. Such higher than average phosphorus levels in these salinity zones reflects the overall results of higher than average freshwater inflows, which was also reflected in higher color and nitrogen levels in these areas of the etuary.

- **Nitrogen to Phosphorus Atomic Ratios** – Calculated atomic inorganic nitrogen to phosphorus ratios for ambient measured concentrations in 2005, as indicated by the long-term averages, show nitrogen to always be the limiting macronutrient at each of the four isohalines.

- **Silica** – Although the observed seasonal peaks of dissolved reactive silica in the lower Peace River/upper Charlotte Harbor estuarine system during 2005 were below those observed in 2003 and 2004, overall concentrations reflected a continuation of the previously noted increasing pattern of higher values at all four isohalines. This increasing pattern was slightly interrupted by the extended drought during 2000-2002, but seems to have accelerated starting late in 2002. Comparisons of long-term (1983-

2004) annual average silica concentrations indicated that levels during 2005 were notably higher than the long-term historic levels within all four salinity zones.

- **Chlorophyll *a*** – The seasonal patterns of freshwater inflows to the estuary during 2005 reflect both much wetter than average conditions during the typically dry early late winter/spring and wetter than average conditions both during the early and late summer wet-season. The resulting seasonal flow patterns combined to produce both higher than average inputs of inorganic nutrients, as well as higher than average levels of water color (resulting in greater light attenuation). Overall, phytoplankton production (chlorophyll *a*) levels in the lower Peace River/upper Charlotte estuary were above the long-term (1983-2004) averages within each of the four salinity zones. As in previous years, phytoplankton blooms were more common within the intermediate (6 and 12 o/oo) isohalines. Somewhat surprisingly, the highest chlorophyll level ever recorded by any of the HBMP monitoring programs occurred during October 2005 at the 12 o/oo isohaline. The actual recorded value was based on a calculation using a very high dilution and therefore represents only a relative estimate. However, this isolated unusual estimated level was nearly double the previous highest measurement. During previous years, taxonomic counts indicated that such “bloom” events within these intermediate salinity zones were typically characterized by high numbers of dinoflagellates (Dinophyceae) or diatoms (Bacillariophycae).

1.5 Conclusions

This document represents the tenth Annual Data Report submitted under the expanded Hydrobiological Monitoring Program (HBMP) initiated in 1996 in compliance with Water Use Permit 2010420.004. The graphical and summary analyzes presented in this document do not indicate any substantial changes, or atypical events in either the physical or biological data collected during 2005, other than those previously noted. These include:

- Freshwater inflows during 2005 were characterized by a much wetter than normal flows during the winter (January and February), unusually high flows during the typical spring dry-season (especially during March and May), much higher than normal flow through the first part of the summer wet-season (June, July and August), and seasonally very high flows from the end of October through mid November.

- A continuation of the previously noted long-term increase in reactive silica concentrations in the lower Peace River.

- Some indications that inorganic phosphorus concentrations in the freshwater entering the estuary has increased slightly in recent years, following decades of major declines that began in the late 1970s.

The “limited” analyzes presented in the annual data report do not suggest that there have been any long-term changes resulting from either current or historic water withdrawals by the Peace River Regional Water Supply Facility.

1.6 Permanent Data

All historic water quality and *in situ* data collected during the fixed and moving station elements of the HBMP used in the preparation of this document are provided on the HBMP 2005 Annual Data Report CD in the directory labeled 2005 Data Sets, as files in ASCII, Excel and/or SAS formats. Table 1.3 provides a summary and links to descriptions of the variables within each of the SAS data sets.

Table 1.3
Long-term Historical HBMP Data Sets

Data Set Name	Time Period	Brief Description
HBMP SAS Data Sets		
Flwd05.sd2	1931-2005	Historic daily flow data for: Peace at Arcadia; Horse Creek near Arcadia; Joshua Creek near Nocatee; and Shell Creek near Punta Gorda. Historic daily Peace River Facility withdrawals. All values in cfs.
Cmov8305.sd2	1983-2005	Water quality, and phytoplankton biomass and uptake measurements from monthly surface samples collected at each of the four moving isohalines. Relative locations reflect distances from the river mouth in kilometers.
Hymov05.sd2	1983-2005	Monthly hydrolab *in situ* water quality measurements taken at 0.5 meter intervals at each of the four moving isohalines. Relative locations reflect distances from the river mouth in kilometers.
Hyfix05.sd2	1996-2005	Monthly *in situ* hydrolab water column profile data taken at 0.5 meter intervals from fixed sample locations from near the river's mouth to just upstream of the Treatment Facility.
Cfix9605.sd2	1996-2005	Monthly surface and bottom chemical water quality samples taken at five intervals from fixed sample locations from near the river's mouth to just upstream of the Treatment Facility.
Efix9605.sd2	1996-2005	Water column extinction coefficients collected at the fixed sampling locations.
Boca05.sd2	1996-2005	Water level at 15-minute intervals from the continuous recording gage near Boca Grande.
HH05.sd2	1996-2005	Water Level, and surface and bottom conductivity and temperature at 15-minute intervals from the continuous recording gage on the Peace River near Harbor Heights (River Kilometer 15.5).
PRH05.sd2	1997-2005	Water Level, and surface and bottom conductivity and temperature at 15-minute intervals from the continuous recording gage on the Peace River near Peace River Heights (River Kilometer 26.7).
Environmental Quality Laboratory Background Data Sets		
SAS Version 6.0.8 Data Sets		
Chall_2.sd2	1976-1990	EQL Charlotte Harbor background water chemistry data.
Hydroall.sd2	1976-1990	EQL Charlotte Harbor hydrolab water column profile data.
SAS Version 6.1.3 Data Sets		
Chem_v12.sd2	1976-1990	EQL Charlotte Harbor background water chemistry data.
Hall_v12.sd2	1976-1990	EQL Charlotte Harbor hydrolab water column profile data.

❖ **Note:** Click on the data set name to review a comprehensive listing of the data set contents.

1.7 Problems Encountered During 2005

Overall, very few data problems occurred during 2005, when compared to some of the difficulties that have occurred during previous years. The following outlines some of the problems and errors encountered during data collection for various elements of the HBMP monitoring program.

- **USGS Continuous Recorders** – Due to short-term instrument failures, a limited number of records for gage height, temperature and/or conductivity are unavailable for the Harbour Heights and Peace River Heights gaging sites during 2005.

- **pH Values –** Due to a problem with the hydrolab pH probe, no values are available for the "moving" isohaline based data from March 2005.

2.0 Peace River Gaged Flows and Regional Water Supply Facility Withdrawals

The purpose of this section is to provide overviews of both 2005 gaged river freshwater inflows to the lower Peace River estuary as well as freshwater withdrawals by Peace River Regional Water Supply Facility (PRF). This section also presents comparisons of the 2005 flow record and facility withdrawal levels with similar long-term information from the historic 1976-2005 period corresponding with HBMP monitoring.

Previously presented **Figures 1.1** and **1.2** depict the location of the Peace River Regional Water Supply Facility in relation to both the lower Peace River watershed and the lower Peace River/upper Charlotte Harbor estuary. As indicated, the point of Peace River Facility withdrawal is located in the tidal portion of the lower river estuarine system, in a reach of the river that is characterized by brackish conditions during periods of low freshwater inflow.

The series of USGS flow monitoring gages used in assessing long-term, yearly and seasonal patterns of freshwater inflows into the lower Peace River and upper Charlotte Harbor are summarized in Table 2.1. Both historic and recent (real time) flow data collected by USGS are obtained from the USGS Web Site (http://fl.water.usgs.gov/Tampa/index.html) and updated into the HBMP data records on a yearly basis. Since such data retrieval for the annual HBMP data reports occur early during each calendar year, all flow data for at least the current year should be considered "provisional" and subject to subsequent revision by USGS before being finalized for the past water year (October through September).

Table 2.1
Primary USGS Gages Used in HBMP Hydrology Analyses

USGS Gage Name	Gage Reference Number	Period Of Record (Complete Years)
Peace River At Arcadia	02296750	1932-2005
Joshua Creek At Nocatee	02297100	1951-2005
Horse Creek Near Arcadia	02297310	1951-2005
Shell Creek Near Punta Gorda	02298202	1966-2005
Myakka River Near Sarasota	02298830	1937-2005

2.1 2005 Gaged Flows to the Lower Peace River

Daily Peace River discharges (in cubic feet per second) at the USGS gaging station at Arcadia, Florida during the reporting period, January through December 2005, are depicted in **Figure 2.1**. Freshwater inflows during 2005 were characterized by a much wetter than normal flows during the winter (January and February), unusually high flows during the typical spring dry-season (especially during March and May), much higher than normal flow through the first part of the summer wet-season (June, July and August), and seasonally very high flows from the end of October through mid November.

Both the magnitude and duration of the high flows observed in the Peace River watershed during the summer wet-season were either directly or indirectly influenced by the succession of hurricanes during 2005 that passed near enough to influence rainfall in the watershed (**Map1**). The season officially began on June 1st, and lasted until the end of November. However, effectively the 2005 hurricane season persisted into January 2006 due to continued storm activity. A record twenty-eight tropical and subtropical storms formed, of which a record fifteen became hurricanes. Of these, seven strengthened into major hurricanes, a record-tying five became Category 4 hurricanes and a record four reached Category 5 strength, the highest categorization for hurricanes on the Saffir-Simpson Scale. Among these Category 5 storms was Hurricane Wilma which briefly was the most intense hurricane ever observed in the Atlantic.

Although the overall hurricane activity during 2005 was much greater than during 2004, the number of storms and the degree to which they directly influenced watershed rainfall/flow patterns was less. During 2004, four hurricanes directly impacted the Peace River watershed (**Map2**). (More detailed descriptions of the influences of the 2004 hurricane season were previously presented in the *HBMP 2004 Annual Data Report*.)

- Hurricane Charlie during the second week of August 2004, entered Charlotte Harbor and the eye generally followed a path northward through the Peace River Watershed
- Hurricane Frances during the first week in September 2004 brought additional extensive rainfall to the Peace River watershed as it moved diagonally across the state on a path from south of Fort Pierce to just north of Tampa before turning northward.
- Although the path of Hurricane Ivan during the second week of September 2004 was well west of Florida's west coast (with landfall in the panhandle) the size of the storm influenced rainfall in the upper Peace River watershed.
- Hurricane Jeanne during the last week in September 2004 followed a very similar path across Florida as Hurricane Frances three weeks earlier bringing additional heavy rainfall throughout the Peace River watershed.

The high flows that characterized most of 2005, like those during the two preceding years 2003-2004, were in marked contrast with the period of severe extended drought that began in 1999 and continued through early 2002.

The seasonal patterns of freshwater inflows during 2005 are further graphically presented in relation to the preceding long-term historical averages (1976-2004) in **Figure 2.2**. Statistical analyses were used to determine long-term average daily "exceedances" of the 10^{th}, 25^{th}, 50^{th} (median), 75^{th} and 90^{th} percentiles for Peace River flow using the daily Arcadia gage record. Thus, the line presented in **Figure 2.2** for Q90 represents a level of freshwater inflow that, over the long-term 1976-2004 average, is only exceeded ten percent of the time on that particular day. This graphic clearly shows that gaged Peace River at Arcadia flows during 2005 were above the corresponding median (Q50) levels almost continually throughout the year (with the exception of the end of the typical summer wet-season during September and October). During the five month period extending from March through July, 2005 flow levels periodically exceeded the statistical Q90, and were thus in the upper ten percent of flows recorded for that date over the preceding long-term 1976-2004 period of HBMP monitoring. Seasonally, very high flows were also observed during 2005 from the end of October through mid-November.

Table 2.2

Freshwater Inflows During 2005 and the Period 1976-2005

Figure	Description
Figure 2.1	Daily Peace River flow at Arcadia (2005)
Figure 2.2	Daily Peace River flow at Arcadia in relation to long-term statistical averages
Figure 2.3	Daily Peace River flow at Arcadia (1976-2005)
Figure 2.4	Monthly mean Peace River flow at Arcadia (1976-2005)
Figure 2.5	3-month moving average Peace River flow at Arcadia (1976-2005)
Figure 2.6	Total daily flow - Peace River + (Horse + Joshua + Shell) Creeks (2005)
Figure 2.7	Total daily flow - Peace River + (Horse + Joshua + Shell) Creeks (1976-2005)
Figure 2.8	Mean monthly flow - Peace River + (Horse + Joshua + Shell) Creeks (1976-2005)
Figure 2.9	3-month moving average flow - Peace River + (Horse + Joshua + Shell) Creeks (1976-2005)
Figure 2.10	Total daily gaged flow – (Peace + Myakka) Rivers + (Horse + Joshua + Shell) Creeks (2005)
Figure 2.11	Total daily gaged flow - (Peace + Myakka) Rivers + (Horse + Joshua + Shell) Creeks (1976-2005)
Figure 2.12	Mean monthly gaged flow - (Peace + Myakka) Rivers + (Horse + Joshua + Shell) Creeks (1976-2005)
Figure 2.13	3-month moving average gaged flow - (Peace + Myakka) Rivers + (Horse + Joshua + Shell) Creeks (1976-2005)

Daily Peace River at Arcadia gage flows between 1976, the beginning of the HBMP and the most recent year (2005) are shown in **Figure 2.3**. This figure clearly shows the magnitude of the extended drought that occurred between 1999 and 2002, and the higher than average flows that immediately followed during 2003, 2004 and 2005. Arcadia gaged flows over the same long-term period are further depicted as mean monthly values in **Figure 2.4** and again based on 3-month moving averages in **Figure 2.5**. Plots similar to those above for total gaged flow entering Charlotte Harbor from the Peace River (Peace River at Arcadia + Horse Creek + Joshua Creek + Shell Creek) are shown in Figures 2.6 through 2.9. Figures 2.10 through 2.13 show comparative plots of daily, mean monthly and 3-month moving average total gaged freshwater inflows to upper Charlotte Harbor by including Myakka River flows (it should be noted that the USGS Myakka River near Sarasota gaging location does not include runoff from a substantial portion of the lower watershed.) Combined, these graphics clearly indicate the seasonal wetter than average conditions that characterized much of 2005, with higher than normal flows occurring during both the typically drier winter and spring months, and again first part of the summer wet-season through the late fall.

Comparison of the data displayed in **Figures 2.2** and **2.3** shows that Peace River average daily flow at Arcadia during 2005 was approximately 202 percent of that calculated over the preceding longer 1976-2004 period. The data displayed in **Figures 2.6** and **2.7** for the sum of average daily flows from the Peace River at Arcadia, Horse Creek, Joshua Creek, and Shell Creek indicate that total freshwater inflows to the lower Peace River estuary during 2005 were roughly 187 percent of the average over the longer preceding time period of HBMP monitoring (1976-2004).

2.2 Peace River Facility Withdrawals

Daily withdrawals from the Peace River (in cubic feet per second) by the Peace River Facility during 2005 are presented in **Figure 2.14**. Two items of note are indicated in this figure. The first being that due to the low flow cutoff of 130 cfs (as measured at the USGS Arcadia gage), there are often extended periods (typically during the spring dry-season) each year when the Peace River Facility does not withdraw water from the river. The second is that, due to the unusually wet conditions and higher than average freshwater flows that occurred during 2005, the Peace River Facility was able to withdraw water from the lower Peace River many more days than during the recent severe 1999-2002 drought.

Daily withdrawals since facility startup are shown from 1980-2005 in **Figure 2.15**. This figure clearly indicates the increases in maximum withdrawals beginning in the later half of 2002 due to the recently completed facility expansion, and the PRMRWSA's increased ability to divert, treat and store larger daily amounts of freshwater.

Plots of the monthly means and 3-month moving averages of withdrawals over this period are depicted in **Figures 2.16** and **2.17.** The effects on water withdrawals from the recent long-term drought, the higher than average flows in 2003, 2004 and 2005, as well as the 2002 facility expansion are clearly evident in **Figure 2.17.** Various relationships between 2005 Arcadia gaged Peace River flows and Peace River Facility withdrawals are further depicted in **Figures 2.18** through **2.21**.

Table 2.3

Facility Withdrawals and Freshwater Inflows During 2005 and the Period 1980-2005

Figure	Description
Figure 2.14	Daily water treatment facility withdrawals (2005)
Figure 2.15	Daily water treatment facility withdrawals (1980-2005)
Figure 2.16	Monthly mean water treatment facility withdrawals (1980-2005)
Figure 2.17	3-month moving average water treatment facility withdrawals (1980-2005)
Figure 2.18	Peace River flows at Arcadia and water treatment facility withdrawals (2005)
Figure 2.19	Total Peace River at Arcadia + (Horse + Joshua + Shell Creek) Flows and water treatment facility withdrawals (2005)
Figure 2.20	Peace River flows at Arcadia vs. water treatment facility withdrawals (2005)
Figure 2.21	Peace River flows at Arcadia vs. % water treatment facility withdrawals (2005)

Facility withdrawals from the river during 2005 reached ten percent of the preceding daily gaged Peace River at Arcadia flow only a small number of days during the year. However, as indicated in **Figure 2.21**, there were a number of times (six) during 2005 when withdrawals exceeded this amount. Historically, the reason for these discrepancies stems from the way that stage/flow data are gathered. The PRMRWSA uses “provisional” preceding day flow data from the water level recorder at the USGS gaging station on the Peace River at Arcadia. Such “provisional” real-time data are obtained directly from the USGS Tampa office’s Web Site a number of times each day by the PRMRWSA. This is accomplished in order to determine an accurate working estimate of the preceding daily Arcadia flow on which to establish the current day’s withdrawal schedule. However, after the fact, the USGS checks and evaluates the data from both the Arcadia gage stage recorder and periodic river cross section measurements collected a number of times each year. Based on such quality assurance checks the USGS may make various revisions to the recent, real-time information before establishing finalized daily flow estimates for the preceding water year. Thus, the daily values used by the PRMRWSA are only “provisional” and can and are often changed as a result of ongoing USGS data quality assurance procedures weeks or even months later. It is therefore not uncommon for subsequent determinations of percent withdrawals, based on the finalized, revised USGS calculations of the initial “provisional” daily flows, to sometimes indicate that daily withdrawals, based on initial real-time flow information, exceeded the District’s permitted maximum ten percent.

2.3 Summary

Annual mean Peace River flows (gaged data only) at Arcadia and the U.S. 41 Bridge are summarized since 1976, the start of the HBMP, in **Table 2.4**. Also included in this table are mean annual Peace River Facility withdrawals (since 1980), and the annual percentages that facility withdrawals have comprised of gaged Peace River flows at measured at Arcadia and the total of all the gages upstream of the U.S. 41 Bridge. Total Peace River Facility withdrawal during 2005 were approximately 1.56 percent of the total gaged freshwater flow measured at the USGS Arcadia gage, and 0.98 percent of the combined average daily flows of the Peace River, and Horse Creek, Joshua Creek, and Shell Creeks. During the entire period of Facility withdrawals 1980-2005, total combined withdrawals have been approximately 1.18 percent of the corresponding gaged Peace River at Arcadia flows and 0.69 percent of the corresponding combined daily flows of the Peace River, and Horse Creek, Joshua Creek, and Shell Creeks.

3.0 In Situ Physical Measurements, Water Chemistry and Phytoplankton Biomass at "Moving" Isohaline Locations

3.1 Introduction

An early objective of the Peace River HBMP was the development of a comprehensive understanding of phytoplankton production and related community structure within the Charlotte Harbor estuarine system. Development of a conceptual understanding of the temporal and spatial relationships between freshwater inflows and phytoplankton production was established as a fundamental goal towards developing an overall understanding of other key interrelated biological communities and physical processes within the estuary, including secondary production and nutrient cycling. Components of the long-term HBMP "isohaline" salinity based monitoring study element were designed in part to develop greater understanding of the interactions of seasonal freshwater inflows and the temporal and spatial responses of phytoplankton production in the lower Peace River/upper Harbor estuarine system. Specific goals of these studies included determining both the immediate and long-term phytoplankton responses to freshwater inputs, including both nutrient loadings (nitrogen) and increased water color (light availability). The HBMP's historic, long-term phytoplankton investigations in the lower Peace River/upper Charlotte Harbor estuarine system provided:

- Measurements of populations and community structure acting as sensitive barometers of changes over both short (daily to weekly) and longer (seasonal) temporal scales.
- Insight into basic spatial/temporal processes affected by water quality and having secondary widespread interrelations and effects upon other estuarine food-web components.

Phytoplankton production generally represents an immediately available food resource, unlike other estuarine production such as that associated with seagrass, mangrove and saltmarsh habitats, where much of the resource becomes available through secondary processes. Of the various inputs into the Charlotte Harbor estuarine system, phytoplankton production represents both the largest single component of primary production and a food source directly accessible to many filter and detrital feeding organisms. Phytoplankton production and community composition, due to the short generation times involved, have also been shown to be effective in demonstrating ephemeral, seasonal and long-term changes in water quality. Phytoplankton production represents a highly integrated estuarine component and can be used to provide information on both direct and predictive secondary impacts of external influences.

3.2 Historical Long-Term Phytoplankton Study Elements

Since its inception in the early 1980s, the HBMP has incorporated a number of long-term monitoring studies designed to answer specific question with regard to spatial and temporal patterns in phytoplankton production, community structure and biomass. The objectives of these

HBMP studies have been to develope sufficient information to evaluate trends and establish a long-term understanding of differences in the harbor's responses to periods of both extended drought as well as unusually high freshwater inflows.

Phytoplankton Primary Production – Statistically comparable levels of phytoplankton ^{14}C fixation rates were measured monthly at each of the four salinity-based isohaline locations between June 1983 and December 1999. In addition to overall estimates of phytoplankton production, carbon uptake rates were determined for three separate size fractions: 1) greater than 20 microns; 2) 5 to 20 microns; and 3) less than 5 microns. The results of this long-term HBMP study clearly showed the quick response of phytoplankton production to brief pulses of relatively nitrogen rich freshwater into the estuary during the early spring. These results further supported the extreme importance to other components of the estuarine food-web of early spring/summer flows to the estuary during the start of the typical summer wet-season.

Phytoplankton Taxonomic Identification – A second element of the HBMP phytoplankton study, conducted monthly between 1989 and 2004, sought to quantify the specific responses of major phytoplankton taxonomic groups to variations in the periodicity of freshwater inflow. The developed monthly phytoplankton taxonomic information included: 1) raw counts of the relative taxonomic structure; 2) percent composition of key major taxonomic groups; and 3) summary species diversity and evenness index estimates. The results of these microscopic phytoplankton surveys generally indicated the relative dominance of the following groups.

- Among samples collected at intermediate and higher salinities, the smallest phytoplankton size fraction (<5 microns) was often observed to be dominated by Cryptophyceae species (*Chroomanas* spp. and *Cryptomonas* spp.). Small Bacillariphyceae (*Thalossiosira* spp., *Nitzschia* spp., *Navicula* spp.) were also often observed to comprise significant portions of the nano-plankton components at these salinities.

- At the very highest salinities, influenced by Gulf waters, chain-forming and larger diatoms frequently dominated the net-plankton size fraction. Seasonally important diatoms at these locations were *Skeletonema costatum*, *Asterionella glacialis*, *Odentella sinensis*, *Corethron criophilum*, *Coscinodiscus centralis*, and *Coscinodiscus eccentricus*, as well as species of Chaetoceros and Rizosolenia. Dinophyceae (*Ceratium* spp. and *Peridinium* spp.) were often seasonally common during the summer months.

- At intermediate salinities, blooms of *Skeletonema costatum* were commonly associated with relative increases in carbon uptake and chlorophyll *a* within the largest size fraction. However, seasonally, dinoflagellates (*Prorocentrum micans*, *P. minimum*, *Gymnodinium* spp. and *Gyrodinium* spp.) were also major components of the largest phytoplankton size fraction. Specifically, at 6 and 12 o/oo salinity at the mouth of the Peace River, during the typical spring phytoplankton increase the larger size fractions were seasonally dominated by blooms of *Gyrodinium splendens*.

- The picoplankton size fraction (< 5 microns) at the lower salinity stations often contained significant numbers of non-flagellated, smooth, circular to ovoid, green cells.

Taxonomically, such cells included Cyanophyceae (*Synechoccus* spp., *Chroococcus* spp., *Anacystis* spp.) as well as Chlorophyceae (*Nannochloris* spp., *Chlorella* spp.). Small phytoflagellates (*Chlamydomonas* spp., *Carteria* spp., *Chroomonas* spp., *Cryptomonas* spp.) were also common components of the picoplankton within the lower salinity areas. The larger size fractions in the riverine portions of the estuary were found to be generally characterized by mixtures of Chlorophyceae (*Ankistrodesmus* spp., *Coelastrum* spp., *Crucigenia* spp., *Pediastrum* spp., *Scenedesmus* spp., *Tetraedron* spp.), Bacillariophyceae (*Cyclotella* spp., *Nitschia* spp., *Navicula* spp., *Fragillaria* spp.), and Cyanophyceae (*Anabaena* spp., *Anacystis* spp.).

Phytoplankton Biomass Estimates – Although direct *in situ* measurements of carbon uptake rates and enumerations of phytoplankton taxonomic structure are no longer being conducted, the HBMP isohaline based monitoring study element continues to collect monthly information of phytoplankton biomass (chlorophyll *a*), in relation to seasonal and flow related variations in physical parameters, water column light profiles, and the major chemical constituents associated with phytoplankton growth. This report presents data collected during the twenty-third year (2005) of this unique long-term study of the relationships between phytoplankton productivity and Peace River flow into upper Charlotte Harbor.

3.3 Overview of “Isohaline” Based Monitoring Methods

The following briefly outlines and summarizes the methodologies used to measure and evaluate the physical, chemical, and biological parameters. Environmental Quality Laboratory, Inc. (EQL) was responsible for all aspects of the HBMP “moving” isohaline based station monitoring between 1983 and July 2000, after which time EarthBalance, Inc. (formerly Florida Environmental) was contracted to conduct the physical water column measurements and collection of water chemistry samples for both the “moving” isohaline and “fixed” HBMP station elements. A number of EarthBalance staff previously worked on the HBMP while with EQL and all previously used field collection procedures have been maintained.

Since the initial inception of the HBMP monitoring program in 1976, all water chemistry analyses had been conducted by the Environmental Quality Laboratory, which was purchased in 2000 by ASCI, Inc. ASCI continued to conduct all HBMP chemical analyses through January 2002. However, due to issues regarding QA/QC and the long-term stability of ASCI, in February 2002 the PRMRWSA changed the chemistry contract to Benchmark EnviroAnalytical, Inc. located in Palmetto, Florida. All laboratory methods previously used by EQL/ASCI have been continued by Benchmark, who conducted all HBMP chemistry analyses during 2005.

The four isohaline based monthly sampling locations in this HBMP study element represent non-fixed surface salinity zones, such that the monthly location of each isohaline is dependent upon both tide stage and the preceding amount of freshwater inflow from the Peace River. Table 3.1 summarizes the historical statistical distribution of these isohaline locations. The four salinity sampling zones are:

- Station 101 = 0 o/oo
- Station 102 = 5-7 o/oo

- Station 103 = 11-13 o/oo
- Station 104 = 20-22 o/oo

Table 3.1

Summary Statistics of the Four Isohaline Locations (Kilometers) from the Peace River’s Mouth for the Period 1983-2005

Isohaline	Minimum	Maximum	Mean	Median
0 o/oo	0.6	37.6	21.3	20.3
6 o/oo	-16.3	27.5	12.2	12.0
12 o/oo	-30.1	24.5	7.1	8.5
20 o/oo	-36.3	18.0	-0.5	2.3

To date, the most upstream occurrence of the 0 o/oo isohaline sampling location has been just over a quarter mile upstream of the point were Horse Creek joins the Peace River (during June 2000). The most downstream occurrence of the 20 o/oo isohaline sampling location has been in the Gulf of Mexico just off Boca Grande (September 1988) (see **Figure 3.1**).

The relative location of each of these four isohalines during 2005 is shown in **Figure 3.2**, while long-term patterns for the period 1983-2005 are presented in **Figures 3.3** and **3.4**. The affects of the extended drought conditions that influenced freshwater flows in the Peace River watershed between 2000 and 2002 are noticeable in the atypical upstream movements and near historic maximum extents of all four isohalines during this extended, unusually dry period following the 1997/1988 El Niño climatic event. Since the end of this most recent drought, the seasonal variability of the relative locations of each of these four measured isohalines have returned to cyclical patterns similar to those previously observed during more normal annual hydrologic conditions.

Table 3.2

Isohaline Locations During 2005 and the Period 1983-2004

Figure	Description
Figure 3.1	Study area with most upstream and downstream locations of salinity sampling zones
Figure 3.2	Relative distance (km) from the mouth of the river (2005)
Figure 3.3	Relative distance from the mouth of the river of 0 and 6 ppt salinity sampling zones (1983-2005)
Figure 3.4	Relative distance from the mouth of the river of 12 and 20 ppt salinity sampling zones (1983-2005)
Figure 3.5	Box & whisker plots of relative distance (km) from the mouth of the river (2005 & 1983-2004)

The box and whisker plots presented in **Figure 3.5** summarize and compare the relative locations of each of the four “moving” isohaline sampling zones during both 2005 and over the preceding 1983-2004 monitoring period. The box indicates the median line (50^{th} percentile) as well as the

25th and 75th percentiles respectively at the bottom and top. Whisker lines then extend from the 25th percentile to the 10th percentile and from the 75th percentile to the 90th percentile. Extreme values (outside the 10th-90th percentiles) are represented by dots at the end of the whiskers. In Figure 3.5, the zero reference line denotes the imaginary mouth of the Peace River as defined in the previous morphometric study. The influence of the higher than average freshwater inflows during 2005 is evident in the seasonal pattern of the locations during 2005 of all four of the HBMP isohalines, in comparison to the long-term 1983-2004 period of HBMP isohaline based monitoring.

3.3.1 *In Situ* Measurements of Physical Parameters

Depth, temperature, dissolved oxygen, conductivity, and pH were measured *in situ* with Hydrolab Surveyor systems. Profiles were made from the surface to the bottom in 0.5m increments at each sampling station location. Depth measurements were determined on the basis of both pre-measured marks on the unit's cable and the unit's depth sensor.

Pre-sampling instrument calibrations were conducted within four hours prior to use. Temperature was measured with a linear resistance thermistor, factory calibrated and accurate to within ±0.2 ^{o}C. Dissolved oxygen (DO) was measured with a temperature-compensated, passive, polarographic cell, which measures the partial pressure of oxygen as parts per million (ppm or mg/l) of oxygen, ±0.2 ppm. The probe was calibrated using the oxygen tension of water-saturated air (temperature corrected) as a standard.

The conductivity probe was calibrated against a KCl solution of known conductivity. Probe response was then tested with a solution of known low and high conductivity to ensure that the reading was within ±1.0 percent of the range selected. The probes are automatically temperature compensated to provide conductivity at 25 ^{o}C.

The Hydrolab pH probes are glass, KCl filled with silver/silver chloride reference electrodes and refillable junctions. They are automatically temperature compensated. Two buffer solutions of 7.0 and 10.0 pH (± 0.1 units) were used to calibrate the accuracy of the probe.

3.2.2 Light Profile

Light intensity profiles were utilized to gather sufficient data to calculate the water column extinction coefficient at each isohaline sampling location. A LI-COR quantum/radiometer/photometer equipped with an underwater quantum sensor was used to measure photo-synthetically active radiation (400-700 nanometers). Light intensities (microeinsteins/m^2/sec) were measured in the air just above the water surface, again just below the surface, and at six selected depths (20, 40, 60, 80, and 100 cm).

3.2.3 Water Chemistry

Surface water samples were collected for analysis at each salinity-based station in pre-labeled, one-liter polyethylene containers. The containers were rinsed with sample water, filled and immediately placed in the dark on ice until returned to the laboratory following standard chain of custody and quality assurance procedures. Specific methods of analyses are listed in **Table 3.3**.

In response to the recommendations contained within the 1998 HBMP Midterm Interpretive Report, the number of water chemistry parameters associated with both the “moving and “fixed” HBMP study elements were decreased from those originally specified in the 1996 monitoring conditions. These changes were made only after extensive consultation with both the HBMP Scientific Review Panel and District Staff. As a result of this coordination, all monitoring during 2005 was conducted using the revised/reduced long-term water quality sampling parameter list implemented starting in March 2003 (**Table 1.2**).

3.4 Physical and Water Chemistry Data Collected in the “Moving” Isohaline Locations

Water quality data collected at the four “moving” isohaline locations in conjunction with the isohaline, salinity based HBMP study element are presented and summarized in the following Tables and Figures. **Tables 3.4** and **3.5** summarize the determinations of key physical, chemical and biological measurements. Seasonal representations of selected parameters are further graphically presented in **Figures 3.6** through **3.13** (see Table 3.6).

Relationships of the 2005 data to those data collected during the preceding twenty-two years of study (1983-2004) are shown for selected physical, chemical and biological measurements in Figures 3.14 through 3.21 (see Table 3.7). Further comparisons of these parameters are presented as box and whisker plots by salinity for both 2005 and long-term data collected between 1983-2004 in Figures 3.22 through 3.29. The box and whisker plots display a detailed distribution of the data, showing the median (50th percentile) at the center of the box and the 25th and 75th percentiles at the bottom and top of the box, respectively. The whiskers are lines that extend from the 25th percentile to the 10th percentile and 75th percentile to the 90th percentile. Extreme values (outside the 10th-90th percentiles) are represented by dots at the ends of the whiskers.

Table 3.6
Summary Tables and Graphics of Key Physical and Chemical Measurements for Data Collected in 2005 at the Four Isohaline Locations

Tables	Description
Table 3.4	Physical and chemical water quality parameters
Table 3.5	Physical and chemical water quality parameters - nutrients
Figures	**Description**
Figure 3.6	Monthly temperature at salinity sampling zones -2005
Figure 3.7	Monthly color at salinity sampling zones -2005
Figure 3.8	Monthly extinction coefficient at salinity sampling zones -2005

Figure 3.9	Monthly nitrite/nitrate at salinity sampling zones -2005
Figure 3.10	Monthly ortho-phosphorus at salinity sampling zones -2005
Figure 3.11	Monthly atomic N/P ratio at salinity sampling zones -2005
Figure 3.12	Monthly silica at salinity sampling zones -2005
Figure 3.13	Monthly chlorophyll *a* at salinity sampling zones -2005

Table 3.7

Summary Graphics of Key Physical and Chemical Measurements for Data Collected During the Period 1983-2005 at the Four Isohaline Locations

Figure	Description
Figure 3.14	Monthly temperature at salinity sampling zones1983-2005
Figure 3.15	Monthly color at salinity sampling zones1983-2005
Figure 3.16	Monthly extinction coefficient at salinity sampling zones1983-2005
Figure 3.17	Monthly nitrite/nitrate at salinity sampling zones1983-2005
Figure 3.18	Monthly ortho-phosphorus at salinity sampling zones1983-2005
Figure 3.19	Monthly atomic nitrogen/phosphorus ratio at salinity sampling zones1983-2005
Figure 3.20	Monthly silica at salinity sampling zones1983-2005
Figure 3.21	Monthly chlorophyll *a* at salinity sampling zones1983-2005
Figure 3.22	Box and whisker plots of temperature at salinity sampling zones (2005) & (1983-2004)
Figure 3.23	Box and whisker plots of color at salinity sampling zones (2005) & (1983-2004)
Figure 3.24	Box and whisker plots of extinction coefficient at salinity sampling zones (2005) & (1983-2004)
Figure 3.25	Box and whisker plots of nitrite/nitrate at salinity sampling zones 2005) & (1983-2004)
Figure 3.26	Box and whisker plots of ortho-phosphorus at salinity sampling zones (2005) & (1983-2004)
Figure 3.27	Box and whisker plots of atomic N/P ratio at salinity sampling zones (2005) & (1983-2004)
Figure 3.28	Box and whisker plots of silica at salinity sampling zones (2004) & (1983-2004)
Figure 3.29	Box and whisker plots of chlorophyll *a* at salinity sampling zones (2005) & (1983-2004)

3.5 Summary

Statistical comparisons between mean 2005 values and long-term 1983-2004 averages for selected parameters are summarized in **Table 3.8.** Overall the data collected during 2005 indicate:

- **Temperature** – Mean water temperatures during 2005 at each of the three higher salinity isohalines were similar to corresponding values measured over the preceding twenty-two year period (1982-2004). The warm water temperatures in the freshwater isohaline during the spring of 2005 were slightly higher those observed at the other three salinity zones, possibly reflecting the increased heating of the more highly colored water. It should be noted, that the water temperatures measured during both January and December 2005 were much warmer than usual in comparison to values measured during the 1983-2004 period.

- **Water Color –** The average color levels throughout the estuary during 2003, 2004 and 2005 were markedly different than those recently observed during the 1999-2002 drought. Color levels in 2005 were well above the long-term averages within each of the four isohalines as a result of the higher than average freshwater inflows during much of 2005. Somewhat surprisingly, the peak very high color levels typically observed during the summer wet-season within the freshwater isohaline was not observed during 2005. This may reflect the higher than usual flows during both the winter and spring of 2005 and that the washout of tannins from uplands and wetlands were distributed over a much longer period, rather than being flushed out simply during the summer period.

- **Extinction Coefficient –** The rates of measured light attenuation at each of the four isohalines reflect both ambient color and phytoplankton biomass (chlorophyll *a*). Comparisons among the mean 2005 extinction values at the four isohalines indicate that even though water color throughout the estuary was higher than average during 2005 due to greater than average freshwater inflows, light extinction coefficients at all four isohalines were below historical annual averages. It is possible that in 2003, 2004 and 2005 higher than average freshwater inflows resulted in higher than average water color, which in turn suppressed normal spring levels of phytoplankton production (chlorophyll *a*), resulting in lower than average measurements of extinction coefficients.

- **Nitrite/Nitrate Nitrogen** - During 2005, the average concentrations of this major inorganic form of nitrogen were lower in the upper freshwater reach of the estuary than the long-term (1983-2004), historical annual average and higher at each of the three higher salinity isohalines. Typically monthly comparisons among the isohalines indicate nitrite/nitrate inorganic nitrogen concentrations in the lower Peace River/upper Charlotte Harbor Estuary are characterized by a distinct spatial gradient. Concentrations typically decrease rapidly with increasing salinity, with inorganic nitrogen levels within the 20 o/oo isohaline often being near method detection limits. Normally, estuarine inorganic nitrogen concentrations usually decline to their lowest levels during the relatively drier, late spring as phytoplankton populations respond to increasing water temperatures and light, and increased primary production remove available inorganic nitrogen. However, the higher than normal freshwater flows during winter and spring of 2005 resulted in differences in the characteristic annual patterns of inorganic nitrogen concentrations in the estuary.

- **Ortho-phosphorus -** Estuarine inorganic phosphorus concentrations in the lower Peace River and upper Charlotte Harbor are heavily influenced by the unusually "very" high natural levels found in the Peace River watershed. As a result, the observed differences in concentrations among the four isohalines simply reflect conservative dilution by Gulf waters. Unlike inorganic nitrogen, seasonal observed changes in phosphorus concentrations in the estuary are for the most part unaffected by biological uptake. Since the late 1970s there has been marked historical declines in inorganic phosphorus levels in the lower Peace River/upper Charlotte Harbor estuarine system due to declines in the combined influences of phosphate mining and processing in the upper reaches of the basin. Inorganic phosphorus concentrations entering the estuary system from the Peace River watershed are typically lower during wetter periods, when a higher proportion of flow results from surface flow (rather than coming from groundwater, which is naturally richer in phosphorus). Average inorganic phosphorus concentrations during 2005 were higher than the long-term averages (1983-2004) at each of the four isohalines. Such higher than average phosphorus levels in these salinity zones reflects the overall results of higher than average freshwater inflows, which was also reflected in higher color and nitrogen levels in these areas of the estuary.

- **Nitrogen to Phosphorus Atomic Ratios –** Calculated atomic inorganic nitrogen to phosphorus ratios for ambient measured concentrations in 2005, as indicated by the long-term averages, show nitrogen to always be the limiting macronutrient at each of the four isohalines.

- **Silica –** Although the observed seasonal peaks of dissolved reactive silica in the lower Peace River/upper Charlotte Harbor estuarine system during 2005 were below those observed in 2003 and 2004, overall concentrations reflected a continuation of the previously noted increasing pattern of higher values at all four isohalines. This increasing pattern was slightly interrupted by the extended drought during 2000-2002, but seems to have accelerated starting late in 2002. Comparisons of long-term (1983-2004) annual average silica concentrations indicated that levels during 2005 were notably higher than the long-term historic levels within all four salinity zones.

- **Chlorophyll *a* –** The seasonal patterns of freshwater inflows to the estuary during 2005 reflect both much wetter than average conditions during the typically dry early late winter/spring and wetter than average conditions both during the early and late summer wet-season. The resulting seasonal flow patterns combined to produce both higher than average inputs of inorganic nutrients, as well as higher than average levels of water color (resulting in greater light attenuation). Overall, phytoplankton production (chlorophyll *a*) levels in the lower Peace River/upper Charlotte estuary were above the long-term (1983-2004) averages within each of the four salinity zones. As in previous years, phytoplankton blooms were more common within the intermediate (6 and 12 o/oo) isohalines. Somewhat surprisingly, the highest chlorophyll level ever recorded by any of the HBMP monitoring programs occurred during October 2005 at the 12 o/oo isohaline. The actual recorded value was based on a calculation using a very high dilution and therefore represents only a relative estimate. However, this isolated unusual estimated level was nearly double the previous highest measurement. During previous years, taxonomic counts indicated that such "bloom" events within these intermediate salinity zones were typically characterized by high numbers of dinoflagellates (Dinophyceae) or diatoms (Bacillariophycae).

4.0 Water Chemistry Data Collected at "Fixed" Station Locations

4.1 Introduction

A number of the HBMP elements prior to 1996 had included collections of water quality data. The majority of these data, however, were limited to *in situ* physical measurements of water column characteristics. Such *in situ* water column profile data were collected during:

1. The monthly HBMP night trawl fish study conducted between 1976-1986.

2. The sea star and benthic invertebrate studies carried out between 1976 and 1984.

3. The long-term monthly fixed station study of water column characteristics undertaken between 1976 and 1986 at numerous fixed sites in the lower Peace River and upper Charlotte Harbor.

In addition, as discussed in **Section 3.0**, both water column profiles and surface water chemistry samples have been collected monthly since 1983 at four "moving" isohaline locations in conjunction with the ongoing HBMP study of phytoplankton estuarine production.

Under the 1996 WUP permit renewal, the monitoring program was expanded to include water chemistry data collections at five fixed sampling locations from near the mouth of the river to upstream of the Peace River Facility. In addition, *in situ* physical water column profile sampling only was initiated at ten additional "fixed" sampling locations beyond the five "fixed" water chemistry sampling locations. These new HBMP water sampling and *in situ* water column investigations were initiated using sampling sites formerly utilized (1975-1990) by General Development Corporation's Environmental Quality Laboratory (EQL) for similar long-term lower Peace River background monitoring. Beginning in 1998, an additional fixed monthly sampling site was added to correspond to the location of the third tide gage that was installed in 1997 at River Kilometer 26.7. The relative locations of these fixed sampling locations are shown in **Figure 4.1**, while **Table 4.1** provides currently used river kilometers as well as previously used EQL station numbers and USGS river mile designations.

Long-term water chemistry data were gathered by EQL between the inception of the HBMP monitoring program in 1976 and 1990 at each of the five water quality monitoring locations in conjunction with General Development Corporation's background monitoring program of the lower Peace River and Charlotte Harbor. Between 1990 and 1996, the District collected some monthly data at two of these locations (River Kilometers -2.4 and 6.6) as part of its Charlotte Harbor SWIM monitoring program, and Charlotte County also collected monthly data at these same two sites as background for the South Gulf Cove and Manchester Waterway Permit monitoring programs. As part of the 1996 expanded HBMP monitoring program, the PRMRWSA contracted the USGS to collect both the *in situ* hydrolab profile and water chemistry information at the "fixed" HBMP monitoring locations. In July 2000, EarthBalance, Inc. (formerly Florida Environmental) became responsible for all of the water chemistry and biological HBMP fieldwork. This has included the taking of physical water column measurements and the collection of water chemistry samples for both the "moving" isohaline and "fixed" HBMP station elements. ASCI (formerly EQL) conducted both the "fixed" and "moving" HBMP chemical analyses through January 2002. However, due to concerns regarding QA/QC issues and the long-term stability of ASCI, in February 2002 the PRMRWSA changed to Benchmark EnviroAnalytical, Inc. located in Palmetto, Florida. Benchmark conducted all the chemistry samples collected during 2005. All laboratory methods previously used by EQL/ASCI have been continued by Benchmark.

4.2 Description of Fixed Station Data Collection

The following description provides an overview and summary of the procedures and methods used during the "fixed" station elements of the HBMP.

The "fixed" station water quality monitoring project consists of two categories of data collection.

1. Monthly physical water column *in situ* water quality measurements at 16 "fixed" sampling sites. *In situ* field measurements made at all sixteen physical water column profile sites include depth, pH, temperature, dissolved oxygen, and specific conductance. Field measurements are made at 0.5 m intervals, beginning at the surface and ending near the bottom.

2. Monthly sub-surface and near-bottom chemical water quality samples are collected at five locations, spaced between the river's mouth and just upstream of the facility along the established river kilometer centerline transect.

Near-surface and near-bottom samples collected at the five monthly water quality monitoring sites were analyzed between 1996 and 2003 for color, turbidity, alkalinity, total nutrients (ammonia nitrogen, ammonia plus organic nitrogen, nitrate plus nitrite nitrogen, nitrite nitrogen, ortho-phosphorus, phosphorus), total organic carbon, total inorganic carbon, dissolved organic carbon, dissolved silica, dissolved chloride, total suspended solids, volatile suspended solids, salinity (estimated from specific conductance), and chlorophyll *a*.

In response to the recommendations contained within the 1998 HBMP Midterm Interpretive Report, the number of water chemistry parameters associated with both the "moving and "fixed" HBMP study elements were decreased from those originally specified in the 1996 monitoring conditions. These changes were made only after extensive consultation with both the HBMP Scientific Review Panel and District staff. As a result of this coordination, the revised/reduced long-term water quality sampling parameter list was implemented starting in March 2003 (**Table 1.2**).

In situ field measurements made in conjunction with sampling at these water quality sites continue to include depth, pH, temperature, dissolved oxygen, specific conductance, and light characteristics.

4.3 Data Collection and Analyses

A detailed compilation of all procedures and protocols used during all elements of the HBMP has been compiled in the "Project and Quality Control Plan" submitted to the District in August 2002. All *in situ* physical water quality procedures and methods used in the "fixed" station HBMP monitoring during 2005 were analogous to previously described methods in **Section 3.0** for the "moving" isohaline study elements, with the added use of a Kemmerer to collect near-bottom water samples at each of the five water quality sampling locations.

4.4 Results and Conclusions

4.4.1 Physical Water Column Characteristics (2005)

The results for the period January through December 2005 of the *in situ* hydrolab water column profiles at the sixteen fixed stations are contained in the appropriate summary data sets summarized in **Table 1.3** (see **Section 1**). These monthly data are presented graphically in Figure 4.2 through Figure 4.6 (see Table 4.2).

Table 4.2

Summary Graphics of Mean Monthly Physical Water Column *In Situ* Water Quality Measurements at the Fixed Sampling Locations During 2005

Figure	Description
Figure 4.2a	Mean monthly temperature at river kilometers –2.4, 6.6, 8.4 and 10.5
Figure 4.2b	Mean monthly temperature at river kilometers 12.7, 12.8, 15.5 and 17.5
Figure 4.2c	Mean monthly temperature at river kilometers 20.1, 21.9, 23.6 and 24.7
Figure 4.2d	Mean monthly temperature at river kilometers 25.9, 29.5, 30.4 and 32.3
Figure 4.3a	Mean monthly dissolved oxygen at river kilometers –2.4, 6.6, 8.4 and 10.5
Figure 4.3b	Mean monthly dissolved oxygen at river kilometers 12.7, 12.8, 15.5 and 17.5
Figure 4.3c	Mean monthly dissolved oxygen at river kilometers 20.1, 21.9, 23.6 and 24.7
Figure 4.3d	Mean monthly dissolved oxygen at river kilometers 25.9, 29.5, 30.4 and 32.3
Figure 4.4a	Mean monthly pH at river kilometers –2.4, 6.6, 8.4 and 10.5
Figure 4.4b	Mean monthly pH at river kilometers 12.7, 12.8, 15.5 and 17.5
Figure 4.4c	Mean monthly pH at river kilometers 20.1, 21.9, 23.6 and 24.7
Figure 4.4d	Mean monthly pH at river kilometers 25.9, 29.5, 30.4 and 32.3
Figure 4.5a	Monthly 1% Light depth at river kilometers –2.4, 6.6, 8.4 and 10.5
Figure 4.5b	Monthly 1% Light depth at river kilometers 12.7, 12.8, 15.5 and 17.5
Figure 4.5c	Monthly 1% Light depth at river kilometers 20.1, 21.9, 23.6 and 24.7

Table 4.2

Summary Graphics of Mean Monthly Physical Water Column *In Situ* Water Quality Measurements at the Fixed Sampling Locations During 2005

Figure	Description
Figure 4.5d	Monthly 1% Light depth at river kilometers 25.9, 29.5, 30.4 and 32.3
Figure 4.6a	Mean monthly specific conductance at river kilometers –2.4, 6.6, 8.4 and 10.5
Figure 4.6b	Mean monthly specific conductance at river kilometers 12.7, 12.8, 15.5 and 17.5
Figure 4.6c	Mean monthly specific conductance at river kilometers 20.1, 21.9, 23.6 and 24.7
Figure 4.6d	Mean monthly specific conductance at river kilometers 25.9, 29.5, 30.4 and 32.3

The following patterns and observations with regards to seasonal differences among the sixteen "fixed" sampling sites are shown and supported by these Figures.

- Previous results have indicated that within the downstream reaches of the river between River Kilometers -2.4 and 10.5, there is typically a wet-season depression of average water column dissolved oxygen levels in response to increased wet-season flows. This seasonal pattern typifies the widely documented hypoxic/anoxic conditions that typically result in upper Charlotte Harbor as a result of the extreme water column stratification that commonly occurs near the mouth of the river and upper regions of the harbor during the summer. This typical observed seasonal depression of average water column dissolved oxygen concentrations in this reach of the lower river is generally more intense and of greater duration than that observed at the more upstream monitoring sites. During 2005 average water column dissolved oxygen levels generally declined during May and reached their lowest levels during June (coincident with the highest flows of the year) throughout the lower river and upper harbor as water temperatures and flows increased. The 2005 HBMP water column profile data did not indicate any residual, lingering influences from the historically massive, wide spread depression of dissolved oxygen levels that occurred throughout the entire water column in the Charlotte Harbor estuary following Hurricane Charlie in August 2004.

- The 2005 HBMP data indicate that both the timing and magnitude of the ability of light to penetrate into the water column (1 percent depth) exhibit seasonal differences among the "fixed" monitoring sites along the HBMP lower Peace River/upper Charlotte Harbor sampling transect. In the estuarine systems, the extinction of light is often highly influenced by ambient chlorophyll concentrations (phytoplankton biomass). However, due to the "black water" characteristics of the freshwater flowing into the harbor, light extinction in the lower Peace River/upper Charlotte Harbor estuarine system is primarily mediated by water color. Figures 4a-4d indicate that water clarity was the greatest in the upper harbor during 2005 low flows periods (see **Figure 2.1**) during the winter (February) and the unusually dry later part of the summer (September). The influences of the relatively high flows during both March and April 2005 resulted in high color inputs and depressed light depths through the lower river/upper harbor estuarine system during the usually spring dry-season.

- Figures 4.6a through 4.6d clearly show the influences of the wetter than average conditions and resulting high river flows during 2005 on the temporal and spatial patterns of conductivity (salinity) throughout the lower Peace River/upper Charlotte Harbor estuarine system. These comparisons are particularly dramatic when contrasted with those previously reported during the extended long-term drought that affected southwest Florida and the Peace River basin during much of the 1999-2002 period. During the drought, very high conductivities were observed even at the most upstream sampling locations each spring. In comparison, the 2005 conductivity data clearly indicate the extent and duration of low conductivity conditions both in the river and upper harbor during both the early spring (February-March) and the wetter than average start of the 2005 summer wet-season. As occurred during 2004, , high conductivity harbor waters were not observed much upstream of approximately River Kilometer twenty-six throughout the entire year.

4.4.2 Chemical Water Quality Characteristics (2005)

The 2005 water chemistry data for the five "fixed" water quality stations are contained in the appropriate summary data sets summarized in **Table 1.3** (see **Section 1**). Comparisons of surface and bottom samples for selected parameters are graphically summarized in Figure 4.7 through Figure 4.15 (see Table 4.3).

Table 4.3

Summary Graphics of Chemical Water Quality Measurements for Monthly Data Collected During 2005 at the Fixed Sampling Locations (River Kilometers –2.4, 6.6, 15.5, 23.6 and 30.4)

Figure	Description
Figure 4.7a	Monthly surface color at fixed sampling stations (2005)
Figure 4.7b	Monthly bottom color at fixed sampling stations (2005)
Figure 4.8a	Monthly surface total suspended solids at fixed sampling stations (2005)
Figure 4.8b	Monthly bottom total suspended solids at fixed sampling stations (2005)
Figure 4.9a	Monthly surface nitrite/nitrate at fixed sampling stations (2005)
Figure 4.9b	Monthly bottom nitrite/nitrate at fixed sampling stations (2005)
Figure 4.10a	Monthly surface total Kjeldahl Nitrogen at fixed sampling stations (2005)
Figure 4.10b	Near bottom total Kjeldahl Nitrogen at fixed sampling stations (2005)
Figure 4.11a	Monthly surface ortho-phosphorus at fixed sampling stations (2005)
Figure 4.11b	Monthly bottom ortho-phosphorus at fixed sampling stations (2005)
Figure 4.12a	Monthly surface silica at fixed sampling stations (2005)
Figure 4.12b	Monthly bottom silica at fixed sampling stations (2005)

Table 4.3

Summary Graphics of Chemical Water Quality Measurements for Monthly Data Collected During 2005 at the Fixed Sampling Locations (River Kilometers –2.4, 6.6, 15.5, 23.6 and 30.4)

Figure	Description
Figure 4.13a	Monthly surface chlorophyll *a* at fixed sampling stations (2005)
Figure 4.13b	Monthly bottom chlorophyll *a* at fixed sampling stations (2005)

These graphics indicate that, for a number of water quality constituents, there were strong spatial and temporal seasonal differences within the areas of the lower Peace River/upper Charlotte Harbor Estuary represented by the five “fixed” water quality monitoring locations. In addition, further differences are also apparent both within and among sampling locations between sub-surface and near-bottom samples. Water color, for example, is clearly seasonally higher further upstream, while late summer water color levels near the river’s mouth are often higher at the surface than near the bottom. During 2005 these differences between surface and bottom values were often not as apparent as during previous years, since the water column was often well mixed due to the periods of very high flows, and the strong winds associated with the unusually active summer hurricane season.

A number of other measured water quality parameters indicated strong seasonal relationships related to annual patterns of increasing and decreasing flow, while other seasonal patterns and spatial relationships for these water quality characteristics reflect far more complex relationships.

- The highest levels of total suspended solids near the surface of the water column often occurred during the spring and fall near the mouth of the river. These seasonal patterns probably reflect both temporal and spatial plankton production patterns in the upper estuary. Correspondingly, lowest levels occurred at all sites during the summer wet-season, while the very highest measured levels were observed near the bottom of the water column during the winter and spring.

- In the Charlotte Harbor estuarine system inorganic nitrite + nitrate nitrogen concentrations are typically the lowest during the peak of the spring dry-season, when high light and water temperatures resulted in increased phytoplankton production and freshwater inflows are low. The data indicated that there is often a distinct spatial gradient in inorganic nitrogen with higher levels progressively occurring upstream.

- Typically, total Kjeldahl nitrogen concentrations in the estuary are generally the highest during the summer wet-season, reflecting the influences of increased freshwater inflows. However, this general pattern was disrupted during 2005 by the periods of high freshwater inflows during both March-April and November.

- As previously discussed (see **Section 3**), phosphorus concentrations in the Peace River estuary follow patterns typical of conservative water quality constituents. Estuarine inorganic phosphorus concentrations are primarily influenced by the dilution as high ambient levels in Peace River freshwater are diluted by saline Gulf water moving up the harbor. Thus the HBMP monitoring data typically indicates distinct spatial patterns in inorganic phosphorus concentrations among the sampling sites, with concentrations being markedly higher upstream than downstream. Following Hurricane Charlie in August 2004 (and the three subsequent storms in September), the data indicated that there were atypical marked increases in inorganic phosphorus levels associated with high levels of flow from the Peace River watershed. During 2005, inorganic phosphorus patterns in the lower river/upper harbor estuarine system returned to more typical seasonal patterns.

- Reactive silica concentrations in the Peace River estuary typically suggest a number of differing temporal and spatial patterns. Typically, during the spring dry-season silica levels are depressed in the river corresponding with periods of increased chlorophyll *a* biomass (potentially reflecting uptake by diatoms in the phytoplankton). Then usually during May and June, as water temperatures increase and the start of the summer wet-season begins, concentrations often rapidly increased throughout the estuary. However, the seasonal patterns in silica concentrations observed during 2005 reflect the unusually high freshwater flows during both March and April. At the most upstream sampling locations, reactive silica concentrations continued to reflect the recently observed pattern of increasing levels noted in previous HBMP reports. Overall levels were however somewhat below the historically high levels observed during 2004 .

- Chlorophyll *a* phytoplankton biomass patterns showed a number of seasonal peaks throughout the year that differed both seasonally and among sampling locations. As in previous years, the 2005 HBMP chlorophyll phytoplankton biomass data showed distinct increases both during the spring and fall. The common occurrence of such spring and fall phytoplankton increases has also been noted throughout the HBMP isohaline-based monitoring program (see **Section 3.0**). However, the unusually high flows during March, April and November, combined with the very low typical summer-wet season flows in September during 2005 resulted in some atypical shifts in the temporal patterns of phytoplankton increases (blooms) within the estuary. In September at River Kilometer 15.5 the calculated dramatic spike in chlorophyll *a* was considerably more than double the previous highest recorded value for any of the fixed station data since 1976. This very unusual high peak followed very high flows during the early summer wet-season, and coincided with relatively low flows during September. This very unusual phytoplankton "bloom" obviously continued for several weeks in this reach of the lower river, since samples taken just downstream of this site during early October as part of the isohaline based monitoring also were found to have historically high chlorophyll levels. The combined results from the two HBMP water quality monitoring study elements strongly suggest that this very unusual, spatially limited very high phytoplankton biomass event continued within this area of the river for a number of weeks.

4.4.3 Long-Term Physical and Chemical Water Quality Characteristics (1976-2005)

During the period 1975-1990, the Environmental Quality Laboratory (EQL) conducted an extensive, long-term monitoring program within the Charlotte Harbor estuarine system, independent of the requirements of the HBMP. These data included chemical water quality analyses of monthly surface and bottom samples, at the same locations, for many of the same parameters that were added to the HBMP permit requirements during 1996. Figures 4.16 through 4.35 (see Table 4.4) graphically compare the data, for a selected number of surface and bottom measurements, gathered during the period 1976-1990 with those subsequently measured as part of the current HBMP effort during 1996-2005.

Table 4.4

Selected Long-Term Physical and Chemical Water Quality Data Collected Monthly Monthly During the Periods 1976-1990 and 1996-2005 at the Fixed Sampling Locations (River Kilometers –2.4, 6.6, 15.5, 23.6 and 30.4)

Figure	Description
Figure 4.14a	Monthly long-term surface salinity River Kilometer –2.4
Figure 4.14b	Monthly long-term surface salinity River Kilometer 6.6
Figure 4.14c	Monthly long-term surface salinity River Kilometer 15.5
Figure 4.14d	Monthly long-term surface salinity River Kilometer 23.6
Figure 4.14e	Monthly long-term surface salinity River Kilometer 30.4
Figure 4.15a	Monthly long-term bottom salinity River Kilometer –2.4
Figure 4.15b	Monthly long-term bottom salinity River Kilometer 6.6
Figure 4.15c	Monthly long-term bottom salinity River Kilometer 15.5
Figure 4.15d	Monthly long-term bottom salinity River Kilometer 23.6
Figure 4.15e	Monthly long-term bottom salinity River Kilometer 30.4
Figure 4.16a	Monthly long-term surface dissolved oxygen levels River Kilometer –2.4
Figure 4.16b	Monthly long-term surface dissolved oxygen levels River Kilometer 6.6
Figure 4.16c	Monthly long-term surface dissolved oxygen levels River Kilometer 15.5
Figure 4.16d	Monthly long-term surface dissolved oxygen levels River Kilometer 23.6
Figure 4.16e	Monthly long-term surface dissolved oxygen levels River Kilometer 30.4
Figure 4.17a	Monthly long-term bottom dissolved oxygen levels River Kilometer –2.4
Figure 4.17b	Monthly long-term bottom dissolved oxygen levels River Kilometer 6.6
Figure 4.17c	Monthly long-term bottom dissolved oxygen levels River Kilometer 15.5
Figure 4.17d	Monthly long-term bottom dissolved oxygen levels River Kilometer 23.6
Figure 4.17e	Monthly long-term bottom dissolved oxygen levels River Kilometer 30.4
Figure 4.18a	Monthly long-term surface water color River Kilometer –2.4
Figure 4.18b	Monthly long-term surface water color River Kilometer 6.6

Table 4.4

Selected Long-Term Physical and Chemical Water Quality Data Collected Monthly Monthly During the Periods 1976-1990 and 1996-2005 at the Fixed Sampling Locations (River Kilometers –2.4, 6.6, 15.5, 23.6 and 30.4)

Figure	Description
Figure 4.18c	Monthly long-term surface water color River Kilometer 15.5
Figure 4.18d	Monthly long-term surface water color River Kilometer 23.6
Figure 4.18e	Monthly long-term surface water color River Kilometer 30.4
Figure 4.19a	Monthly long-term bottom water color River Kilometer –2.4
Figure 4.19b	Monthly long-term bottom water color River Kilometer 6.6
Figure 4.19c	Monthly long-term bottom water color River Kilometer 15.5
Figure 4.19d	Monthly long-term bottom water color River Kilometer 23.6
Figure 4.19e	Monthly long-term bottom water color River Kilometer 30.4
Figure 4.20a	Monthly long-term surface nitrite/nitrate nitrogen River Kilometer –2.4
Figure 4.20b	surface nitrite/nitrate nitrogen River Kilometer 6.6
Figure 4.20c	Monthly long-term surface nitrite/nitrate nitrogen River Kilometer 15.5
Figure 4.20d	Monthly long-term surface nitrite/nitrate nitrogen River Kilometer 23.6
Figure 4.20e	Monthly long-term surface nitrite/nitrate nitrogen River Kilometer 30.4
Figure 4.21a	Monthly long-term bottom nitrite/nitrate nitrogen River Kilometer –2.4
Figure 4.21b	Monthly long-term bottom nitrite/nitrate nitrogen River Kilometer 6.6
Figure 4.21c	Monthly long-term bottom nitrite/nitrate nitrogen River Kilometer 15.5
Figure 4.21d	Monthly long-term bottom nitrite/nitrate nitrogen River Kilometer 23.6
Figure 4.21e	Monthly long-term bottom nitrite/nitrate nitrogen River Kilometer 30.4
Figure 4.22a	Monthly long-term surface total Kjeldahl Nitrogen River Kilometer –2.4
Figure 4.22b	Monthly long-term surface total Kjeldahl Nitrogen River Kilometer 6.6
Figure 4.22c	Monthly long-term surface total Kjeldahl Nitrogen River Kilometer 15.5
Figure 4.22d	Monthly long-term surface total Kjeldahl Nitrogen River Kilometer 23.6
Figure 4.22e	Monthly long-term surface total Kjeldahl Nitrogen River Kilometer 30.4
Figure 4.23a	Monthly long-term bottom total Kjeldahl Nitrogen River Kilometer –2.4
Figure 4.23b	Monthly long-term bottom total Kjeldahl Nitrogen River Kilometer 6.6
Figure 4.23c	Monthly long-term bottom total Kjeldahl Nitrogen River Kilometer 15.5
Figure 4.23d	Monthly long-term bottom total Kjeldahl Nitrogen River Kilometer 23.6
Figure 4.23e	Monthly long-term bottom total Kjeldahl Nitrogen River Kilometer 30.4
Figure 4.24a	Monthly long-term surface ortho-phosphorus River Kilometer –2.4
Figure 4.24b	Monthly long-term surface ortho-phosphorus River Kilometer 6.6

Table 4.4

Selected Long-Term Physical and Chemical Water Quality Data Collected Monthly Monthly During the Periods 1976-1990 and 1996-2005 at the Fixed Sampling Locations (River Kilometers –2.4, 6.6, 15.5, 23.6 and 30.4)

Figure	Description
Figure 4.24c	Monthly long-term surface ortho-phosphorus River Kilometer 15.5
Figure 4.24d	Monthly long-term surface ortho-phosphorus River Kilometer 23.6
Figure 4.24e	Monthly long-term surface ortho-phosphorus River Kilometer 30.4
Figure 4.25a	Monthly long-term bottom ortho-phosphorus River Kilometer –2.4
Figure 4.25b	Monthly long-term bottom ortho-phosphorus River Kilometer 6.6
Figure 4.25c	Monthly long-term bottom ortho-phosphorus River Kilometer 15.5
Figure 4.25d	Monthly long-term bottom ortho-phosphorus River Kilometer 23.6
Figure 4.25e	Monthly long-term bottom ortho-phosphorus River Kilometer 30.4
Figure 4.26a	Monthly long-term surface silica River Kilometer –2.4
Figure 4.26b	Monthly long-term surface silica River Kilometer 6.6
Figure 4.26c	Monthly long-term surface silica River Kilometer 15.5
Figure 4.26d	Monthly long-term surface silica River Kilometer 23.6
Figure 4.26e	Monthly long-term surface silica River Kilometer 30.4
Figure 4.27a	Monthly long-term bottom silica River Kilometer –2.4
Figure 4.27b	Monthly long-term bottom silica River Kilometer 6.6
Figure 4.27c	Monthly long-term bottom silica River Kilometer 15.5
Figure 4.27d	Monthly long-term bottom silica River Kilometer 23.6
Figure 4.27e	Monthly long-term bottom silica River Kilometer 30.4
Figure 4.28a	Monthly long-term surface chlorophyll *a* River Kilometer –2.4
Figure 4.28b	Monthly long-term surface chlorophyll *a* River Kilometer 6.6
Figure 4.28c	Monthly long-term surface chlorophyll *a* River Kilometer 15.5
Figure 4.28d	Monthly long-term surface chlorophyll *a* River Kilometer 23.6
Figure 4.28e	Monthly long-term surface chlorophyll *a* River Kilometer 30.4
Figure 4.29a	Monthly long-term bottom chlorophyll *a* River Kilometer -2.4 **
Figure 4.29b	Monthly long-term bottom chlorophyll *a* River Kilometer 6.6 **
Figure 4.29c	Monthly long-term bottom chlorophyll *a* River Kilometer 15.5 **
Figure 4.29d	Monthly long-term bottom chlorophyll *a* River Kilometer 23.6 **
Figure 4.29e	Monthly long-term bottom chlorophyll *a* River Kilometer 30.4 **

- ❖ Note: EQL samples not analyzed for chlorophyll *a* are indicated as "Zero"
- ❖ Plot scales may not include unusually high "outlier" data points

These presented graphical analyzes indicate a number of interesting patterns.

- Record high surface and bottom salinities occurred at each of the five HBMP "fixed" water quality monitoring locations during the recent extended drought that began in 1999 and extended through the first half of 2002. In both 2003, 2004 and 2005, by comparison, near record low salinity levels were observed both near the surface and bottom of the water column, at the more downstream sampling sites.

- Salinities at the two most upstream sampling sites (River Kilometers 23.6 and 30.4) were generally higher during the recent 1999-2002 drought than during the similar extended drought that occurred in 1984 and 1985 following the 1983 El Niño.

- Near-bottom dissolved oxygen concentrations show clear seasonal cycles in response to summer wet-season freshwater inflows. Both the duration and magnitude of these periods of depressed dissolved oxygen concentrations increase towards the river's mouth. The highly unusual period of hypoxic/anoxic conditions that immediately followed Hurricane Charlie in August 2004 are evident from both the subsurface and near bottom measurements taken throughout the lower river and upper harbor.

- Temporally, water color levels increase very quickly in response to changes in freshwater inflow. As expected, levels are spatially much higher upstream than near the mouth of the river, although very high color can reach well into the harbor during periods of high freshwater inflow such as occurred during much of 2005.

- Both inorganic nitrite + nitrate and total Kjeldahl nitrogen concentrations indicate very similar seasonal patterns and levels of annual variation over the entire thirty year monitoring period. As expected, spatially inorganic nitrogen concentrations markedly increase moving upstream. Peaks in total Kjeldahl nitrogen levels at the upstream sampling locations were clearly evident following Hurricane Charlie in 2004.

- Most of the previously reported apparent marked declines in inorganic phosphorus concentrations that have occurred in the lower Peace River/upper Charlotte Harbor estuary took place prior to 1985. Since that time inorganic phosphorus concentrations have shown fairly consistent seasonal patterns over a comparably narrow range of variation (excluding a few periodic data points). However, since the end of the 1999-2002 drought the data indicate that phosphorus levels in the Peace River estuarine system have increased to levels not seen for over twenty years, with the sharpest rise following Hurricane Charlie.

- Plots of the long-term data clearly show that reactive silica concentrations have both increased and exhibit a much wider range of variation during the recent monitoring period when compared to data collected during the 1976-1990 period. Silica levels are much higher at the upstream sampling sites, and show a strong seasonal pattern.

- The long-term data show that high chlorophyll *a* concentrations or "blooms" commonly occurred during the late 70s and early 80s throughout the lower Peace River/upper

Charlotte Harbor estuarine system. During the drier period of the later 80s and early 90s the frequency of such events seemed to decline. However, as flows have increased again in recent years so has the occurrence of periodic spikes in phytoplankton biomass.

Table 4.5 presents statistical summaries of mean near-surface values at each of the five "fixed" sampling locations during 2005, in comparison to previous data gathered during the six-year period 1996-2004.

5.0 USGS Continuous Recorders

5.1 Overview

In August 1996, the U.S. Geological Survey (USGS) began a cooperative water quality data collection program with the PRMRWSA. As the initial part of this program, the USGS commenced continuous (15-minute intervals) monitoring at two locations.

- The first USGS gaging site consisted of monitoring water level, surface and bottom specific conductance and temperature at the end of an exiting private dock at Harbour Heights on the Peace River. The USGS designated this site as 02297460, and it is located at River Kilometer 15.5.

- Historically, USGS also measured just water levels at a site adjacent to Boca Grande. The USGS designated this site 2293332, and it was located approximately near River Kilometer –31.8. Tide stage data were collected at this location between 1996 and 2004. The original purpose of this gage was to assess potential gradual increases in sea level expected to occur over time in order to account for natural increases in salinity that might be occurring in the lower Peace River estuary. However, USGS staff felt that any conclusions regarding sea level rises at this site would be compromised due to the gages location near the mouth of the pass. As a result, the PRMRWSA (after consultation with the Scientific Review Panel) decided to delete continued collection of water level information at this site at the end of 2004.

In November 1997, at the request of the PRMRWSA, the USGS added a third gaging and conductance monitoring location (see **Figure 5.a**). This site is designated by USGS as 02297350 and it is located at a private dock near Peace River Heights. This upstream monitoring site is located at River Kilometer 26.7 and 15-minute interval information includes measurements of water level, surface and bottom specific conductance, and corresponding measurements of temperature.

5.2 Field Activities at Continuous Recorder Sites

Water level is measured at the two remaining continuous recording sites (stations 02297460 and 02297350) utilizing a float sensor in a PVC stilling well (Rantz and others, 1982). Data is recorded at 15-minute intervals using a Campbell Scientific CR-10 electronic data logger. Near-surface and near-bottom specific conductance and temperature are measured using USGS combination temperature and specific conductance probes. Readings are averaged over a two-minute interval and are recorded at 15-minute intervals.

Near-surface sensors are suspended one-foot below the surface using a float in a stilling well. The near-bottom sensors are suspended about one-foot from the bottom in the same stilling well as the near-surface sensor.

Data are retrieved at approximately monthly intervals or more often as needed. Once data are retrieved, the calibration stability of the specific conductance and temperature sensors is checked using a field thermometer and specific conductance standards with values that bracket the range of expected values in the Peace River. The sensors are cleaned, inspected, and rechecked with the thermometer and specific conductance standards. If needed, the sensor readings are adjusted to the standard values. The sensors are considered calibrated if the temperature is within 0.5 °C and the specific conductance is within 5 percent of the standard values. Calibrations are recorded on calibration forms and these records are maintained by the USGS in Tampa, Florida.

5.3 Results from USGS Continuous Recorders (2005)

All current (2005) and historical data gathered at the USGS continuous recording conductivity gages at Harbor Heights (0229746) and Peace River Heights (02297350), as well as historical information for stage level gage near Boca Grande (2293332) are contained in the appropriate summary data sets summarized in **Table 1.3** (see **Section 1**)..

Gage height, as well as surface and bottom conductivity and temperature readings collected in 2005 at 15-minute intervals at Harbour Heights on the Peace River (USGS Station 02297460, River Kilometer 15.5) are presented in Figures 5.1 through 5.5. Similar plots are shown in Figures 5.6 through 5.10 for the continuous gage at Peace River Heights on the Peace River (USGS Station 02297350, River Kilometer 26.7). These graphics are summarized in Table 5.1.

The duration and magnitude of the higher than average freshwater flows in the Peace River watershed are clearly evident by the surface and bottom conductivities observed at Harbor Heights gage during the early spring (March-April), summer (June-September) and fall (November) of 2005. Conductivities indicative of the upstream movement of higher conductivity harbor waters were evident for only very brief periods during the period between February and May at the more upstream Peace River Heights recording gage.

Table 5.1

Summary Graphics of 2005 Data from USGS Continuous Recorders

Figure	Description
Figure 5.1	Gage height (15-minute intervals) for Peace River fixed station at Harbour Heights – USGS Gage 02297460 (River Kilometer 15.5)
Figure 5.2	Surface conductivity (15-minute intervals) for Peace River fixed station at Harbour Heights – USGS Gage 02297460 (River Kilometer 15.5)
Figure 5.3	Bottom conductivity (15-minute intervals) for Peace River fixed station at Harbour Heights – USGS Gage 02297460 (River Kilometer 15.5)
Figure 5.4	Surface temperature (15-minute intervals) for Peace River fixed station at Harbour Heights – USGS Gage 02297460 (River Kilometer 15.5)
Figure 5.5	Bottom temperature (15-minute intervals) for Peace River fixed station at Harbour Heights – USGS Gage 02297460 (River Kilometer 15.5)
Figure 5.6	Gage height (15-minute intervals) for Peace River fixed station at Peace River Heights – USGS Gage 02297350 (River Kilometer 26.7)

Table 5.1

Summary Graphics of 2005 Data from USGS Continuous Recorders

Figure	Description
Figure 5.7	Surface conductivity (15-minute intervals) for Peace River fixed station at Peace River Heights – USGS Gage 02297350 (River Kilometer 26.7)
Figure 5.8	Bottom conductivity (15-minute intervals) for Peace River fixed station at Peace River Heights – USGS Gage 02297350 (River Kilometer 26.7)
Figure 5.9	Surface temperature (15-minute intervals) for Peace River fixed station at Peace River Heights – USGS Gage 02297350 (River Kilometer 26.7)
Figure 5.10	Bottom temperature (15-minute intervals) for Peace River fixed station at Peace River Heights – USGS Gage 02297350 (River Kilometer 26.7)

Comparisons of gage heights and both surface and bottom conductivity measurements at the two Peace River gage locations, Harbour Heights (River Kilometer 15.5) and Peace River Heights (River Kilometer 26.7), are presented in Figures 5.11 through 5.22 for the last two weeks in May 2005 (dry-season) and first two weeks of June 2005 (wet-season). These intervals were selected since, somewhat surprisingly, this four week period encompassed both the lowest and highest flows observed during 2005. An overview of these graphics is presented in Table 5.2.

Table 5.2

Summary Graphics of Comparisons of Stage Height and Surface and Bottom Conductivity During May and June 2005 at the USGS Continuous Recorders

Figure	Description
Figure 5.11	Surface conductivity and stage height in May - station 02297460 (River Kilometer 15.5)
Figure 5.12	Bottom conductivity and stage height in May – station 02297460 (River Kilometer 15.5)
Figure 5.13	Surface and bottom conductivity in May - station 02297460 (River Kilometer 15.5)
Figure 5.14	Surface conductivity and stage height in June -station 02297460 (River Kilometer 15.5)
Figure 5.15	Bottom conductivity and stage height in June – station 02297460 (River Kilometer 15.5)
Figure 5.16	Surface and bottom conductivity in June – station 02297460 (River Kilometer 15.5)
Figure 5.17	Surface conductivity and stage height in May - station 02297350 (River Kilometer 26.7)
Figure 5.18	Bottom conductivity and stage height in May - station 02297350 (River Kilometer 26.7)
Figure 5.19	Surface and bottom conductivity in May – station 02297350 (River Kilometer 26.7).
Figure 5.20	Surface conductivity and stage height in June - station 02297350 (River Kilometer 26.7)
Figure 5.21	Bottom conductivity and stage height in June - station 02297350 (River Kilometer 26.7)
Figure 5.22	Surface and bottom conductivity in June - station 02297350 (River Kilometer 26.7)

As indicated in previous HBMP annual reports, **Figures 5.11** and **5.12** show that both surface and bottom conductivities at the downstream Harbour Heights site (River Kilometer 15.5) are very strongly influenced by tide (water stage) during periods when river flows are relatively low. During May, in the dry-season, it was not uncommon for surface and bottom conductivities to vary 1000 to 17000 uS/cm (roughly from .3 to 10.0 ppt salinity) over a tidal cycle. During June, in the wet-season, this lower reach of the Peace River was characteristically far fresher and daily variations in both surface and near bottom conductivities resulting from tidal influences are greatly reduced.

At the more upstream continuous USGS gage at Peace River Heights (River Kilometer 26.7), the conductivity data collected showed fresh, hard water (high specific conductance) conditions with only small, infrequent differences in conductivity (usually less than 100 uS/cm) resulting from tidal variations during the May 2005 dry-season. During the wet-season (in early June), conductivities were low and showed no variations due to normal daily tidal cycles in water levels during the period shown in **Figures 5.20** and **5.21**.

6.0 PRMRWSA Continuous Recorders

6.1 Overview

The overall primary goal of the combined HBMP study elements is to provide the District with sufficient information to determine whether the water quality characteristics and biological communities of the lower Peace River/upper Charlotte Harbor estuarine system have been, are being, or may be significantly adversely impacted by permitted facility withdrawals. In addition, the ongoing base of ecological information developed in conjunction with the HBMP regarding the lower Peace River and upper Charlotte Harbor estuarine system provides the District with critical information related to the estuarine systems overall status and relative "health", by evaluating the status and trends of selected water quality and biological characteristics. As such, the primary focus and key elements of the HBMP design needs to cost-effectively address the articulated goals and objectives delineated in the District's specific Water Use Permit conditions. When combined, the elements of the program design needs to meet the specific expectations and objectives set forth in the permit as well as provide sufficient long-term information on which to base the development of answers to future questions.

As previously discussed in **Section 5**, the HBMP monitoring study design has for a number of years included continuous (fifteen-minute interval) measurements of subsurface and near bottom water column conductivities at two fixed USGS monitoring gages located at river kilometers 15.5 and 26.7 (**Figure 6.1**). The particular locations of these two gages on existing docks were established in part due to the USGS need to be able to have land based access for the ease of routine maintenance and the downloading of data. As **Figures 6.2** and **6.3** summarized in Table 6.1 indicate, the influences of tide, wind and antecedent flow conditions can individually and combined result in an extremely wide range of observed variation in daily averaged conductivity measurements at the Harbour Heights gage located at River Kilometer 15.5 when compared to corresponding flows at the Peace River at Arcadia gage. At the more upstream USGS Peace River Heights gaging site (located at River Kilometer 26.7), the influences of these confounding affects is noticeably less (see **Figures 6.4** and **6.5**). However, as indicated, the Facility cannot begin freshwater withdrawals until after Peace River at Arcadia flows have reached 130 cfs, when this upper reach of the river generally is characterized by freshwater conditions. Thus, while the location of the more upstream USGS continuous recording gage is appropriate to detect potential long-term systematic shifts in the freshwater/saltwater interface during low levels of freshwater inflow, it is extremely doubtful if the direct influences of the facility can typically be measured at this location.

Table 6.1
Average Daily Conductivity Versus Flow at USGS Continuous Recorders

USGS Gage / River Kilometer	Subsurface Conductivity	Near Bottom Conductivity
Harbour Heights 15.5	**Figure 6.2**	**Figure 6.3**
Peace River Heights 26.7	**Figure 6.4**	**Figure 6.5**

Therefore, in the *2002 HBMP Comprehensive Report* (finalized in September 2004) it was recommended that additional continuous conductivity gages be established by the PRMRWSA downstream of the existing upstream USGS Peace River Heights (RK 26.7) monitoring location. The primary objective of such additional PRMRWSA continuous conductivity recording gages, when combined with the two existing USGS sites, would be to obtain greater resolution of the direct relationships among freshwater flow, stage height and conductivity downstream of the Facility during periods of withdrawals. These additional gages would specifically be used in determining potential impacts within the reach of the river characterized by the movement of the freshwater/saltwater interface at flows immediately above the 130 cfs threshold. A as such, these new gages would be potentially subject to the most direct salinity changes do to Facility withdrawals under lower flow conditions.

6.2 Deployment of Additional PRMRWSA Gages

During 2005, a number of both possible alternative sites and deployment methodologies for the additional continuous conductivity monitoring devices were evaluated by the PRMRWSA. These additional monitoring sites would be used as part of an expanded HBMP study element directed specifically toward measuring Facility withdrawal impacts under lower flow conditions. Ultimately, analyses of conductivity data from these new monitoring locations would be used to extend the graphical and statistical results previously conducted and presented as part of the *2002 HBMP Comprehensive Summary Report*.

The initial first step to deploying additional continuous recorders was to determine the potential spatial distribution of arraying such new continuous recorders downstream of the Facility. The primary objective was to maximize their ability to detect salinity changes (impacts) that could be directly attributed to Facility freshwater withdrawals. Existing statistical models and graphical analyses of salinity/flow relationships were reviewed from the long-term HBMP fixed stations and USGS continuous recorders in this reach of the lower Peace River. These results were next evaluated in relationship to potential existing physical structures (docks, pilings, etc.) to which additional continuous recorders might be attached. The series of potential new monitoring sites located between the two existing USGS continuous recorders that were selected for evaluation are summarized in **Table 6.2.** The relative locations of those evaluated potential monitoring sites, located more upstream nearer the Peace River Facility, are depicted in **Figure 6.6**. A series of additional potential sites exist downstream, due to the recent placement of Manatee Speed Zone markers along the river. The PRMRWSA was able to receive permission from US Fish and Wildlife to establish continuous recorders using these markers.

Three of these Manatee Speed Zone markers were chosen for the initial deployment of the new PRMRWSA HBMP continuous recorders, the locations of which are indicated by the light-green arrows in **Figure 6.7**. The methodologies used for deployment of the three new continuous recorders are depicted in **Figure 6.8** and Photographs 6.1 through 6.4.

- **Figure 6.8** – This diagram shows the method used to attach the PVC stilling well to the deep side of one of the selected Manatee Speed Zone signs, using a series of stainless steel hose clamps.

- **Photo 6.1** – The photograph shows actually strapping the PVC stilling well to the inside of one of the Manatee Speed Zone signs.

- **Photo 6.2** – The method used to attach the YSI conductivity/temperature sonde to the bullet floats is shown in this photograph. The size of the bullet floats was selected based on the weight of the sonde, and the diameter of the stilling well. Unlike the USGS continuous recorders, these YSI units have been deployed to measure conductivity and temperature only just below the surface. As indicated in Table 6.2, the Manatee Speed Zone signs are located in relatively shallow depths along the sides of the main river channel. As a result, these locations are not well suited for measuring differences between surface and bottom values. If at a later time, additional bottom conductivity or dissolved oxygen levels are added to the monitoring array, an alternative method of deployment will be required.

- **Photo 6.3** – In this photograph the YSI conductivity/temperature sonde attached to two bullet floats is shown being readied for placement in the stilling well.

- **Phto 6**.4 – This last photograph shows the stilling well (with the locking cap) as seen from the river.

6.3 Control River "Pump Test" Design

The PRMRWSA and District (with the aid of the Scientific Review Committee) have for a number of years discussed the need to conduct a series of controlled "Pump Tests" to actually measure the magnitude of salinity changes downstream of the Facility resulting from actual maximum permitted freshwater withdrawals. When combined with the two existing USGS continuous recorders, the three new PRMRWSA's recorders will provide the spatial and temporal intensive conductivity data needed for the PRMRWSA to begin conducting actual direct measurements of withdrawal salinity impacts downstream of the Facility. The following discussion summarizes and presents the potential timing options, design criteria, and/or alternatives the PRMRWSA plans to implement (starting in 2006) as a series of "Pump Tests" field tests to quantify actual salinity impacts of withdrawals by the Peace River Facility under variable flow conditions. The primary objectives for conducting this series of "Pump Tests" over the next few years will be to check the real world accuracy of the various statistical salinity models of salinity/flow relationships that have been developed both by District studies and the PRMRWSA in conjunction with various summary HBMP reports dating back to the late 1980s. Additionally, the resulting information from the "Pump Tests" will be important in further refining the District's upcoming mechanistic flow/salinity model for the lower Peace River/upper Charlotte Harbor, and evaluating the upcoming District's proposed minimum flows and levels criteria.

The District, PRMRWSA and Scientific Review Panel have discussed the need for conducting such a series of controlled withdrawal experiments, or field “Pump Tests”, in order to provide additional lines of evidence in support of the overall conclusions reached by previous statistical models. The results of these statistical models have estimated the magnitude and spatial extent of salinity changes potentially resulting along the lower Peace River using both previous and predicted future Facility withdrawals. These models have uniformly suggested that the predicted potential salinity changes due to the permitted freshwater withdrawal schedule range from only 0.1 to 0.5 ppt. While quantifying the spatial and temporal extent of such salinity changes is an important criteria in understanding the potential magnitude of current and possible future water withdrawals, such changes are far below both the typical daily tidal and seasonal salinity variations that naturally occur along the lower river, and probably could not be detected using either fixed, moving, or randomized monitoring designs. It has therefore been suggested that by conducting actual temporally intense field measurements during comparable flow conditions during which the Facility would either withdraw controlled volumes of water or not withdraw any water, it would be possible to provide an additional conclusive experimental line of evidence needed to defend the conclusions reached by the existing statistical lower river salinity models.

6.3.1 Location/Timing

The initial question that must be addressed regarding the design of a Facility “Pump Test” pertains to whether there are specific ranges of flows and/or seasons when potential Facility salinity impacts would be expected to be more easily detected. Results of analyses conducted in conjunction with the *2002 HBMP Comprehensive Summary Report* indicated that the greatest probability of actually being able to detect salinity changes due to the Facility’s withdrawals increases both closer to the point of withdrawal and under low river flow conditions. The higher ambient salinity levels that naturally occur further downstream, when taken in conjunction with the confounding influences of both the increasing volumes of tidal exchange and daily variations in wind patterns, make detecting the small salinity differences caused by the Facility withdrawals increasingly difficult further downstream away from the point of withdrawal.

Probably the most opportune time to potentially detect changes in salinities due to Facility withdrawals would coincide with periods when river flows are both above the low flow cut off of 130 cfs but not high enough to have moved the freshwater/saltwater interface too far downstream from the Facility. Seasonally, extended periods meeting these flow criteria typically occur during both the late fall/winter low flow interval and the spring dry-season. Brief periods of rain associated with the passage of cold fronts during the fall and winter often result in marked spikes in flow. Conversely, while river flows are typically more stable during the spring dry-season, they are often too low for the Facility to be consistently taking a full permitted ten percent of flow for any consistent period of time.

Therefore, while the historic flow data suggest that ideal conditions for implementing actual field testing of salinity changes due to Facility withdrawals commonly occur, the specific timing will be difficult to predict very far in advance, and that conditions can be expected to change rapidly. This is especially true regarding both southerly or northerly winds preceding and following fall/winter cold fronts, which can be sustained over several days and then rapidly reverse. During periods of low to moderate rates of river inflow, wind shifts can be as or more important than tides in determining the salinity structure along the lower river. These confounding influences will make the scheduling and deployment of field crews to conduct field sampling problematic and extremely difficult. The design of any Facility "Pump Test" will therefore need to primarily rely on the implementation of an array of automated continuous recorders similar to those USGS recorders already in place.

6.3.2 Pump Test Design Criteria

The PRMRWSA has developed a series of criteria to be applied in conducting a series of Facility "Pump Tests" over the next few years the pump tests are designed to test the overall conclusions previously reached by the results of statistical models regarding withdrawal impacts on salinity changes in the lower Peace River. The primary objectives of the upcoming series of "Pump Tests" will be to physically measure the magnitude, as well as temporal and spatial extent of directly measured salinity changes that can be separated and attributed solely to Facility withdrawals.

- Predicted daily tide tables have been reviewed to establish potential pairs of days during 2006 and 2007 with expected comparable tides that are both approximately similar in timing and magnitude. **Figure 6.9** shows potential pairs of days in 2006 on both April 16 and 17, and then again on April 18 and 19.

- Whenever real-time provisional river flows for the USGS Peace River gage at Arcadia are within the selected target range (approximately 150 to 250 cfs), the Facility will check both the predicted tides and expected weather (rainfall and wind) to determine if a "Pump Test" event could be effectively conducted. (Assuming Facility demands and storage can be met.)

- Predicted sustained winds from either the north or south should be less than 10 mph over the two day "Pump Test" period if at all possible. Unless extremely strong and/or predicted to shift, winds from the east or west are of less consequence.

- If conditions meet the established criteria and the Facility can spare the water the facility would then withdraw water on one of the two days of the pair and not the other. Withdrawals should be sustained over the test period at the maximum permitted amount (10% of Arcadia flow) to maximize the potential for detecting potential impacts.

- This procedure should be repeated as frequently as practical over a period of several years.

- Based on finalized USGS gage data, the resulting "Pump Tests" will be grouped into differing classes for analyses of salinity impacts based on both flows and tides.

- Graphical analyses similar to those conducted as part of the *2002 HBMP Comprehensive Summary Report* will be utilized to determine the potential magnitude of salinity changes due to withdrawals under differing conditions.

- Potential temporal and spatial modifications to the initial "Pump Test" design may be made based on initial summary results or coincide with potential future Facility or withdrawal schedule modifications.

7.0 Adverse Impact

Since its inception in 1976 the HBMP has incorporated numerous physical, chemical, and biological study elements directed toward assessing both the overall "health of the estuary" as well as direct and indirect adverse impacts potentially associated with Facility withdrawals. To date none of the extensive HBMP analyses have found or suggested any significant long-term physical, chemical or biological changes in the lower Peace River/upper Charlotte Harbor estuarine system, resulting from either current or historic water withdrawals by the Facility.

The *2002 HBMP Comprehensive Report* proposed an approach for determining from the HBMP data whether permitted surface water withdrawals are (or have) caused adverse environmental impacts in the lower Peace River estuarine system. In addition, a hierarchy of management actions was proposed to be implemented in response to detected changes that could forewarn of potential future changes that would constitute an adverse impact.

7.1 Regulatory Basis of Review

The Southwest Florida Water Management District's *Basis of Review* has established a specific series of performance standards for Water Use Permits associated with withdrawals from natural surface waterbodies, such as the Peace River.

- *Flow rates shall not deviate from the normal rate and range of fluctuation to the extent that water quality, vegetation, and animal populations are adversely impacted in streams and estuaries.*
- *Flow rates shall not be reduced from the existing level of flow to the extent that salinity distributions in tidal streams and estuaries are significantly altered as a result of withdrawals.*
- *Flow rates shall not deviate from the normal rate and range of fluctuation to the extent that recreational use or aesthetic qualities of the water resource are adversely impacted.*

From a technical standpoint, adverse environmental impact can be defined using a wide range of metrics that quantify deviations from the pre-withdrawal salinity patterns, water quality conditions, and biological distribution and abundance. The Peace River HBMP Scientific Review Panel (Panel) has been established primarily to assist District staff in assessing the continued technical efficacy and ability of the HBMP to detect potential adverse impacts caused by the Facility, and secondarily to assist District staff in the interpretation of HBMP data.

7.2 Resource Management Goals and Relevant Hydrobiological Indicators

In issuing the Peace River Facility's Water Use Permit, the District has identified the primary resources of interest, as well as resource management and protection goals for the lower Peace River and upper Charlotte Harbor estuarine system.

1. Protect the extent, distribution, and diversity of physical and biological habitats in the lower Peace River and upper Charlotte Harbor.

2. Protect the abundance of fish and invertebrate species of sport and commercial importance in the lower Peace River and upper Charlotte Harbor.

3. Protect the estuarine fish nursery function in the lower Peace River and upper Charlotte Harbor.

4. Protect the spatial and temporal distributions of organisms that are important food sources for fish in the lower Peace River.

5. Protect seasonal patterns of nutrient delivery to the estuary so that trophic interactions are maintained in the lower Peace River, so that Goals 1 through 4 are met.

6. Protect seasonal patterns of organic matter delivery to the estuary so that trophic interactions are maintained in the lower Peace River, so that Goals 1 through 4 are met.

7. Protect the temporal and spatial characteristics of salinity distributions in the estuary so that Goals 1 through 4 are met.

8. Protect dissolved oxygen concentrations in the estuary so that Goals 1 through 4 are met.

9. Protect the abundance of any rare, threatened or endangered species that use the lower Peace River or upper Charlotte Harbor.

10. Protect suitable habitats and water quality for fish and wildlife that are not of sport or commercial importance.

7.3 Rationale for Defining Adverse Impact

Inherent in the District rules is the recognition that surface water withdrawals are linked to potential changes in salinity, associated water quality constituents and biological communities. It should be noted that, while freshwater withdrawals have a direct and instantaneous physical affect on salinity, the effects of freshwater withdrawals on other water quality constituents, and biological communities in particular, are typically indirect and more complex (**Figures 7.1** and

7.2). Such indirect impacts are mediated by physical and chemical processes, and are typically manifested on slower time scales (e.g. weeks, months, or seasons).

District staff, with assistance from the HBMP Scientific Review Panel, is responsible for the interpretation of data collected from the HBMP and other sources to determine if the permitted Facility surface water withdrawals have caused harm to the lower Peace River/upper Charlotte Harbor estuarine systems. Since the term *adverse impact* has distinct legal meaning in the context of Water Use Permitting, it was proposed in the *2002 HBMP Comprehensive Report* that this term be supplanted by *significant environmental change* with respect to the role of the District staff and the HBMP Scientific Review Panel, and be used as the established criteria for assessing the findings of the HBMP.

Significant Environmental Change

> ***A detected change, supported by statistical inference or a preponderance of evidence, in the normal or pre-withdrawal abundance, distribution, species composition, or species richness of biological communities of interest in the lower Peace River and upper Charlotte Harbor that is directly attributable to reductions in freshwater inflows caused by the permitted surface water withdrawals.***

Conditions meeting the working definition of *significant environmental change* stated above could be measured and described in many different ways. Some simple examples are described below.

- **Change in species richness or community balance** - numerous measures and indices exist to describe species richness, community balance, and biodiversity (e.g. Shannon-Weaver index) for various biotic indicators.

- **Dislocation of an indicator species' distribution -** the "center of abundance" statistic and observed first and last occurrences have been used in the HBMP with respect to the distribution of larval and juvenile fish, benthos, and vegetation.

- **Elimination or reduced abundance of a "desirable" indicator species -** the elimination, or a significant reduction in the abundance, of a desirable (e.g. economically or ecologically important) indicator species would likely be considered a significant environmental change.

- **Introduction or increased abundance of an "undesirable" indicator species** - the converse of the above described scenario, the introduction, or a significant increase in the abundance, of an "undesirable" (e.g. non-native or nuisance) indicator species within a reporting unit would also likely be considered a significant environmental change.

Using this framework for identifying if a significant environmental change has occurred, a series of hierarchy of management responses can be developed and structured according to various potential criteria and outcome objectives.

7.4 PRMRWSA's Management Response Plan (MRP) to a Potential Observed Significant Environmental Change

Determining adverse environmental impact for surface water withdrawals involves the identification of appropriate management actions or remedial measures to be undertaken if significant environmental change is detected or appears likely. Waiting until an adverse environmental impact has occurred to initiate appropriate management actions or remedial measures reduces the opportunity to adequately protect resources that may be at risk. Therefore, the PRMRWSA has adopted a MRP that is a proactive approach to protecting the resources of concern in the lower Peace River estuarine system.

The plan recommends that salinity deviations be used as the primary indicator of significant environmental change that could lead to potential adverse environmental impact. In addition, salinity deviations will be used as the triggering mechanism for a range of management responses aimed at reversing or minimizing the change to prevent potential adverse environmental impact. Salinity deviations from the target distribution will be evaluated in terms of magnitude, spatial extent, and/or temporal duration to develop a decision tree that is linked to various management actions (**Figure 7.3**). Using this approach, the intensity and urgency of the management response would be appropriately linked to the degree of the observed salinity deviations (**Figure 7.4**).

Various management actions will be implemented in response to an observed significant deviation in the statistical distribution of salinity measurements. The initial management actions will focus on determining if the observed deviation is in fact real and not a measurement error or an artifact of the sampling design. If the change is determined to be real, the next series of management actions will focus on better understanding and describing the change, and determining potential cause and affect relationships. Finally, the most intense management actions may involve regulatory enforcement actions as well as remediation and mitigation.

A hierarchy of management actions, contained in the PRMRWSA's MRP is listed sequentially in order of increasing intensity and urgency below.

1. **Data QA/QC Audit** - This action would involve the performance of an intense QA/QC audit to determine if the detected change was the result of laboratory problems, data entry errors, violation of sampling protocols, etc.

2. **Data Comparison (Correlates)** - This action would involve a review of data correlates (e.g., specific conductance is a correlate to salinity) to determine if there is more than one line of evidence reflecting the detected change.

3. **Scientific Review Panel Meeting** - If Steps 1 through 2 indicate that the detected change is not due to quality control problems, and is reflected in multiple lines of evidence, the next step would involve convening a special meeting of the HBMP Scientific Review Panel. The purpose of the meeting would be to review the findings of

Steps 1 through 2, and to determine a possible modified course of action to refine the understanding of the magnitude and extent of the detected change. If deemed appropriate, the Panel could recommend additional data analyses, or a redirected and focused sampling effort to better elucidate the detected change. Recommendations of the Panel would be subject to further review and approval by District staff.

4. **Redirected Sampling Effort** - This action would involve conducting more focused supplemental sampling in the affected river segments with the objective of gaining a better understanding of the detected change. The additional data collected from this effort could then be subjected to Steps 1 and 2 above if deemed appropriate. This action would determine if detection of the change is repeatable under a more focused sampling program. Although this step could be valuable, it may not be necessary for a redirected sampling effort to be conducted for all hydrobiological changes detected by the HBMP. For some hydrobiological changes, District staff could recommend proceeding directly to Step 5 without conducting any redirected or additional sampling.

5. **Determination of Significant Environmental Change** - Based on the findings of Steps 1 through 4, the next step would be to reconvene the Scientific Review Panel with the objective of evaluating whether the detected change is substantial enough to potentially constitute an adverse environmental impact. This step would involve a detailed assessment of the data analyses conducted in Steps 1 through 4 to ascertain whether conditions consistent with the working definition of significant environmental change presented above have been met. A formal determination of significant environmental change would be made via a consensus of professional opinion by District staff and the Panel members in consideration of technical and scientific factors only. Following this determination, the Peace River/Manasota Regional Water Supply Authority Board would be briefed on the findings and recommendations of District staff and the Panel.

6. **Regulatory Summit Meeting** - If after the completion of Step 5 District staff and the Panel conclude that a significant environmental change has occurred, the next step would be to convene a meeting with all applicable regulatory agencies and affected parties to determine the appropriate regulatory course of action. At a minimum, the regulatory agencies represented would include SWFWMD and FDEP, however, depending on the environmental changes involved other state and federal agencies may be involved (e.g., Florida Fish and Wildlife Conservation Commission; U.S. Fish and Wildlife Service). Actions by the group in attendance would include revisiting Steps 1, 2 and 4 above, If after reviewing the presented evidence the group (via a consensus of professional opinion) formally determines that significant environmental change has occurred, then the group must decide on the urgency or type of regulatory actions required. Further actions could include deferral to the Water Management District Governing Board, or immediate enforcement of regulatory actions such as temporary modification of the withdrawal schedule. If more substantial regulatory actions such as permanent modifications to the withdrawal schedule and/or mitigation were determined to be appropriate, preparations would be made for presenting recommendations to the District Governing Board for formal action.

7. **District Governing Board Hearing** - This step would involve the presentation of data and other evidence indicating the occurrence of significant environmental change to the District Governing Board. The formal determination of adverse impact from a regulatory and legal standpoint would be made by the District Governing Board. If it is determined that the detected change constitutes an adverse environmental impact, then the Governing Board could require appropriate remediation and or mitigation.

1. **Remediation** - The requirement of appropriate remedial measures by the District Governing Board could include such actions as permanent modifications to the permitted withdrawal schedule. Modifications to the withdrawal schedule could include provisional or temporary reductions in withdrawal rates, or modifications to the schedules such that greater withdrawals would occur during high flows, but lesser withdrawals would occur during low flows. In the event that the permitted withdrawals resulted in irreversible significant harm to resources of concern, mitigation could be required.

In the implementation of the sequence of management responses described above, the primary objective is the prevention of any adverse impacts. However, the intensity of the management response should not be the only criteria considered. The detection of any hydrobiological change must always be framed within the degree of certainty that the detected change is real, and not solely due to chance. Therefore, the intensity of the management response should be tied not only to the magnitude or severity of the hydrobiological change, but also to the degree of certainty that the detected change is real, and if it is caused by Authority withdrawals. Table 7.1 below presents a conceptual matrix approach that integrates the magnitude of the detected change and the probability that the change is due to chance alone (e.g. alpha).

As shown in Table 7.1, the intensity of the selected management response is a function of both factors. If the detected change is relatively large, but the degree of certainty is low (e.g. high alpha) then a less intense management response would be appropriate. If, on the other hand, the detected change is considered to be moderate, but the degree of certainty is high (e.g. low alpha), then a more intense management response would be indicated. The application of this approach would obviously vary with the specific hydrobiological changes and statistical measures of certainty involved. The approach of the selected management response would also depend on whether the observed change was found to be attributable directly to Facility withdrawals or potentially to anthropogenic upstream activities.

Table 7.1

Conceptual Decision Matrix For Determining An Appropriate Management Response To Detected Hydrobiological Change

Probability of Making a Type I Error	Magnitude of Detected Hydrobiological Change		
Alpha	**Small**	**Moderate**	**Large**
0.20	Data Comparison	Scientific Review Panel Meeting	Redirected Sampling
0.10	Scientific Review Panel Meeting	Redirected Sampling	Determination of Significant Change
0.05	Redirected Sampling	Determination of Significant Change	Regulatory Summit Meeting

7.5 Assessment of Permitted Withdrawals

Since its inception in 1976 the HBMP has incorporated numerous physical, chemical, and biological study elements directed toward assessing both the overall "health of the estuary" as well as direct and indirect adverse impacts potentially associated with Facility withdrawals. To date none of the extensive analyses that have been conducted in conjunction with these long-term monitoring program elements, and reported in numerous previous HBMP documents submitted to the District, have found or suggest any significant long-term physical, chemical or biological changes in the lower Peace River/upper Charlotte Harbor estuarine system resulting from either current or historic water withdrawals by the Facility. The data and analyses presented in this 2005 HBMP Annual Data Report continue to support this overall conclusion. Higher than average flows during 2005 resulted in downriver shifts in a number of water quality characteristics when compared to the longer, historic HBMP information. In other instances, constituents such as silica and orthophosphorus, have shown progressive, systematic changes over time (trends). However, these trends have been shown to be associated with other changes in the watershed and not related to Facility withdrawals.

The analyses and evaluations of the 2005 HBMP data presented in Sections 2 through 5 neither indicated any potential "Significant Environmental Changes", nor were any changes observed that required administrative action as per the PRMRWSA's Management Response Plan.

8.0 References

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2005 HBMP Tables

This section contains tables not included directly in the text for each section

- **Section 1 – Introduction / Summary**
- **Section 2 – Gage Flows and Withdrawals**
- **Section 3 – "Moving" Isohaline Monitoring**
- **Section 4 – "Fixed" Station Monitoring**
- **Section 6 – Authority Continuous Recorders**

Table 1.1

HBMP Fixed Sampling Locations

USGS River Mile	USGS Location Number	Previous EQL Station Number	Additional Sampling	New River Kilometer designation based on Morphometric Study
Current *In Situ* Water Column Profile Sampling Locations				
CH6	265355082075500	9	Water Quality	**-2.4**
RM3.95	265640082033500	10	Water Quality	**6.6**
RM4.88	265724082024400	21		**8.4**
RM6.25	265727082012800	11		**10.5**
RM8.61	265711081595500	Shell Creek 9 (92)		**12.7**
RM8.6B	265819082003200	22		**12.8**
RM10.2	2297460	12	Water Quality/Tide Gage/Conductivity	**15.5**
RM11.2	270022081591000	23		**17.5**
RM 12.55	270124081592500	13		**20.1**
RM13.95	270235081592400	24		**21.9**
RM14.82	270318081593100	14	Water Quality	**23.6**
RM15.45	270337081595800	25		**24.7**
RM16.29	270418082001600	15		**25.9**
N/A	2297350	N/A	Tide Gage/ Conductivity	**26.7**
RM18.25	270451081595100	17		**29.5**
RM18.95	2297330	18	Water Quality	**30.4**
RM19.5	270537081585800	19		**32.3**
Vegetation Transect Locations				
N/A	N/A	I		**15.6**
N/A	N/A	II		**22.3**
N/A	N/A	III		**20.4**
Previous EQL Water Column and Chemistry Sampling Sites				
N/A	N/A	16		**27.1**
N/A	N/A	20		**34.1**

Table 1.2

HBMP Chemical Water Quality Parameters

Ongoing Long-term Analytes	Analytes Deleted Starting March 2003
Salinity	Alkalinity
Chloride	Turbidity
Color	Total Phosphorus
Silica	Inorganic Carbon
Ortho-Phosphorus	Total Organic Carbon
Nitrate + Nitrite Nitrogen	Dissolved Organic Carbon
Ammonia/Ammonium Nitrogen	
Total Kjeldahl Nitrogen	
Total Nitrogen	
Suspended Solids	
Volatile Solids	
Chlorophyll *a*	

Table 2.4

Long-Term Yearly Mean Measurements of Peace River Flows and Facility Withdrawals during HBMP Monitoring Period

Year	Means (in cubic ft/sec)			Withdrawal as Percent of Gaged Flow at:	
	Peace River Flow at Arcadia	Peace Arcadia + Horse Creek + Joshua Creek + Shell Creek	Facility Withdrawal	Arcadia	US 41 Bridge
1976	703.3	959.6	No Withdrawals Until 1980		
1977	478.7	731.9			
1978	997.2	1525.8			
1979	1171.4	2080.5			
1980	495.2	726.3	3.93	0.66	0.45
1981	288.4	629.6	5.10	1.77	0.81
1982	1610.5	2746.9	5.91	0.37	0.21
1983	1371.3	2319.9	5.11	0.37	0.22
1984	567.0	1102.7	4.07	0.72	0.37
1985	368.9	680.7	7.24	1.96	1.06
1986	548.9	1013.6	7.50	1.37	0.74
1987	802.7	1357.8	7.59	0.95	0.56
1988	1054.0	1738.4	9.48	0.90	0.55
1989	373.6	699.0	9.60	2.57	1.37
1990	402.4	741.4	8.72	2.17	1.18
1991	771.1	1567.6	10.38	1.35	0.66
1992	784.6	1543.6	9.41	1.20	0.61
1993	698.5	1249.3	12.02	1.72	0.96
1994	1365.9	2359.0	11.65	0.85	0.52
1995	1708.1	3071.6	12.23	0.72	0.40
1996	598.2	928.8	12.46	2.08	1.34
1997	1059.9	1777.6	12.12	1.14	0.68
1998	1915.9	2921.3	15.43	0.81	0.53
1999	565.2	1142.5	12.8	2.26	1.15
2000	139.4	342.4	5.7	4.09	1.66
2001	1038.1	1914.7	7.9	0.76	0.41
2002	1180.7	2191.2	22.8	1.93	1.04
2003	1853.9	2920.0	26.1	1.41	0.89
2004	1740.3	2785.4	24.2	1.39	0.87
2005	1858.4	2953.5	18.8	1.56	0.98

Table 3.3

Current and Historic Water Chemistry Methods used during Isohaline Based "Moving" Station HBMP Monitoring Study Element

Parameter	Method	Detection Limit
Color	EPA 110.2	1.0 Co_Pt Units
Chloride	EPA 325.2	0.4 mg/l
Turbidity	EPA 180.1	0.1 NTU
Total Suspended Solids	EPA 160.2	0.8 mg/L
Volatile Suspended Solids	EPA 160.4	0.8 mg/L
Alkalinity	EPA 310.1	0.1 mg/l
NO2+NO3 Nitrogen	EPA 353.2	0.002 mg/l
NH3+NH4 Nitrogen	EPA 350.1	0.002 mg/l
Total Kjeldahl	EPA 351.2	0.1 mg/l
Ortho-Phosphorus	EPA 365.2	0.002 mg/l
Total Phosphorus	EPA 365.4	0.002 mg/l
Silica	EPA 370.1	0.05 mg/l
Inorganic Carbon	SM 5310 B	1.0 mg/l
Total Organic Carbon	EPA 415.1	1.0 mg/l
Dissolved Organic Carbon	SM 5310 B	1.0 mg/l
Iron	EPA 236.1	0.04 mg/l
Chlorophyll *a*	Flurometeric SM 10200H.3 Spectrophotometric SM10200H.2	0.25 ug/l 2.0 ug/l

Table 3.4

Physical and Chemical Water Quality Parameters

Year	Month	Sample Location	Temperature (C)	Color (CPU)	Light Extinction Coefficient	Iron (mg/l)	Silica (mg/l)
2005	Jan	0 o/oo	19.6	175	2.4	0.32	5.54
2005	Jan	6 o/oo	20.2	150	1.9	0.30	4.87
2005	Jan	12 o/oo	20.0	100	2.1	0.22	2.61
2005	Jan	20 o/oo	19.2	75	1.5	0.13	1.45
2005	Feb	0 o/oo	19.0	175	2.6	0.20	5.12
2005	Feb	6 o/oo	19.1	175	2.5	0.23	3.52
2005	Feb	12 o/oo	18.8	100	1.9	0.20	2.18
2005	Feb	20 o/oo	18.2	90	1.4	0.16	0.82
2005	Mar	0 o/oo	17.9	160	2.4	0.35	4.78
2005	Mar	6 o/oo	18.7	160	1.9	0.25	3.90
2005	Mar	12 o/oo	18.7	140	1.9	0.22	3.05
2005	Mar	20 o/oo	19.0	80	1.1	0.14	1.95
2005	Apr	0 o/oo	24.0	140	3.3	0.58	4.40
2005	Apr	6 o/oo	24.2	120	2.6	0.59	1.51
2005	Apr	12 o/oo	23.5	100	2.7	0.51	0.36
2005	Apr	20 o/oo	23.4	60	1.8	0.13	0.39
2005	May	0 o/oo	30.3	200	2.8	0.35	6.29
2005	May	6 o/oo	27.2	180	1.5	0.21	3.97
2005	May	12 o/oo	26.3	160	1.2	0.18	2.77
2005	May	20 o/oo	26.4	60	0.8	0.06	1.68

Table 3.4 (continued)

Physical and Chemical Water Quality Parameters

Year	Month	Sample Location	Temperature (C)	Color (CPU)	Light Extinction Coefficient	Iron (mg/l)	Silica (mg/l)
2005	Jun	0 o/oo	30.2	200	2.7	0.48	5.52
2005	Jun	6 o/oo	27.1	200	1.8	0.44	5.56
2005	Jun	12 o/oo	27.8	150	1.4	0.25	4.26
2005	Jun	20 o/oo	27.7	80	1.0	0.11	2.78
2005	Jul	0 o/oo	29.8	250	2.9	0.50	4.91
2005	Jul	6 o/oo	33.6	225	2.6	0.43	5.21
2005	Jul	12 o/oo	31.5	200	1.7	0.25	4.81
2005	Jul	20 o/oo	28.8	125	1.4	0.13	4.95
2005	Aug	0 o/oo	30.0	175	2.6	0.59	5.33
2005	Aug	6 o/oo	31.2	150	1.3	0.40	5.32
2005	Aug	12 o/oo	30.3	125	1.6	0.29	5.35
2005	Aug	20 o/oo	31.5	70	1.1	0.29	5.32
2005	Sep	0 o/oo	28.8	200	3.1	0.41	6.55
2005	Sep	6 o/oo	29.1	200	2.6	0.34	6.46
2005	Sep	12 o/oo	29.1	125	2.3	0.18	6.50
2005	Sep	20 o/oo	28.6	80	1.4	0.03	5.18
2005	Oct	0 o/oo	29.4	180	2.7	0.35	4.51
2005	Oct	6 o/oo	28.5	180	2.1	0.23	4.36
2005	Oct	12 o/oo	28.5	200	1.7	0.15	5.63
2005	Oct	20 o/oo	28.1	80	1.4	0.10	5.04

Table 3.4 (continued)

Physical and Chemical Water Quality Parameters

Year	Month	Sample Location	Temperature (C)	Color (CPU)	Light Extinction Coefficient	Iron (mg/l)	Silica (mg/l)
2005	Nov	0 o/oo	23.6	200	3.2	0.49	5.69
2005	Nov	6 o/oo	24.2	180	2.6	0.32	4.18
2005	Nov	12 o/oo	23.7	140	1.8	0.25	4.73
2005	Nov	20 o/oo	24.1	120	1.6	0.16	2.31
2005	Dec	0 o/oo	19.3	140	2.2	0.39	8.58
2005	Dec	6 o/oo	19.7	120	2.2	0.36	6.65
2005	Dec	12 o/oo	20.0	100	2.3	0.25	5.44
2005	Dec	20 o/oo	19.7	80	1.4	0.16	3.67

Table 3.5
Physical and Chemical Water Quality Parameters - Nutrients

Year	Month	Sample Location	Ammonia/ Ammonium (mg/l)	Nitrite/ Nitrate (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Orthophosphorus (mg/l)	Available N/P Atomic Ratio
2005	Jan	0 o/oo	0.006	0.727	0.73	0.610	2.7
2005	Jan	6 o/oo	0.006	0.624	1.24	0.565	2.5
2005	Jan	12 o/oo	0.006	0.390	0.86	0.401	2.3
2005	Jan	20 o/oo	0.006	0.158	0.59	0.320	1.2
2005	Feb	0 o/oo	0.006	0.657	1.16	0.978	1.5
2005	Feb	6 o/oo	0.010	0.262	1.45	0.784	0.8
2005	Feb	12 o/oo	0.010	0.075	0.89	0.574	0.3
2005	Feb	20 o/oo	0.006	0.004	0.67	0.371	0.1
2005	Mar	0 o/oo	0.069	0.184	1.04	0.810	0.7
2005	Mar	6 o/oo	0.010	0.118	0.90	0.810	0.4
2005	Mar	12 o/oo	0.023	0.128	0.80	0.693	0.5
2005	Mar	20 o/oo	0.006	0.052	0.63	0.410	0.3
2005	Apr	0 o/oo	0.183	0.200	1.40	0.923	0.9
2005	Apr	6 o/oo	0.104	0.004	1.33	0.557	0.4
2005	Apr	12 o/oo	0.442	0.004	0.75	0.399	2.6
2005	Apr	20 o/oo	0.118	0.004	0.30	0.230	1.2
2005	May	0 o/oo	0.107	0.169	1.20	0.830	0.8
2005	May	6 o/oo	0.060	0.033	0.92	0.620	0.3
2005	May	12 o/oo	0.053	0.028	1.08	0.490	0.4
2005	May	20 o/oo	0.055	0.015	0.66	0.410	0.4

Table 3.5 (continued)
Physical and Chemical Water Quality Parameters - Nutrients

Year	Month	Sample Location	Ammonia/ Ammonium (mg/l)	Nitrite/ Nitrate (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Orthophosphorus (mg/l)	Available N/P Atomic Ratio
2005	Jun	0 o/oo	0.006	0.234	0.22	0.399	1.4
2005	Jun	6 o/oo	0.006	0.189	1.49	0.279	1.6
2005	Jun	12 o/oo	0.006	0.116	0.97	0.337	0.8
2005	Jun	20 o/oo	0.006	0.006	0.54	0.275	0.1
2005	Jul	0 o/oo	0.006	0.108	0.64	0.263	1.0
2005	Jul	6 o/oo	0.006	0.010	0.78	0.318	0.1
2005	Jul	12 o/oo	0.006	0.007	0.58	0.267	0.1
2005	Jul	20 o/oo	0.006	0.004	1.06	0.177	0.1
2005	Aug	0 o/oo	0.006	0.195	1.39	0.268	1.7
2005	Aug	6 o/oo	0.006	0.241	1.19	0.241	2.3
2005	Aug	12 o/oo	0.006	0.015	1.53	0.216	0.2
2005	Aug	20 o/oo	0.006	0.069	1.35	0.157	1.1
2005	Sep	0 o/oo	0.006	0.361	0.93	0.671	1.3
2005	Sep	6 o/oo	0.006	0.434	0.99	0.604	1.7
2005	Sep	12 o/oo	0.006	0.378	0.64	0.626	1.4
2005	Sep	20 o/oo	0.006	0.187	0.66	0.313	1.4
2005	Oct	0 o/oo	0.006	0.453	1.51	0.801	1.3
2005	Oct	6 o/oo	0.006	0.157	1.84	0.736	0.5
2005	Oct	12 o/oo	0.006	0.022	7.92	0.574	0.1
2005	Oct	20 o/oo	0.006	0.143	0.94	0.528	0.6

Table 3.5 (continued)
Physical and Chemical Water Quality Parameters - Nutrients

Year	Month	Sample Location	Ammonia/ Ammonium (mg/l)	Nitrite/ Nitrate (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Orthophosphorus (mg/l)	Available N/P Atomic Ratio
2005	Nov	0 o/oo	0.057	0.270	1.10	0.713	1.0
2005	Nov	6 o/oo	0.059	0.254	0.97	0.535	1.3
2005	Nov	12 o/oo	0.059	0.279	0.88	0.461	1.7
2005	Nov	20 o/oo	0.061	0.232	0.73	0.297	2.3
2005	Dec	0 o/oo	0.006	0.517	0.89	0.708	1.7
2005	Dec	6 o/oo	0.006	0.344	0.96	0.428	1.9
2005	Dec	12 o/oo	0.006	0.257	0.96	0.381	1.6
2005	Dec	20 o/oo	0.006	0.117	0.62	0.260	1.1

Table 3.8

Mean Near Surface Values for Key Physical, Chemical and Biological Measurements by Isohaline

Isohaline	TEMP	COLOR	N23	OP	NP	SI	EXC	CHLA
Summary of data from current year – 2005								
0 o/oo Salinity	25.2	183	0.340	0.665	0.6	5.60	2.7	22.8
6 o/oo Salinity	25.2	170	0.223	0.540	0.5	4.63	2.1	30.6
12 o/oo Salinity	24.9	137	0.142	0.452	0.4	3.97	1.9	91.0
20 o/oo Salinity	24.6	83	0.083	0.312	0.4	2.96	1.3	17.5
Summary of data from preceding period 1983-2005								
0 o/oo Salinity	24.9	143	0.495	0.736	0.8	3.00	2.9	9.3
6 o/oo Salinity	25.2	117	0.216	0.524	0.6	2.55	2.6	23.1
12 o/oo Salinity	25.1	89	0.100	0.369	0.4	1.98	2.2	24.9
20 o/oo Salinity	24.8	52	0.036	0.216	0.4	1.24	1.6	13.6

Temp = Temperature ^{o}C
Color = Color Co_Pt units mg/L
N23 = Nitrate/Nitrite nitrogen mg/L
OP = Orthophosphorus mg/L
NP = Atomic Inorganic nitrogen to phosphorus ratio
SI = Reactive silica mg/L
EXC = Extinction coefficient
CHLA = Chlorophyll *a* ug/L

Table 4.1
HBMP Fixed Sampling Locations

USGS River Mile	USGS Location Number	Previous EQL Station Number	Additional Sampling	New River Kilometer designation based on Morphometric Study
Current *In Situ* Water Column Profile Sampling Locations				
CH6	265355082075500	9	Water Quality	**-2.4**
RM3.95	265640082033500	10	Water Quality	**6.6**
RM4.88	265724082024400	21		**8.4**
RM6.25	265727082012800	11		**10.5**
RM8.61	265711081595500	Shell Creek 9 (92)		**12.7**
RM8.6B	265819082003200	22		**12.8**
RM10.2	2297460	12	Water Quality/Tide Gage/Conductivity	**15.5**
RM11.2	270022081591000	23		**17.5**
RM 12.55	270124081592500	13		**20.1**
RM13.95	270235081592400	24		**21.9**
RM14.82	270318081593100	14	Water Quality	**23.6**
RM15.45	270337081595800	25		**24.7**
RM16.29	270418082001600	15		**25.9**
N/A	2297350	N/A	Tide Gage/ Conductivity	**26.7**
RM18.25	270451081595100	17		**29.5**
RM18.95	2297330	18	Water Quality	**30.4**
RM19.5	270537081585800	19		**32.3**
Vegetation Transect Locations				
N/A	N/A	I		**15.6**
N/A	N/A	II		**22.3**
N/A	N/A	III		**20.4**
Previous EQL Water Column and Chemistry Sampling Sites				
N/A	N/A	16		**27.1**
N/A	N/A	20		**34.1**

Table 4.5

Mean Near Surface Values for Key Physical, Chemical and Biological Measurements at Fixed Sampling Sites

River Kilometer	Color	Iron	N23	TKN	OP	Si	Chla
Summary of data from current year – 2005							
-2.4	68	0.13	0.047	0.66	0.29	1.9	16.0
6.6	124	0.31	0.167	0.92	0.51	3.3	25.7
15.5	164	0.4	0.269	1.25	0.75	4.8	108.3
23.6	187	0.42	0.339	1.18	0.88	5.3	33.3
30.4	183	0.44	0.398	1.31	0.88	5.6	31.3
Summary of data from preceding period 1976-2004							
-2.4	59	0.37	0.042	0.71	0.21	2.0	16.0
6.6	93	0.34	0.09	0.84	0.30	2.7	13.0
15.5	143	0.37	0.246	1.13	0.54	4.4	18.1
23.6	147	0.39	0.453	1.03	0.68	5.1	12.8
30.4	149	0.38	0.521	1.03	0.71	5.0	10.0

Color = Color Co_Pt Units
Iron = Iron mg/L

TOC = Total Organic Carbon mg/L
N23 = Nitrite+Nitrate Nitrogen mg/L
TKN = Total Kjeldhal Nitrogen mg/L

OP = Ortho-phosphorus mg/L
SI = Reactive Silica mg/L
CHLA = Chlorophyll *a* ug/L

Table 6.2
Evaluation of Potential Locations for Additional Authority Continuous Recorder Deployments

ID	Name	Location	# pilings	Depth 1 (feet)	Depth 2 (feet)	Channel Depth (feet)	Latitude		Longitude		Channel Position
USGS1	USGS Campground	Campground (Dock)					27	4.629	82	0.432	
MZ-1	MZ above Navigator	Between Navigator & campground	2	3.0	3.2		27	4.204	82	0.203	side
Dock 1	Dock (Alderon)	Upstream of Navigator	multiple	9.6			27	3.781	82	0.098	side
Dock 2	Dock (south of Alderon)	Upstream of Navigator	multiple	10.5			27	3.78	82	0.095	side
MZ-2	MZ across from Navigator	Across from Navigator	2	2.4	2.4		27	3.65	81	59.96	side
MZ-3	MZ below Navigator across from Cattail marsh	Downstream of Navigator	2	3.0	3.0	11.0	27	3.247	81	59.48	side
MZ-4	MZ North tip Liverpool I.	Tip upstream of Liverpool channel	2	3.4	3.4	8.0	27	2.58	81	59.36	side
MZ-5	MZ mid Liverpool, middle channel	Mid Liverpool mid channel	2	4.3	4.4	4.4	27	2.069	81	59.49	side
R/G-A	Red/Green Marker A	South tip Island 33	1	8.2		16	27	1.975	81	59.52	side
R-14	Red Marker 14	South tip Liverpool	1	4.0		12.4	27	1.896	81	59.47	side
MZ-6	MZ South tip Liverpool	South tip Liverpool	2	3.2	3.2	12.4	27	1.884	81	59.44	side
R-12	Red Marker 12	South tip Liverpool	1	8.1		11.6	27	1.815	81	59.45	side
G-11	Green Marker 11		1	7.6		8.0	27	1.443	81	59.41	side
Dock 3	Dock just below Marker 11	West bank below Marker 11	multiple	6.0		8.0	27	1.36	81	59.44	center
R-10	Red Marker 10	Immediately above upper power lines	1	8.2		10.0	27	1.09	81	59.12	side
G-9	Green Marker 9	Below upper power lines	1	5.2		19.0	27	0.58	81	59.03	side
G-7	Green Marker 7		1	6.7		8.0	27	0.371	81	59.21	side
G-5	Green Marker 5		1	8.3		8.3	27	0.216	81	59.3	mid
R-4	Red Marker 4	Immediately above lower power lines	1	6.4		7.0	27	0.036	81	59.32	side
R-2	Red Marker 2	Immediately below lower power lines	1	10.3		14.0	26	59.8	81	59.35	side
MZ7	MZ adjacent to Red Marker 2	Immediately below lower power lines	2	9.4	9.4	14.0	26	59.8	81	59.34	side
USGS2	USGS Harbor Heights Gage	At end of dock					26	59.25	81	59.58	

*** Note**: MZ denotes Manatee zone US Fish & Wildlife markers; R denotes “red” channel navigational markers that are identified by their number; G denotes “green” channel navigational markers that are identified by their number.

2005 HBMP Figures

- Section 1 – Introduction / Summary
- Section 2 – Gage Flows and Withdrawals
- Section 3 – "Moving" Isohaline Monitoring
- Section 4 – "Fixed" Station Monitoring
- Section 5 – Continuous Recorders
- Section 6 – Authority Continuous Recorders
- Section 7 – Adverse Impacts

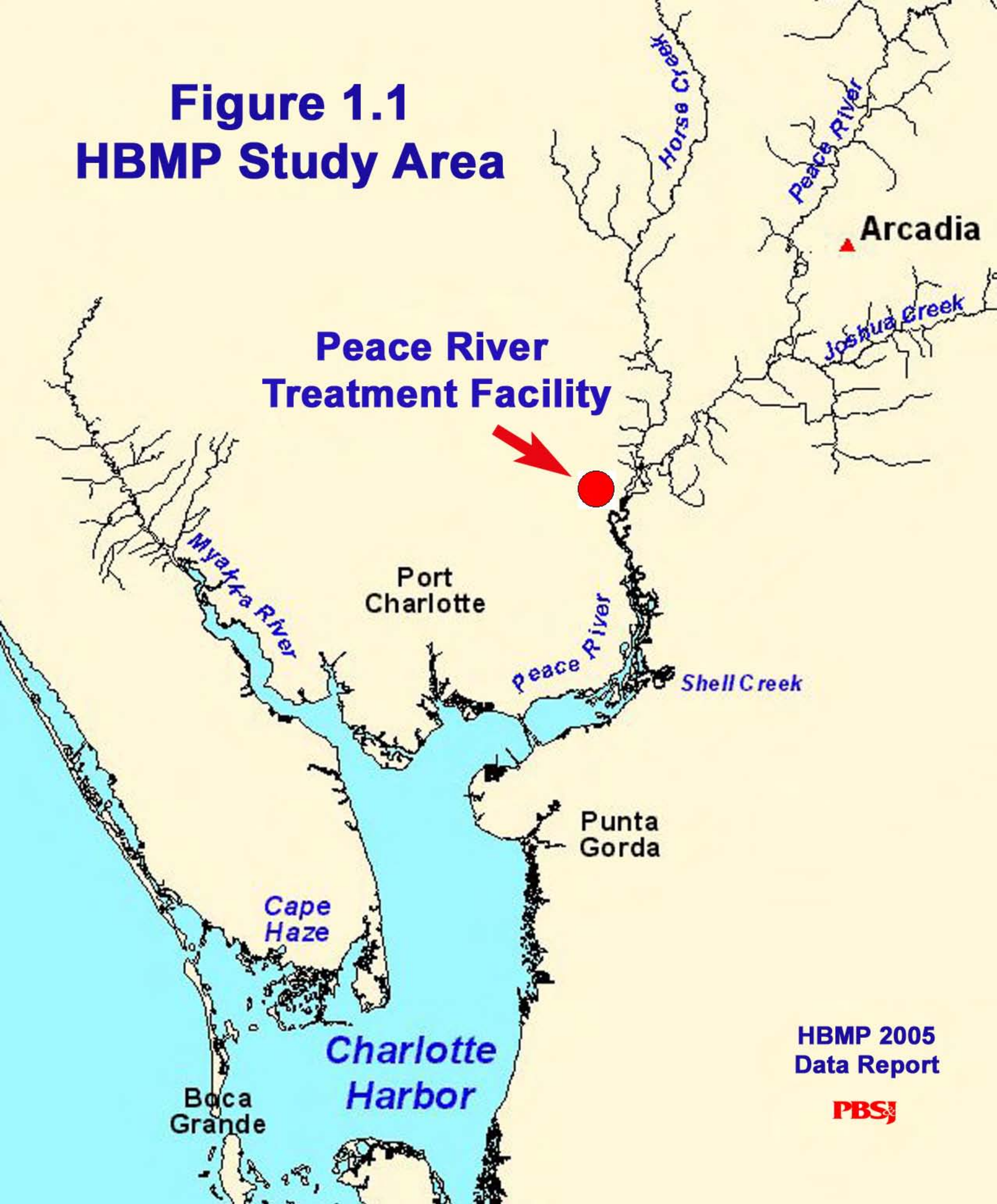
Figure 1.1
HBMP Study Area
Horse Creek
Peace River
Arcadia
Joshua Creek
Peace River
Treatment Facility
Myakka River
Port
Charlotte
Peace River
Shell Creek
Punta
Gorda
Cape
Haze
Charlotte
Harbor
Boca
Grande
HBMP 2005
Data Report
PBSJ

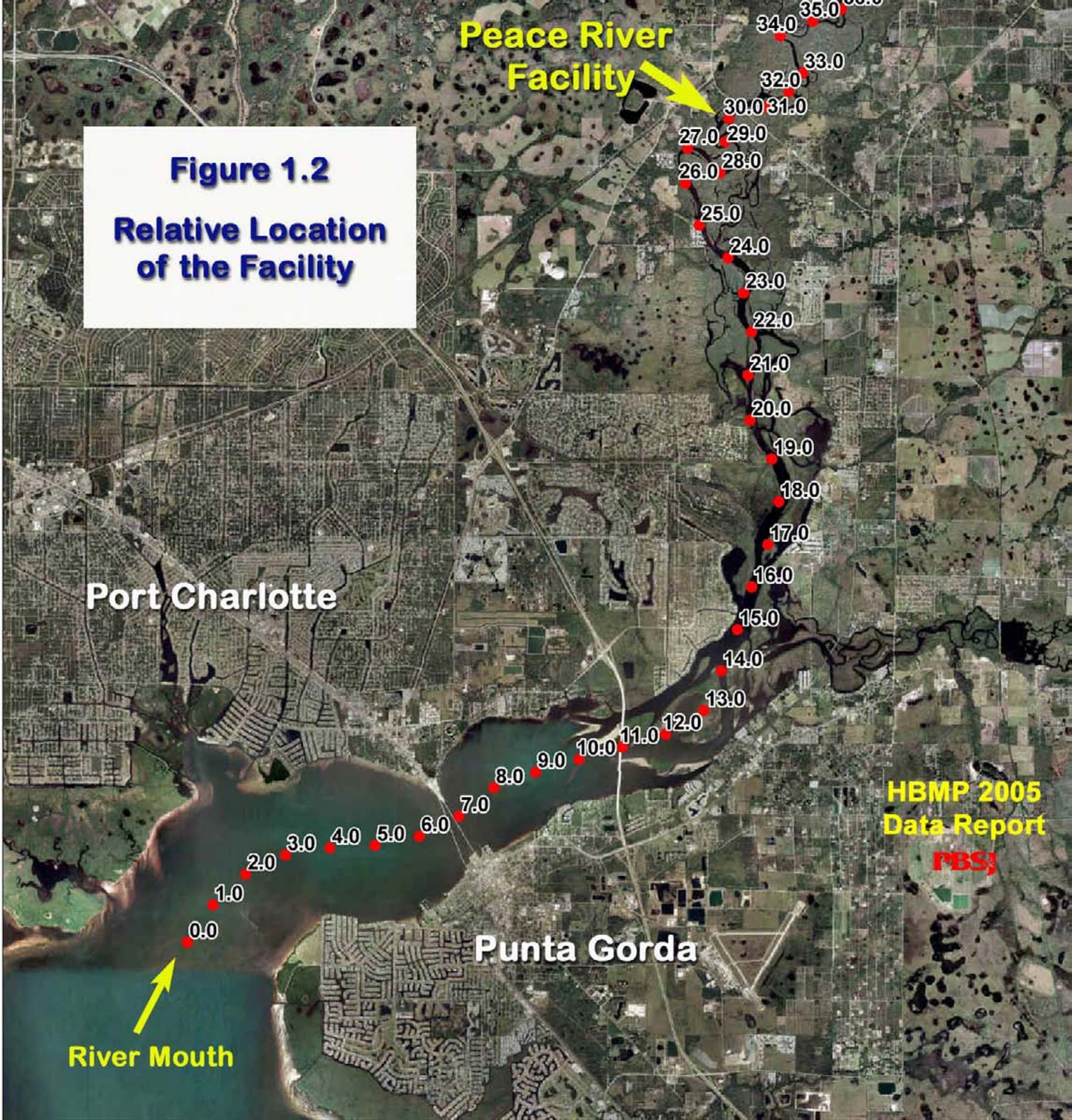
Figure 1.2
Relative Location of the Facility
Peace River Facility
Port Charlotte
Punta Gorda
River Mouth
HBMP 2005 Data Report
PBSJ
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
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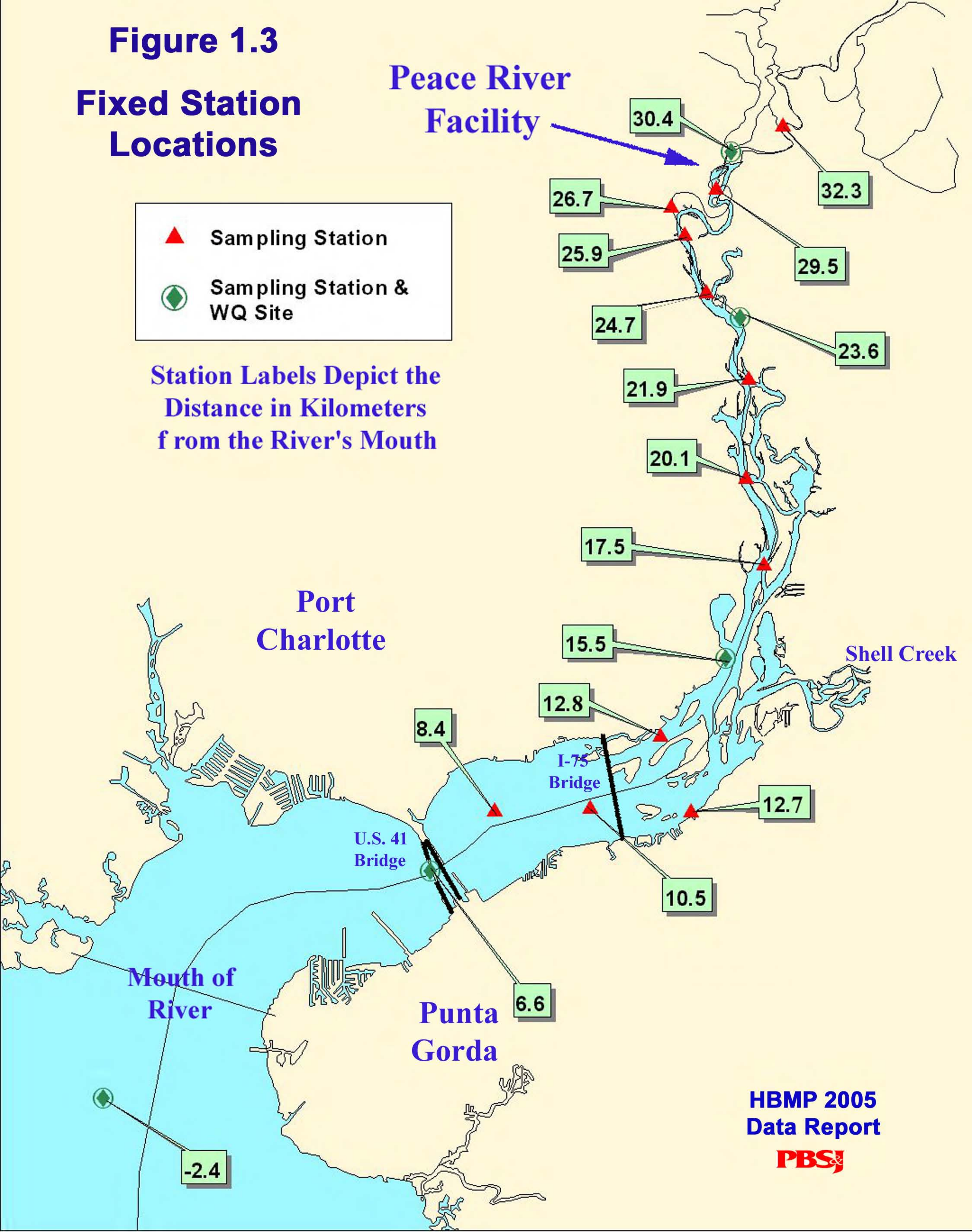


Figure 1.3
Fixed Station Locations
Peace River Facility
Sampling Station
Sampling Station & WQ Site
Station Labels Depict the Distance in Kilometers from the River's Mouth
30.4
32.3
26.7
29.5
25.9
24.7
23.6
21.9
20.1
17.5
Port Charlotte
15.5
Shell Creek
12.8
8.4
I-75 Bridge
12.7
U.S. 41 Bridge
10.5
Mouth of River
6.6
Punta Gorda
-2.4
HBMP 2005 Data Report
PBSJ

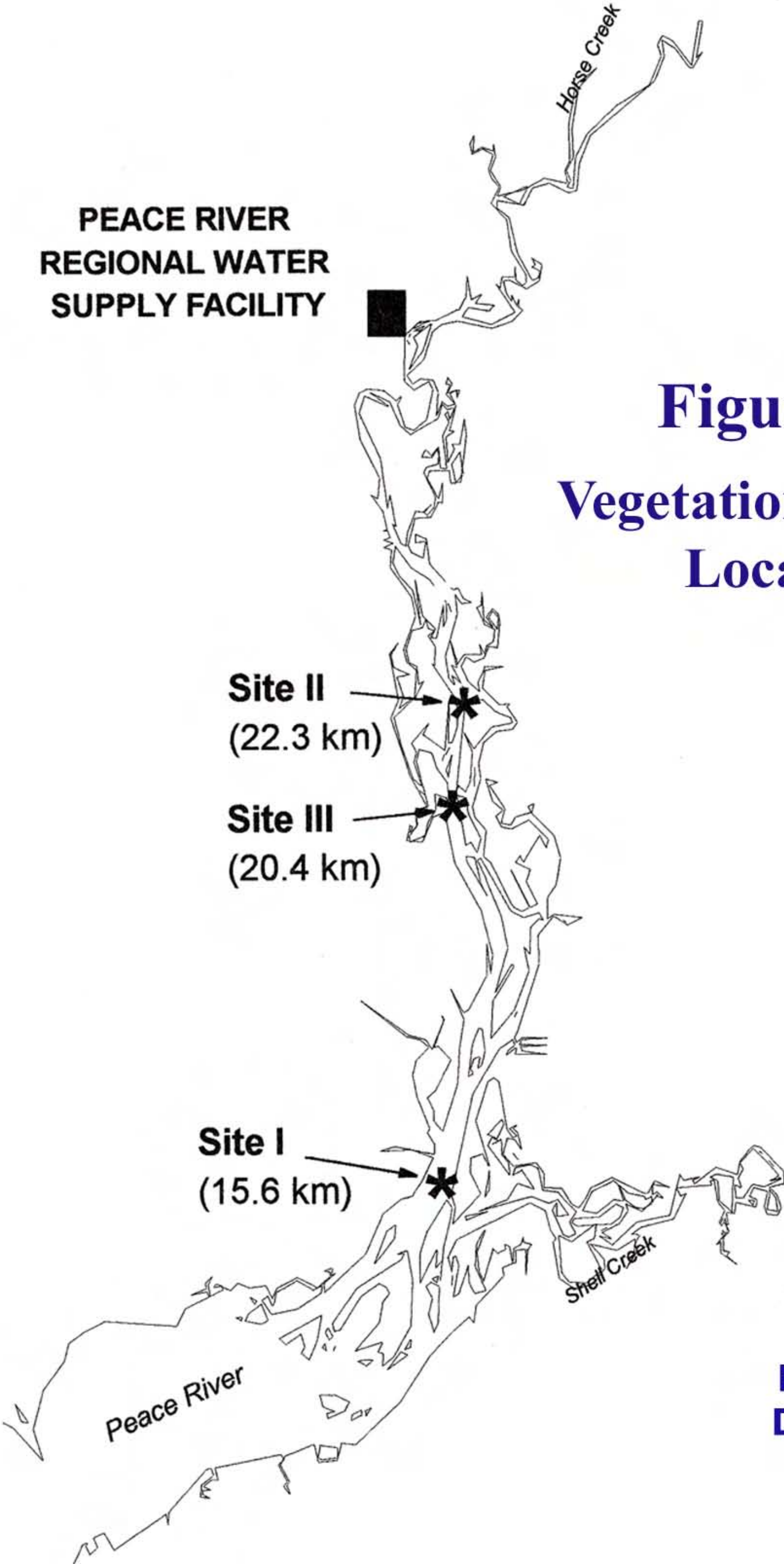


Figure 1.4
Vegetation Transect Locations

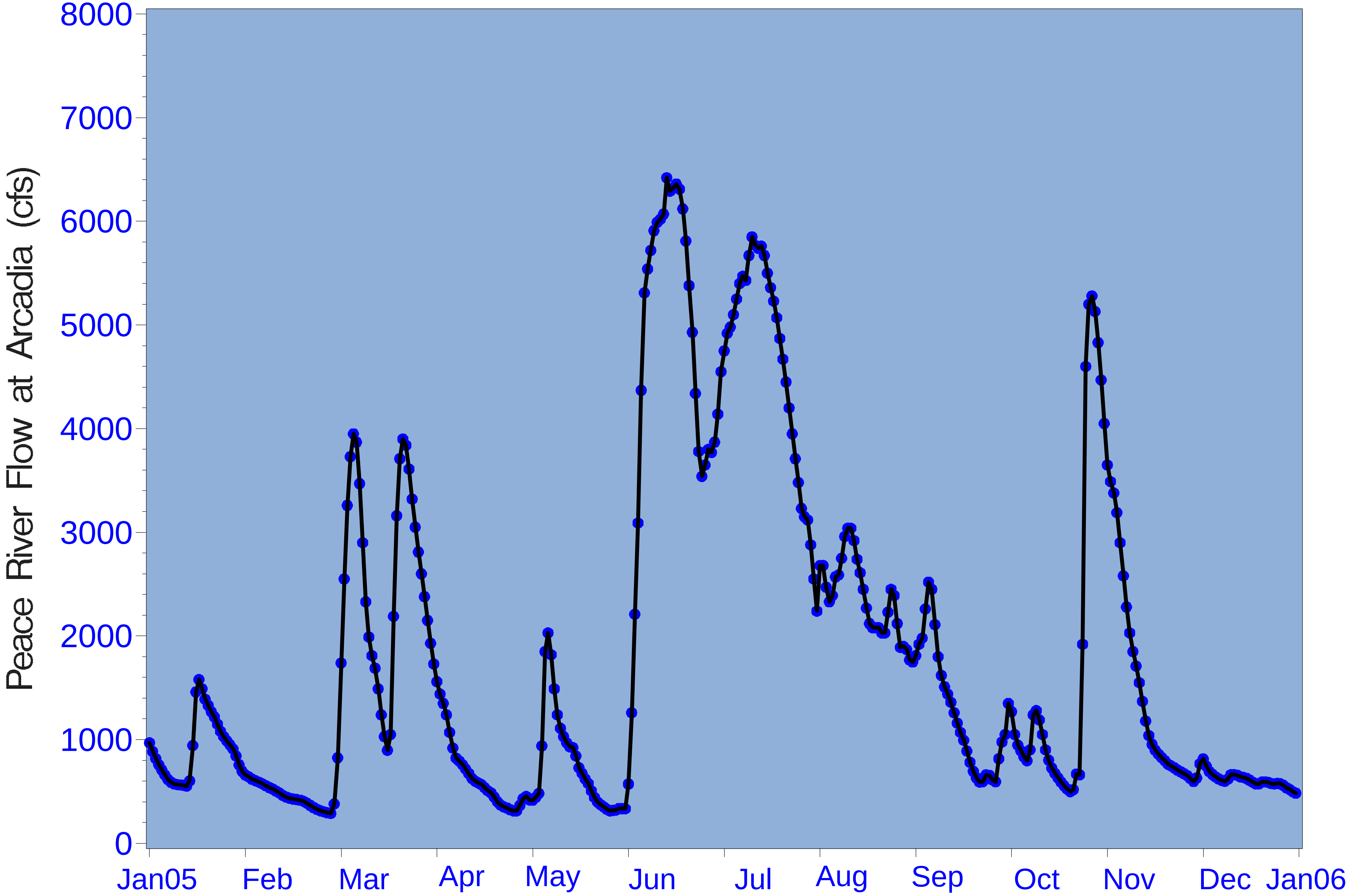


Figure 2.1 Daily Peace River flow at Arcadia (2005)

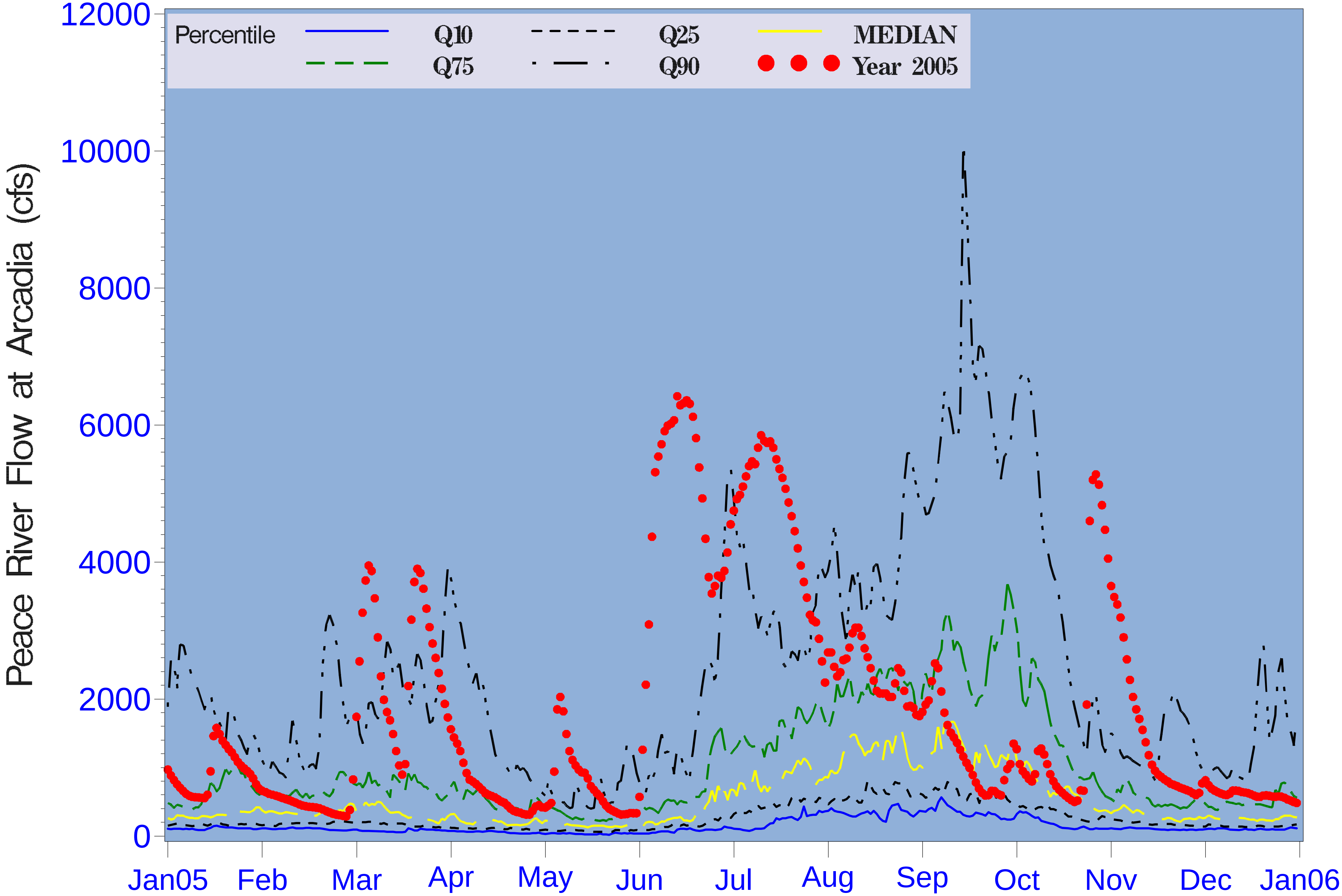


Figure 2.2 Daily Peace River flow at Arcadia in relation to long-term statistical averages

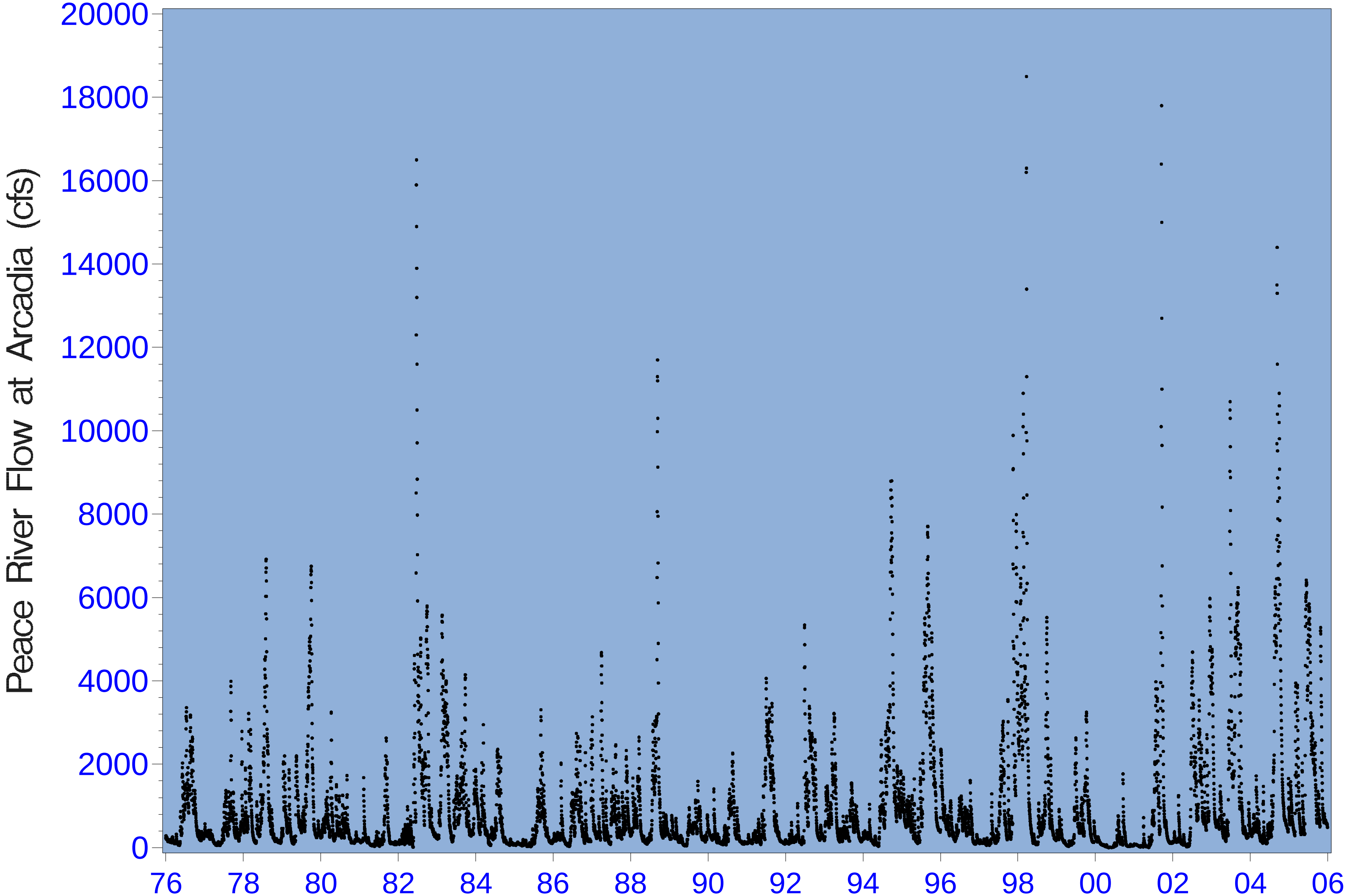


Figure 2.3 Daily Peace River flow at Arcadia (1976-2005)

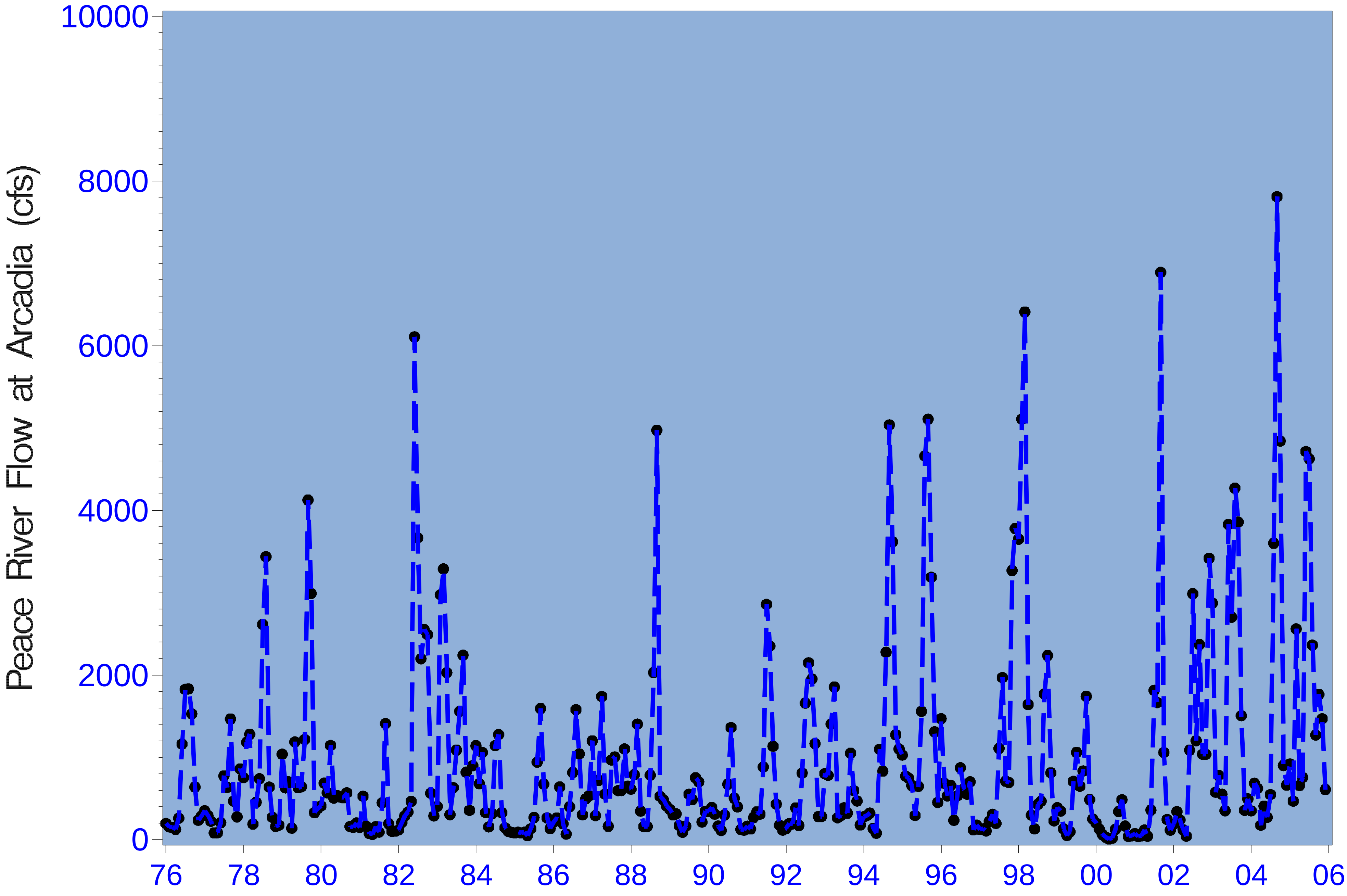


Figure 2.4 Monthly mean Peace River flow at Arcadia (1976-2005)

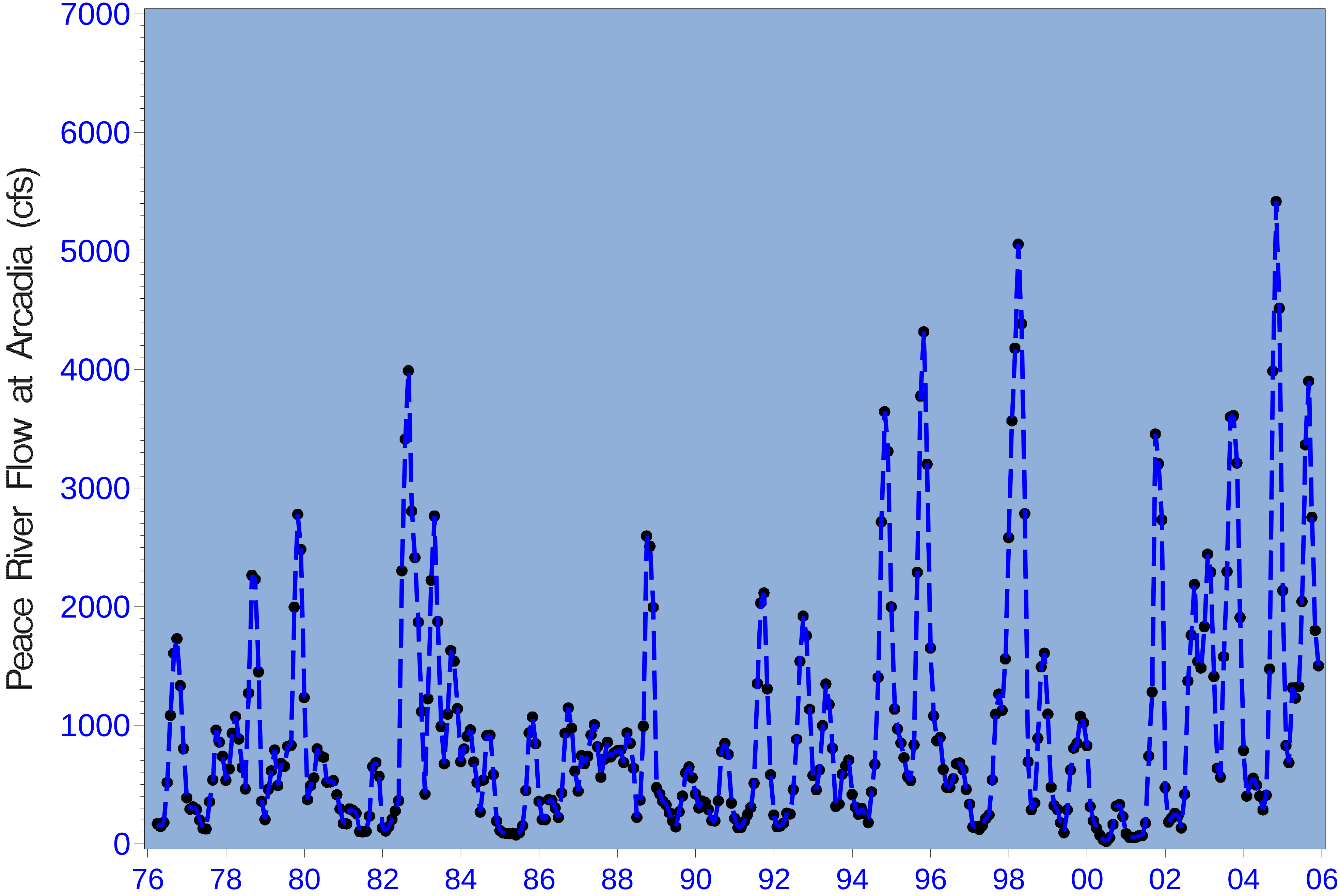


Figure 2.5 3-Month moving average Peace River flow at Arcadia (1976-2005)

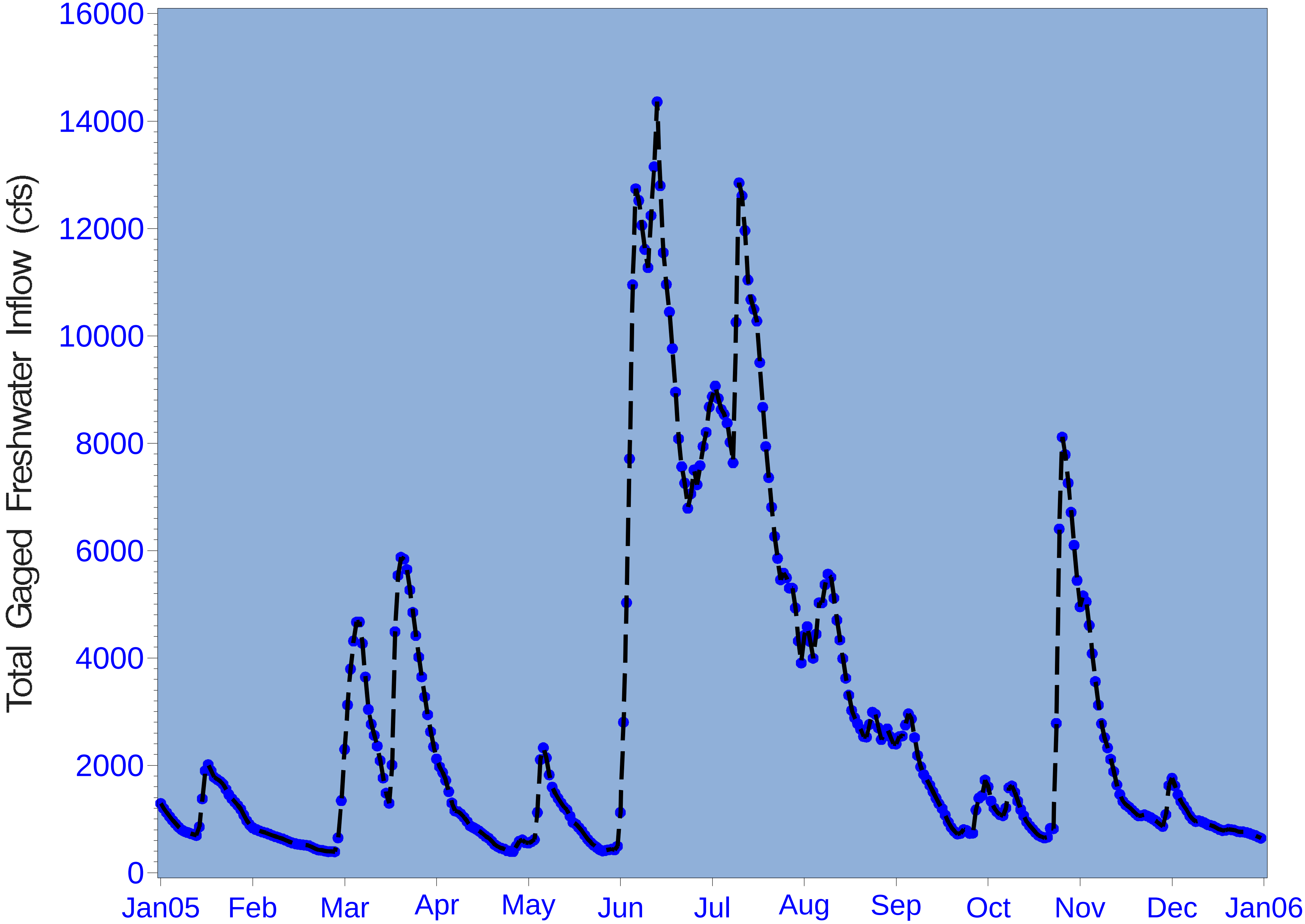


Figure 2.6 Total daily gaged flow - Peace River at Arcadia + Horse, Joshua and Shell Creeks (2005)

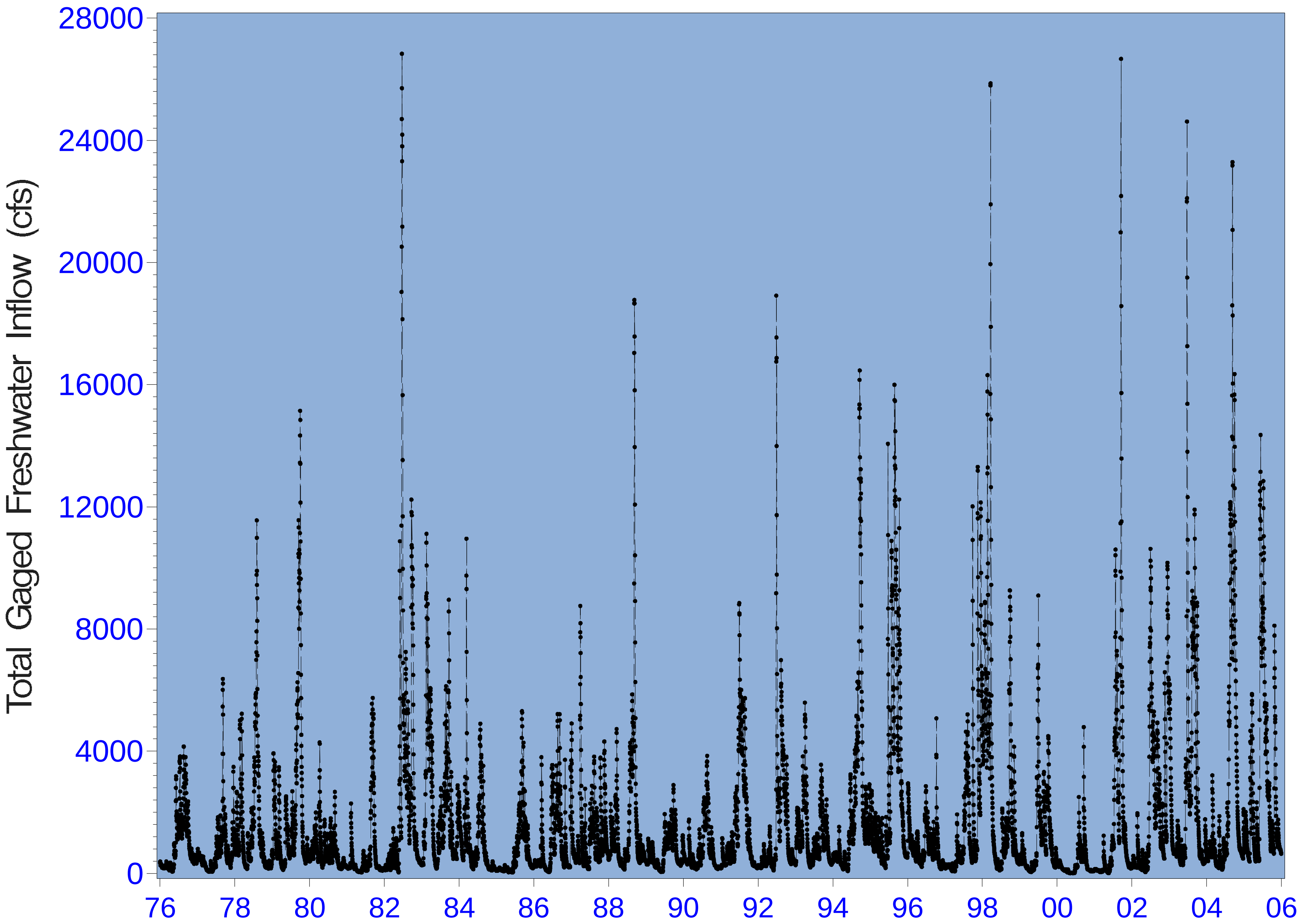


Figure 2.7 Total daily gaged flow - Peace River at Arcadia + Horse, Joshua and Shell Creeks (1976-2005)

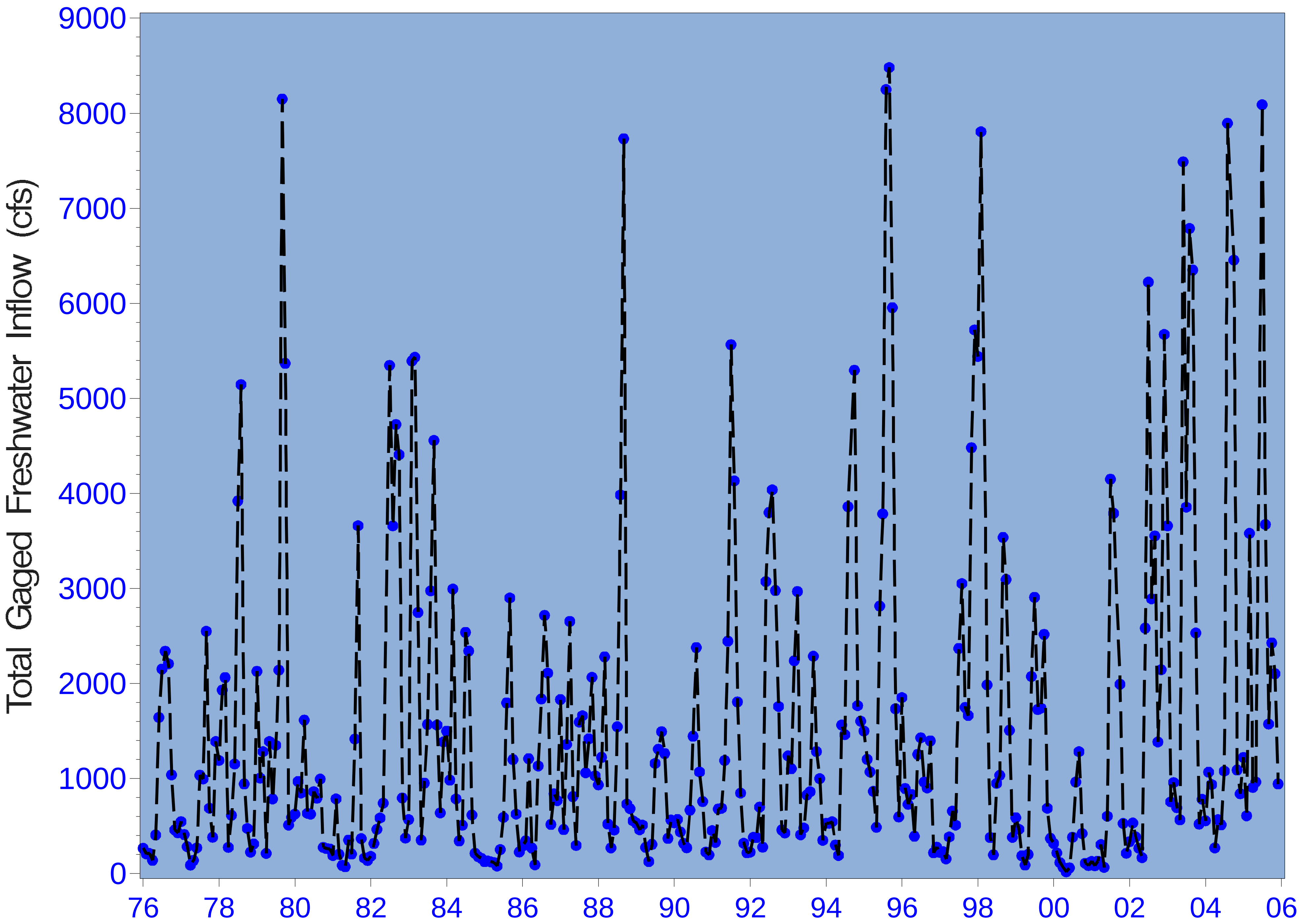


Figure 2.8 Mean monthly flow - Peace River at Arcadia + Horse, Joshua and Shell Creeks (1976-2005)

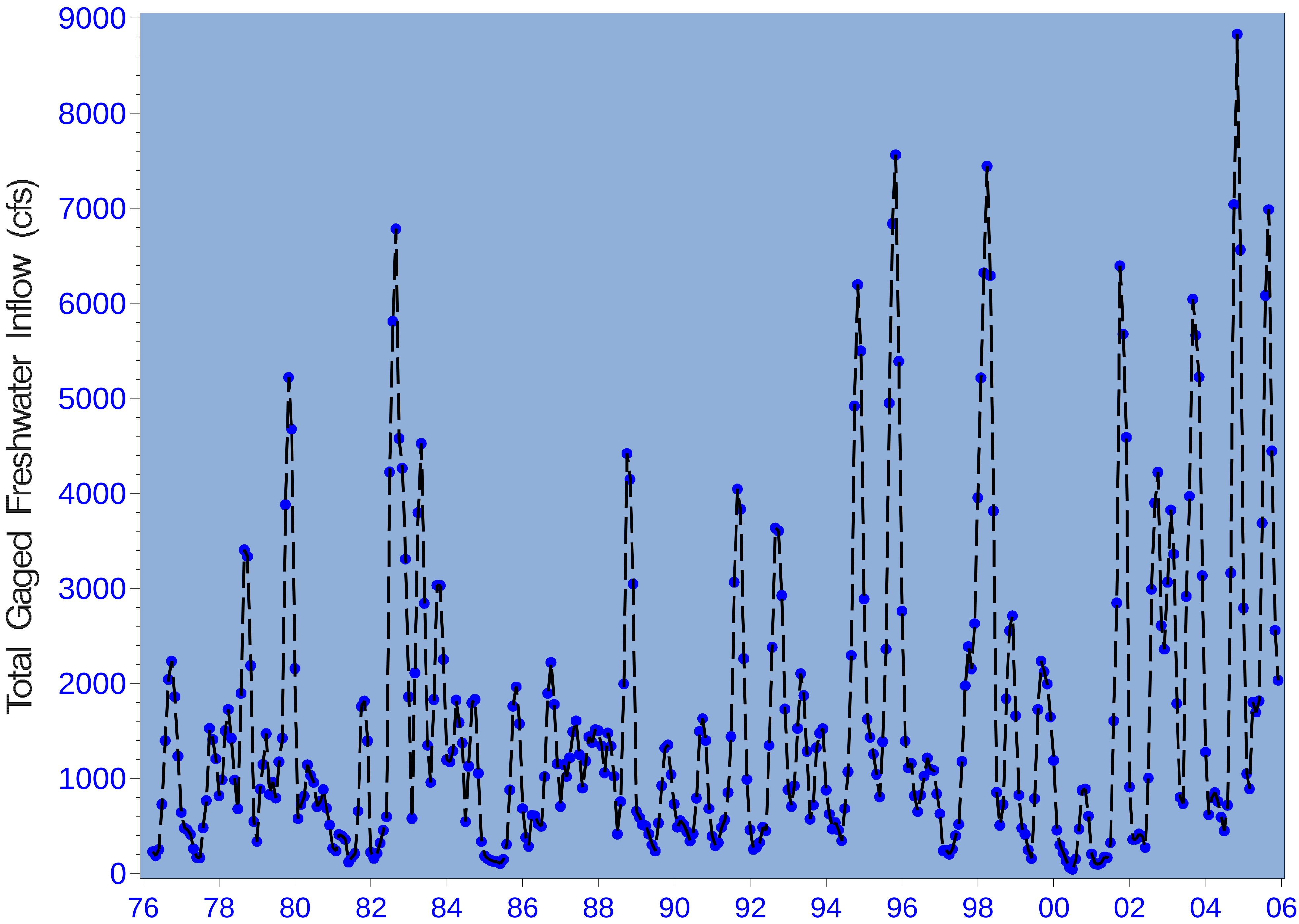


Figure 2.9 3-Month moving average flow - Peace River + Horse, Joshua and Shell Creeks (1976-2005)

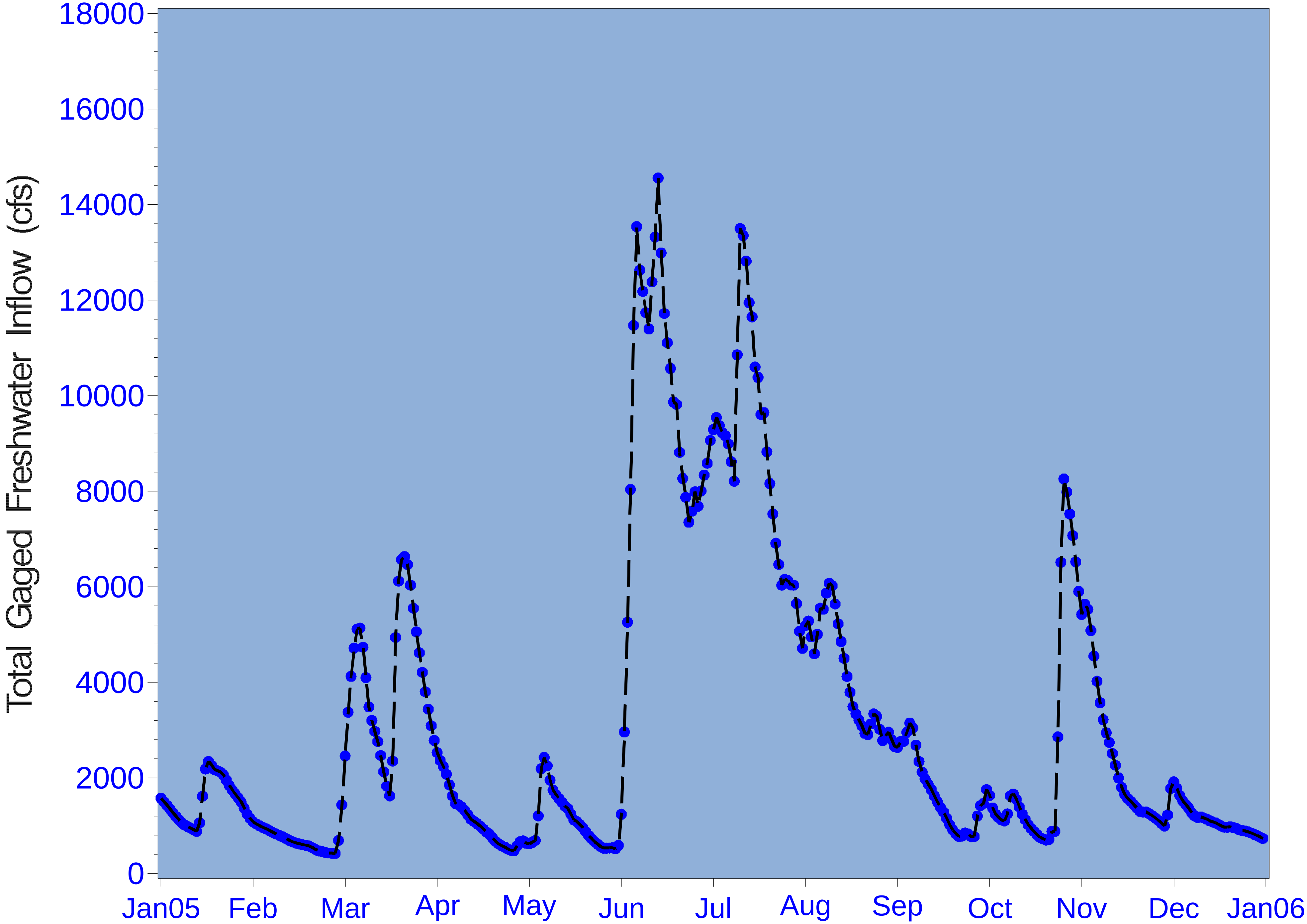


Figure 2.10 Total daily gage flow -Peace & Myakka Rivers + Horse, Joshua and Shell Creeks (2005)

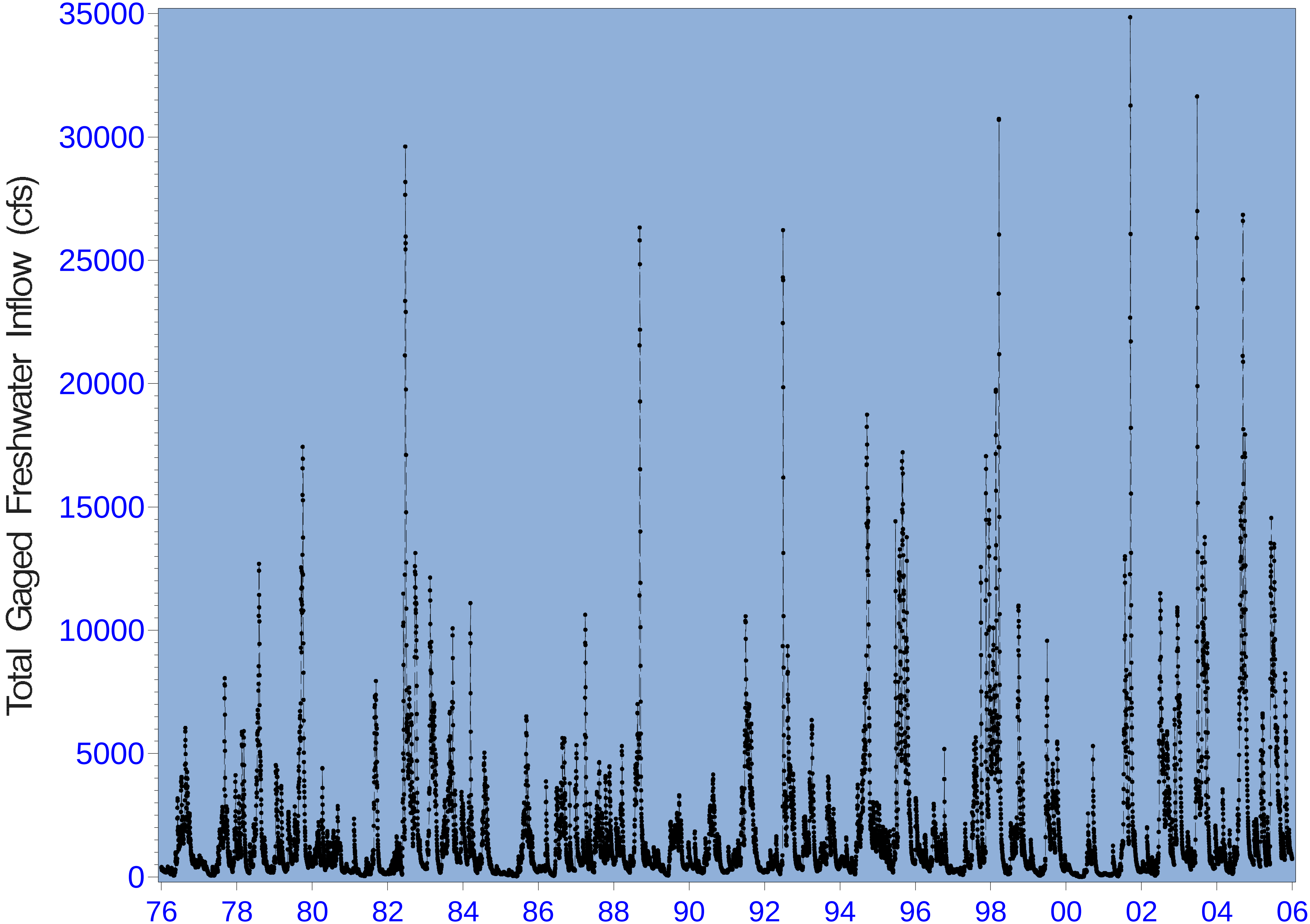


Figure 2.11 Total daily gaged flow - Peace & Mykka Rivers + Horse, Joshua and Shell Creeks (1976-2005)

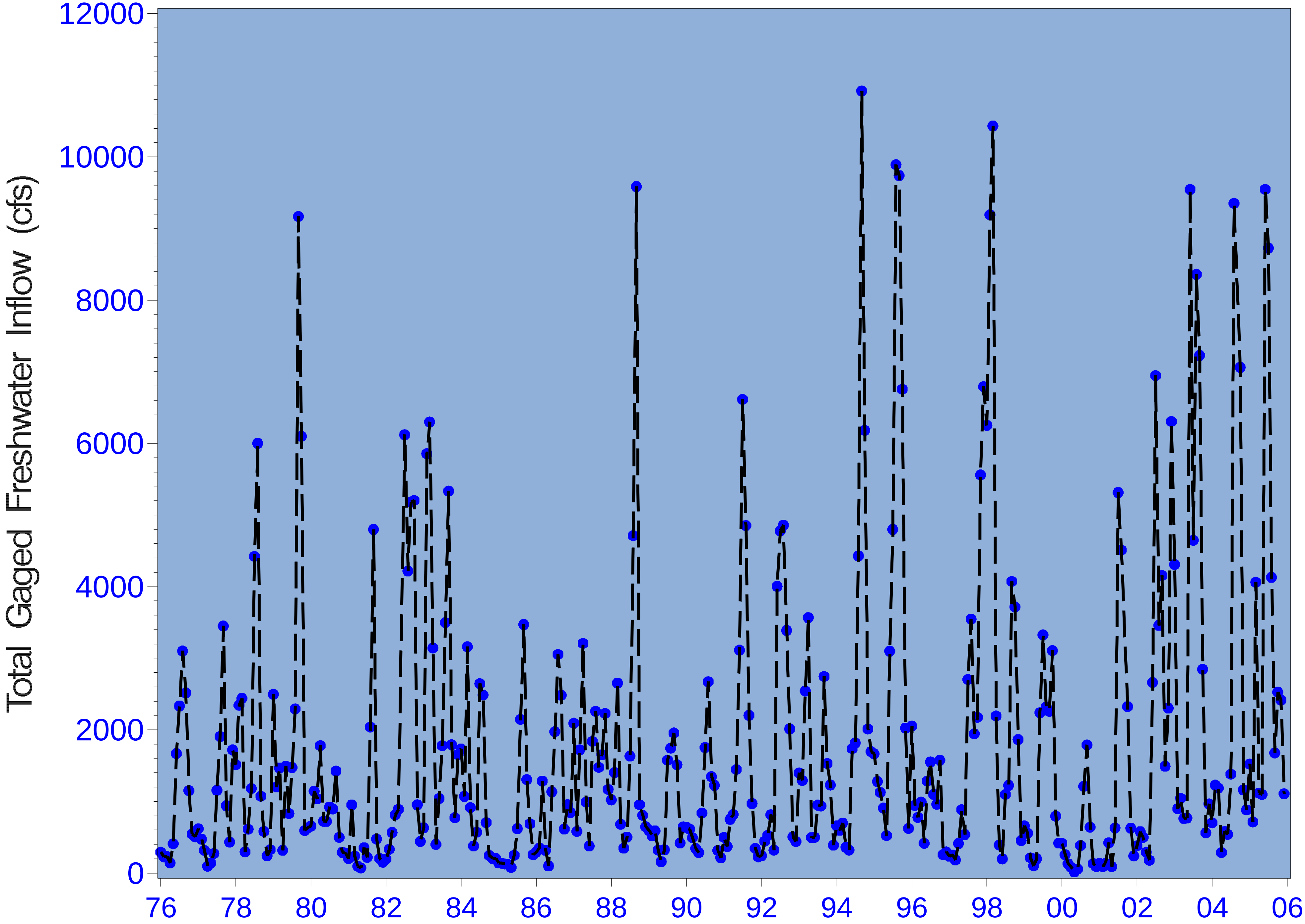


Figure 2.12 Mean monthly flow - Peace & Myakka Rivers + Horse, Joshua and Shell Creeks (1976-2005)

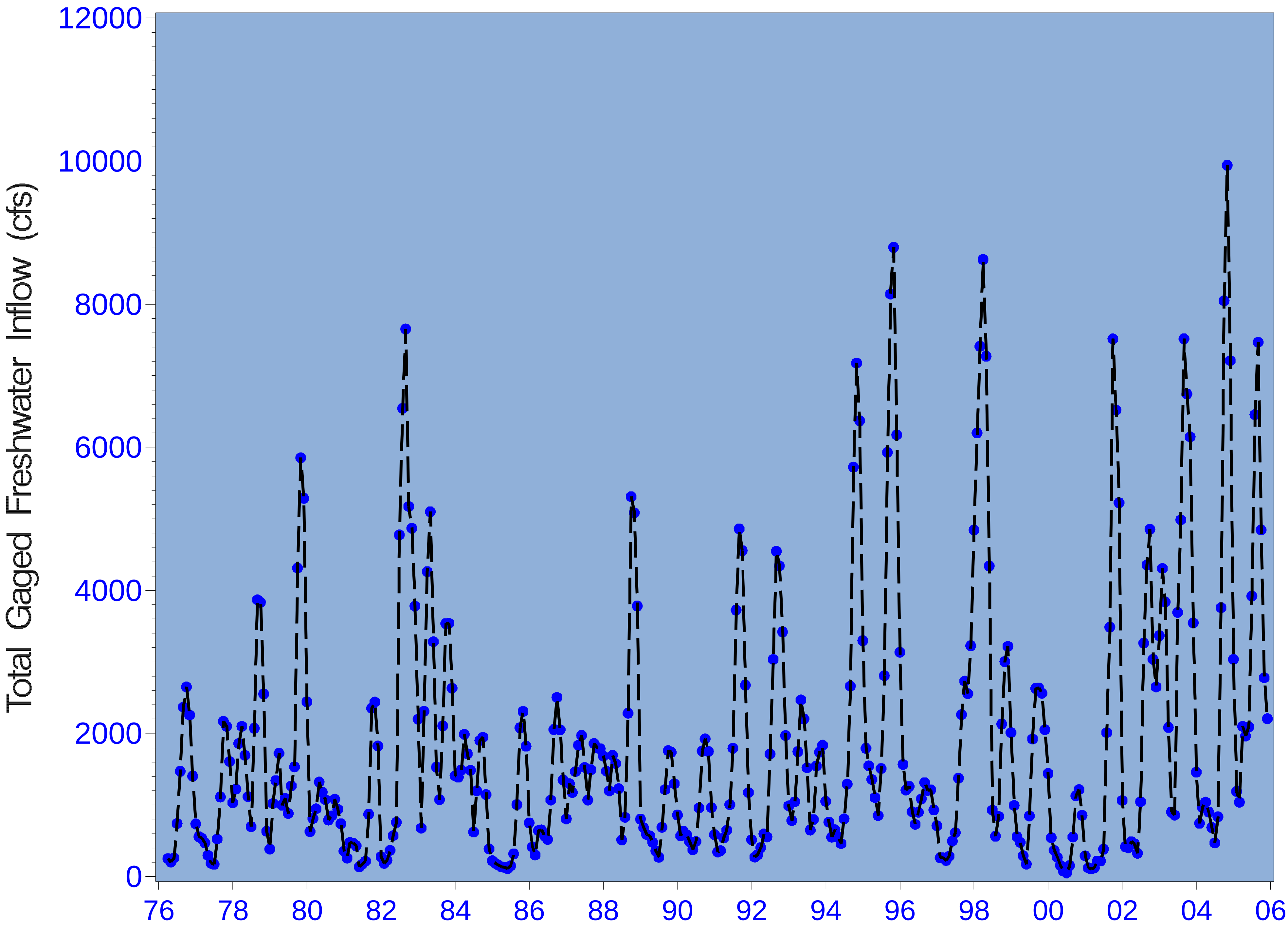


Figure 2.13 3-Month moving average flow - Peace & Myakka Rivers + Horse, Joshua and Shell Creeks (1976-2005)

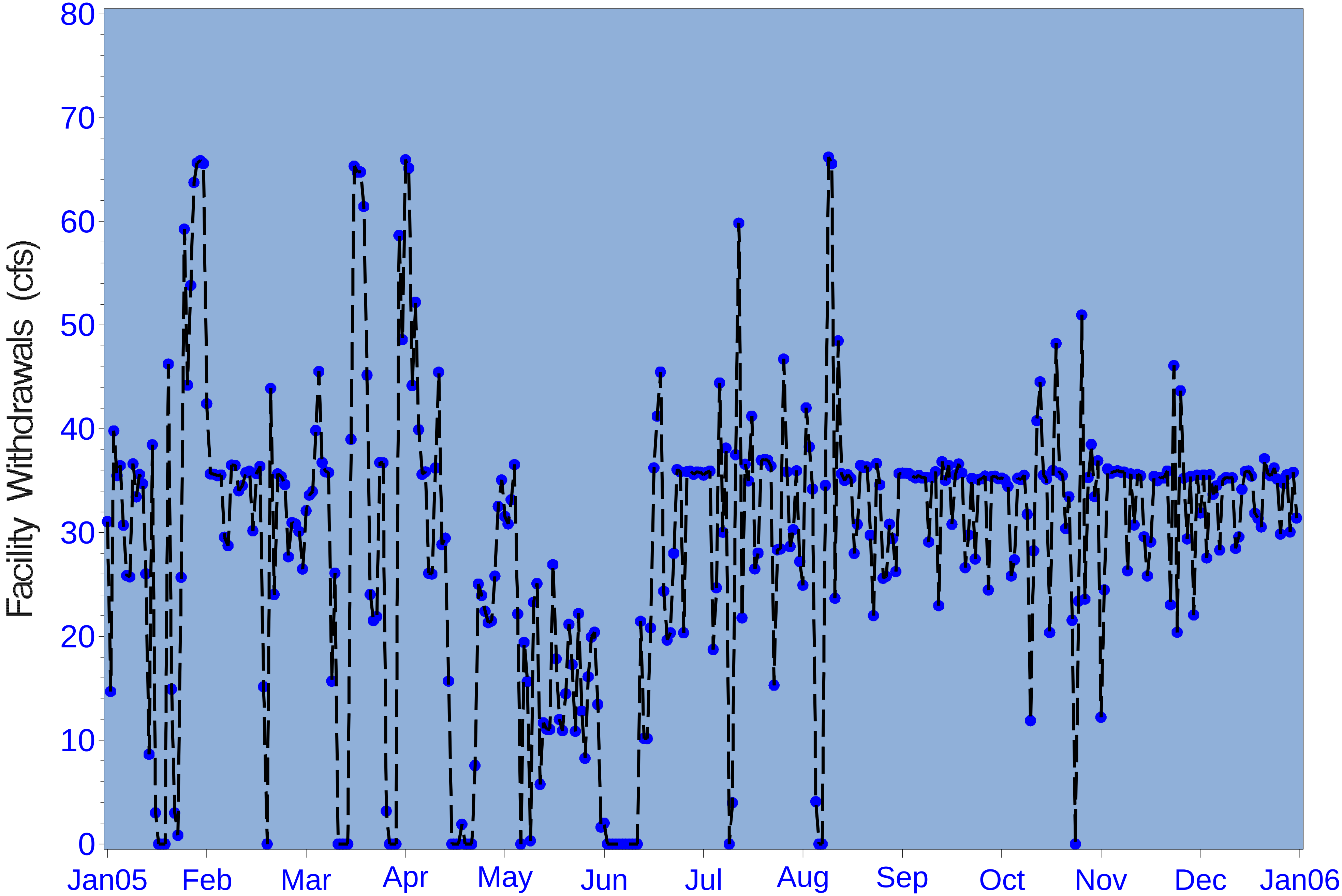


Figure 2.14 Daily water treatment facility withdrawals (2005)

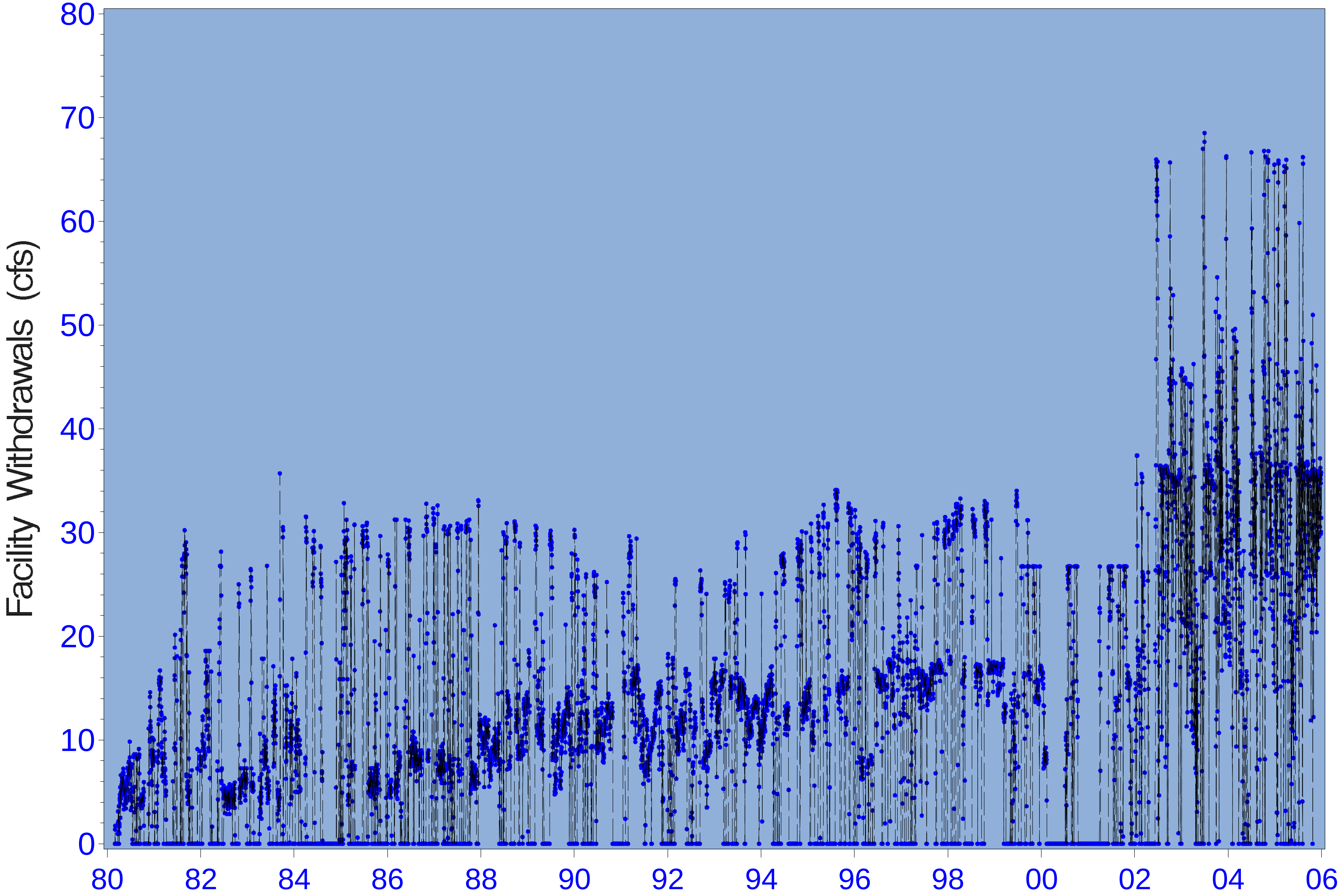


Figure 2.15 Daily water treatment facility withdrawals (1980-2005)

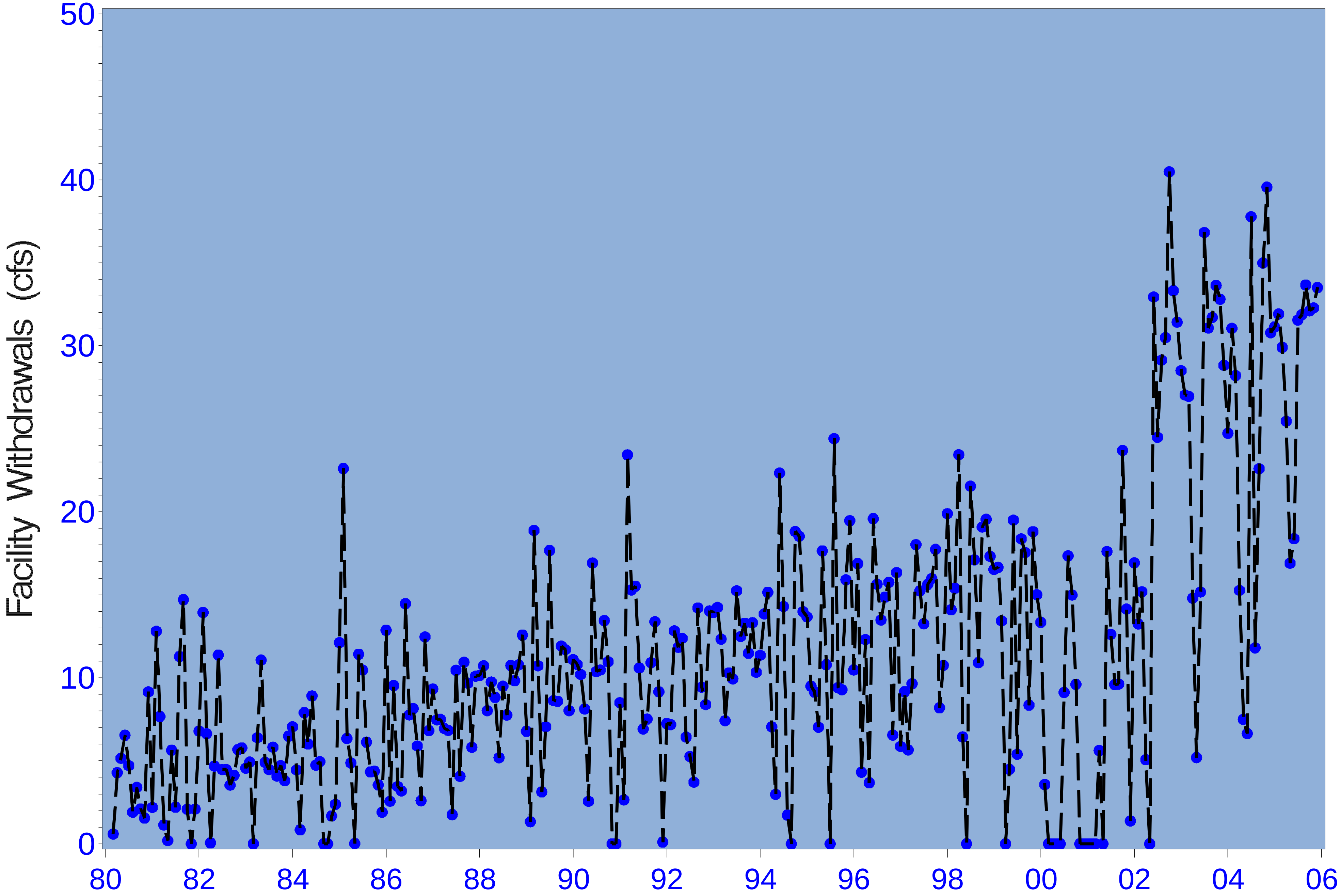


Figure 2.16 Monthly mean water treatment facility withdrawals (1980-2005)

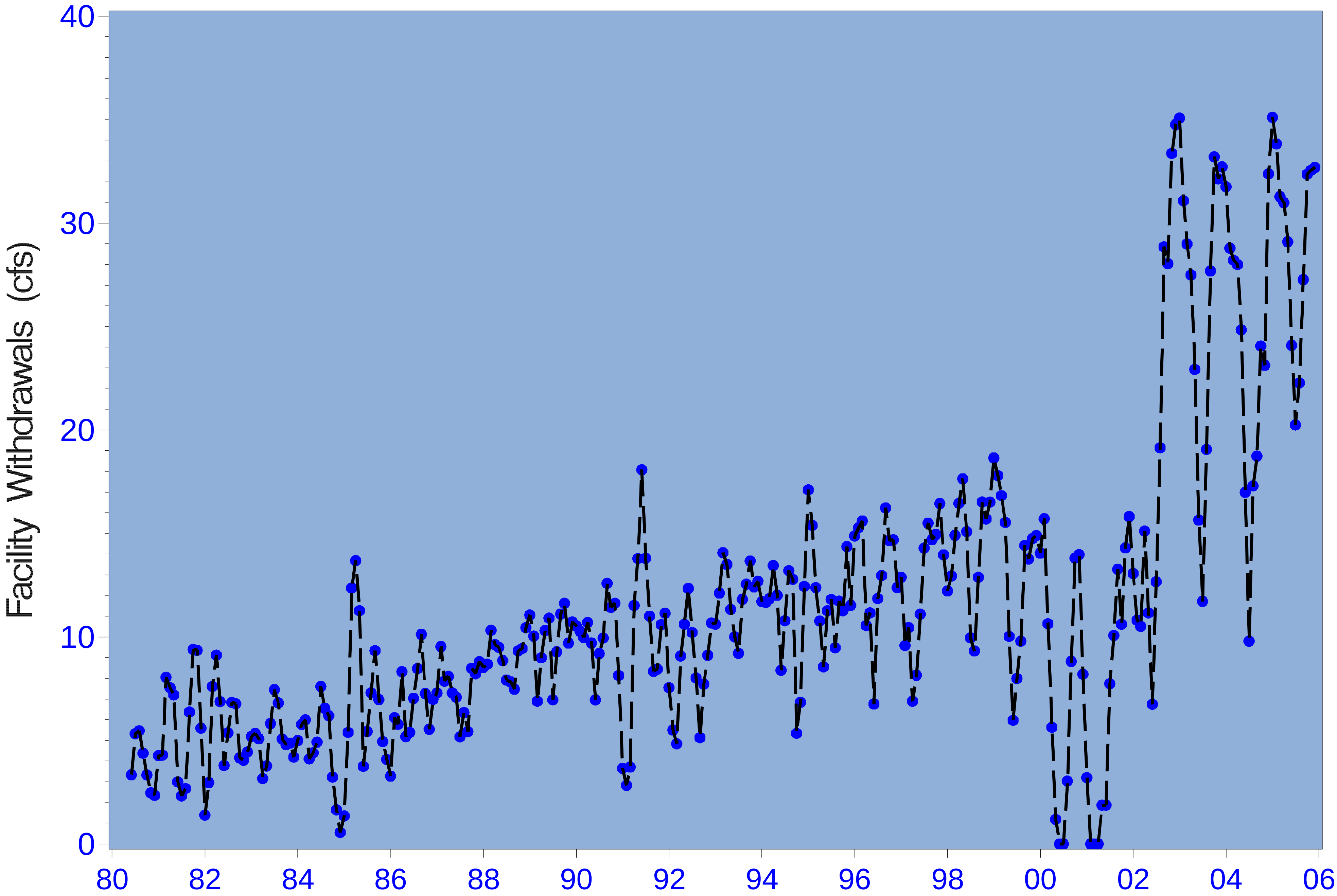


Figure 2.17 3-Month moving average water treatment facility withdrawals (1980-2005)

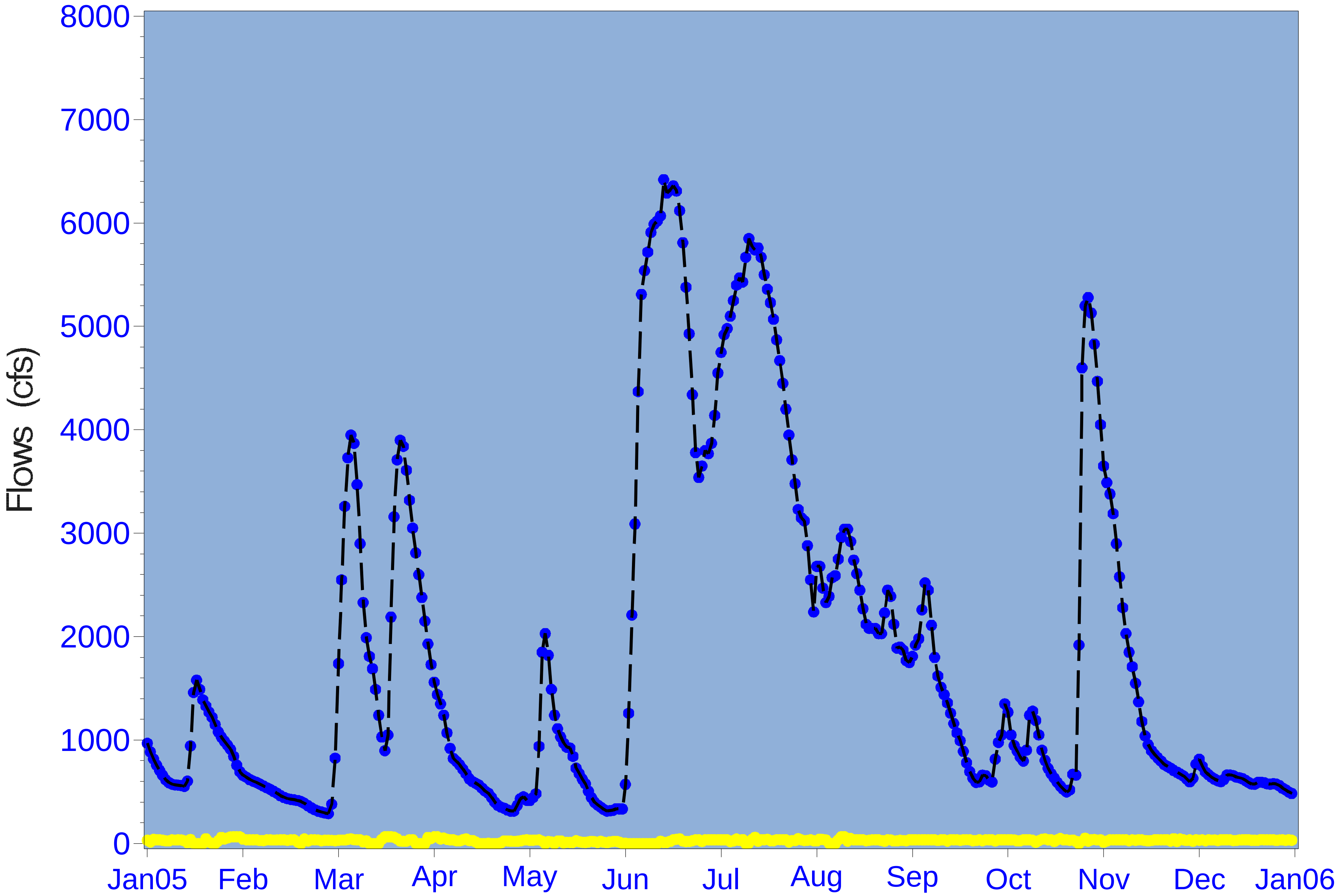


Figure 2.18 Peace River flows at Arcadia and water treatment facility withdrawals (2005)

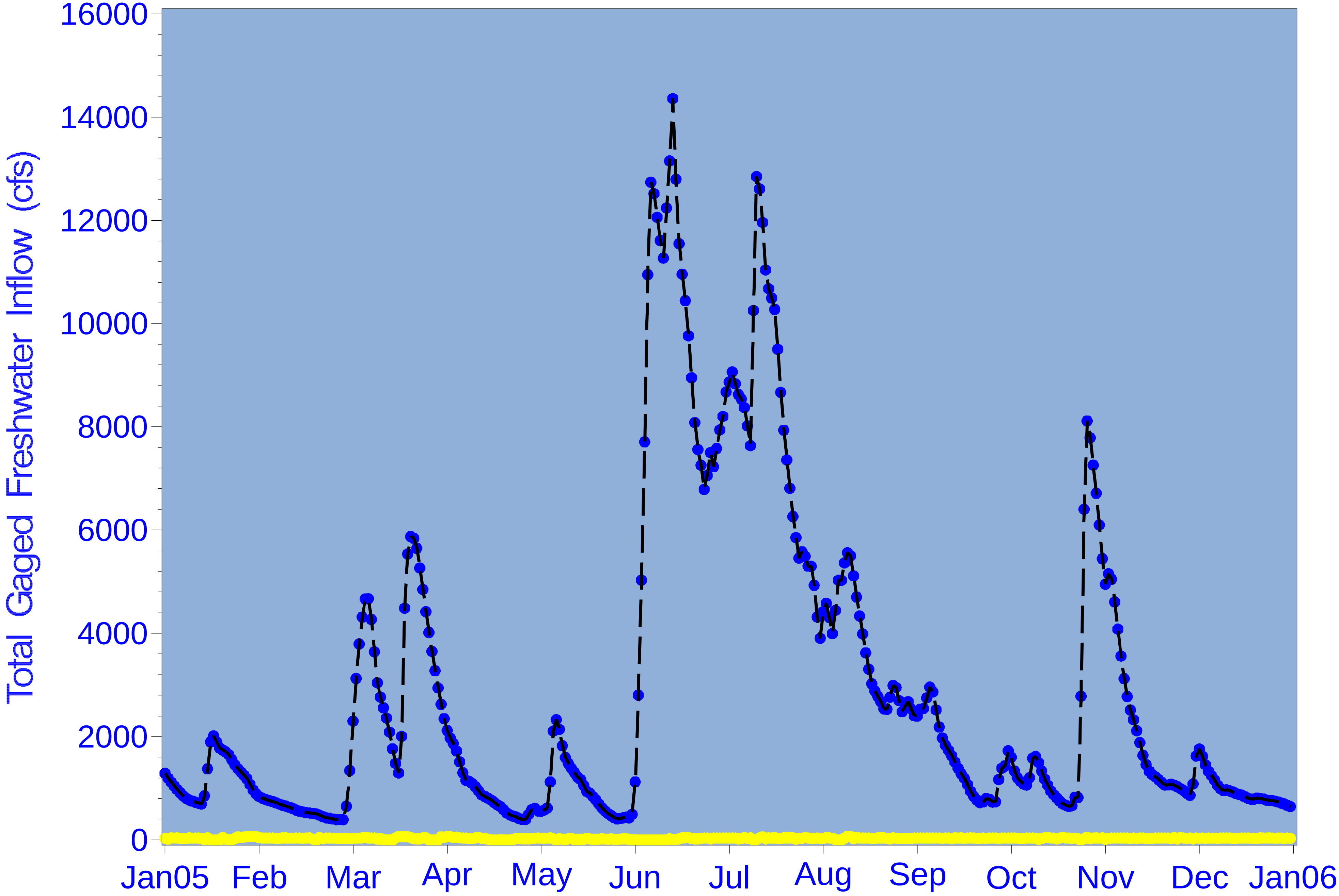


Figure 2.19 Total Peace River + (Horse + Joshua + Shell Creeks) Flows and Withdrawals

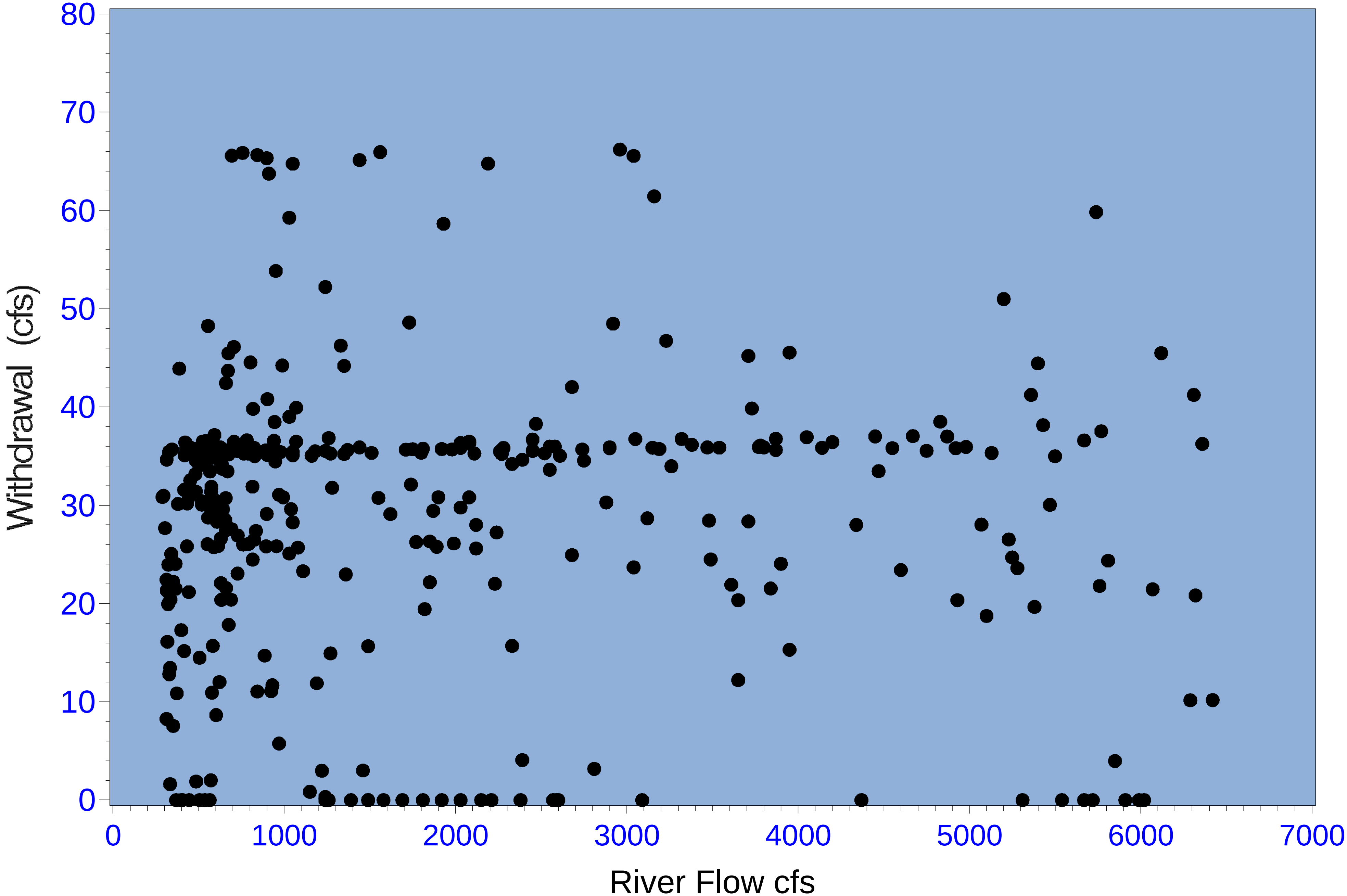


Figure 2.20 Peace River flows at Arcadia vs. water treatment facility withdrawals (2005)

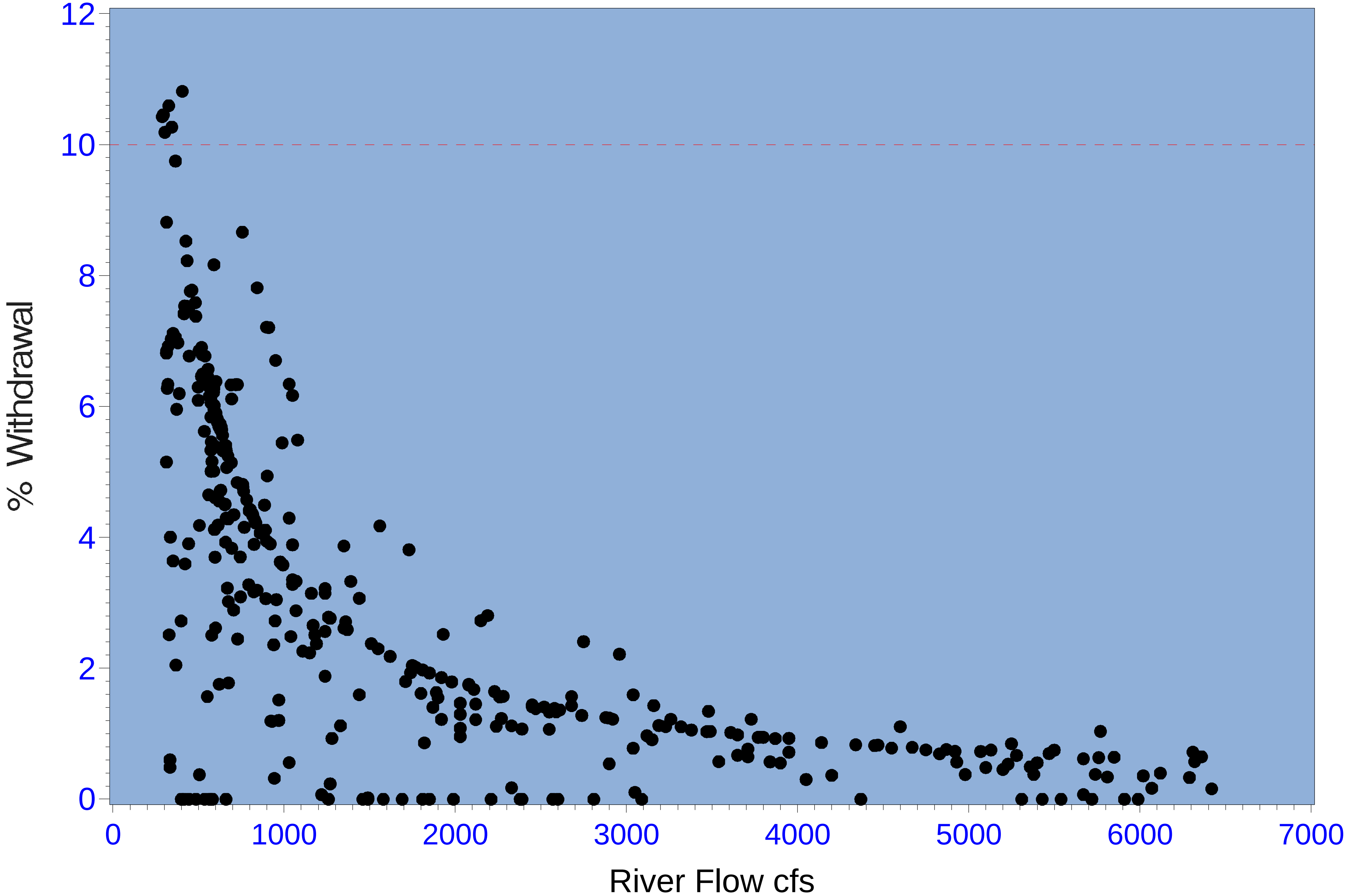
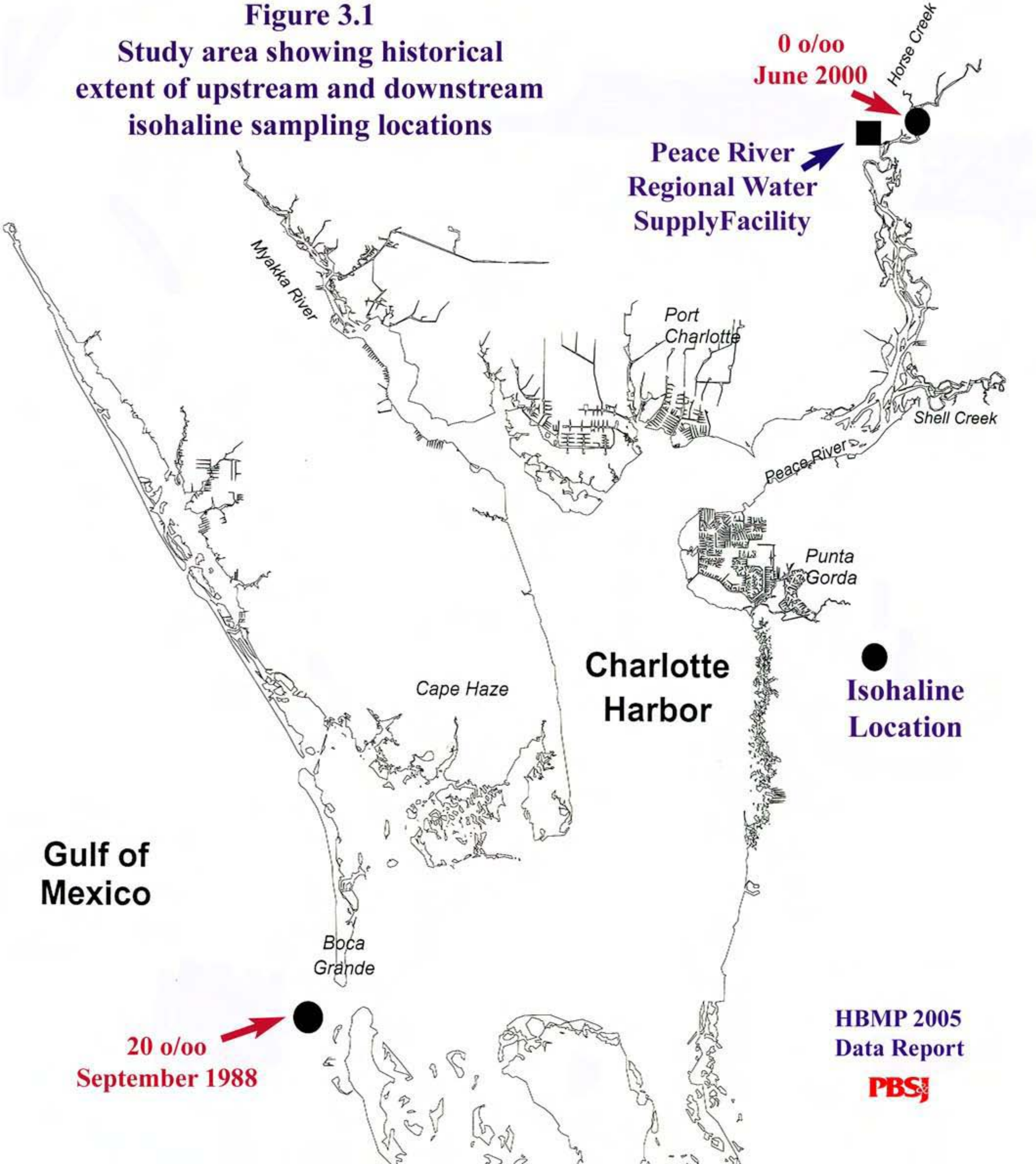


Figure 2.21 Peace River flows at Arcadia vs. % water treatment facility withdrawals (2005)

Figure 3.1
Study area showing historical extent of upstream and downstream isohaline sampling locations



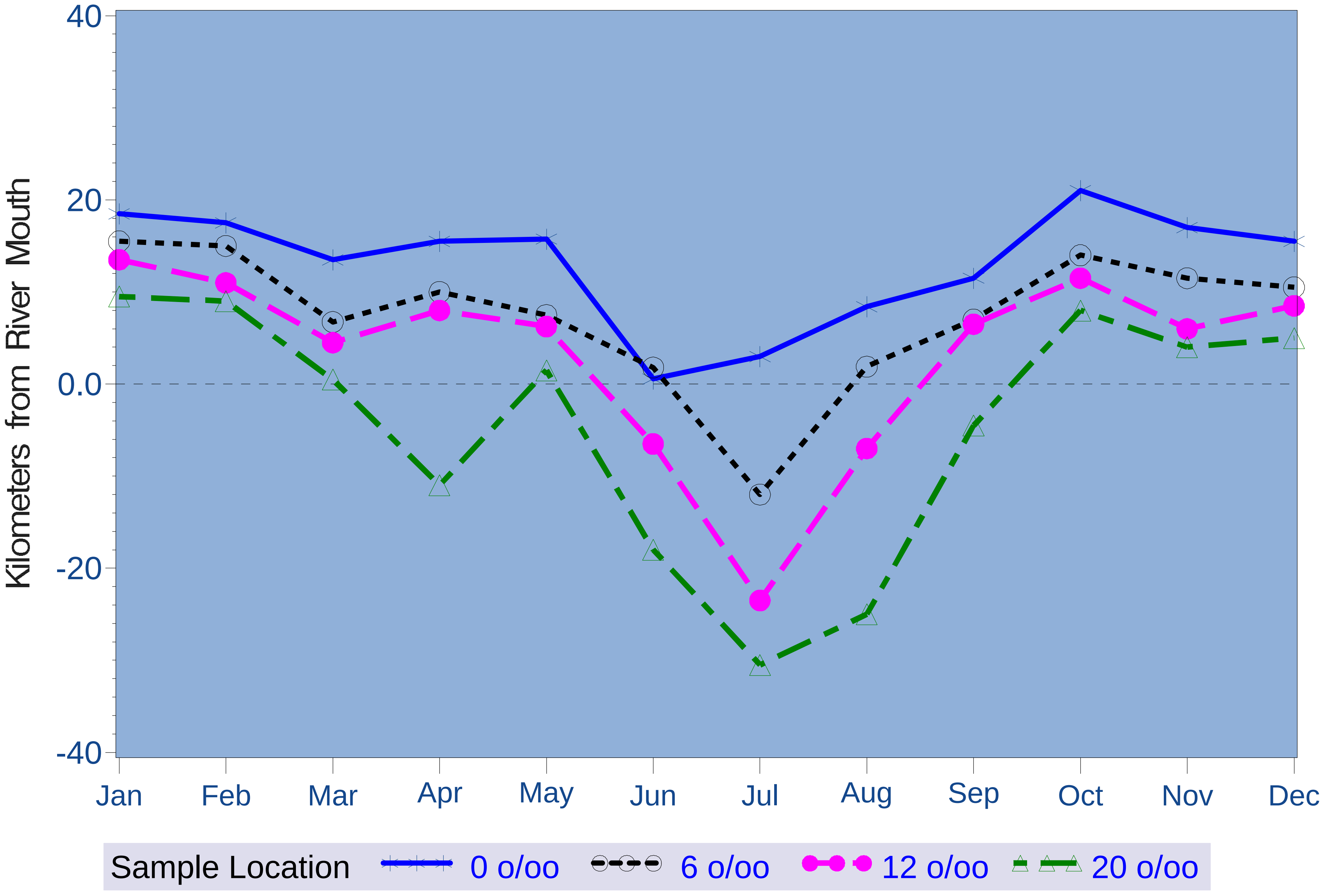


Figure 3.2 Relative distance (km) from the mouth of the river (2005)

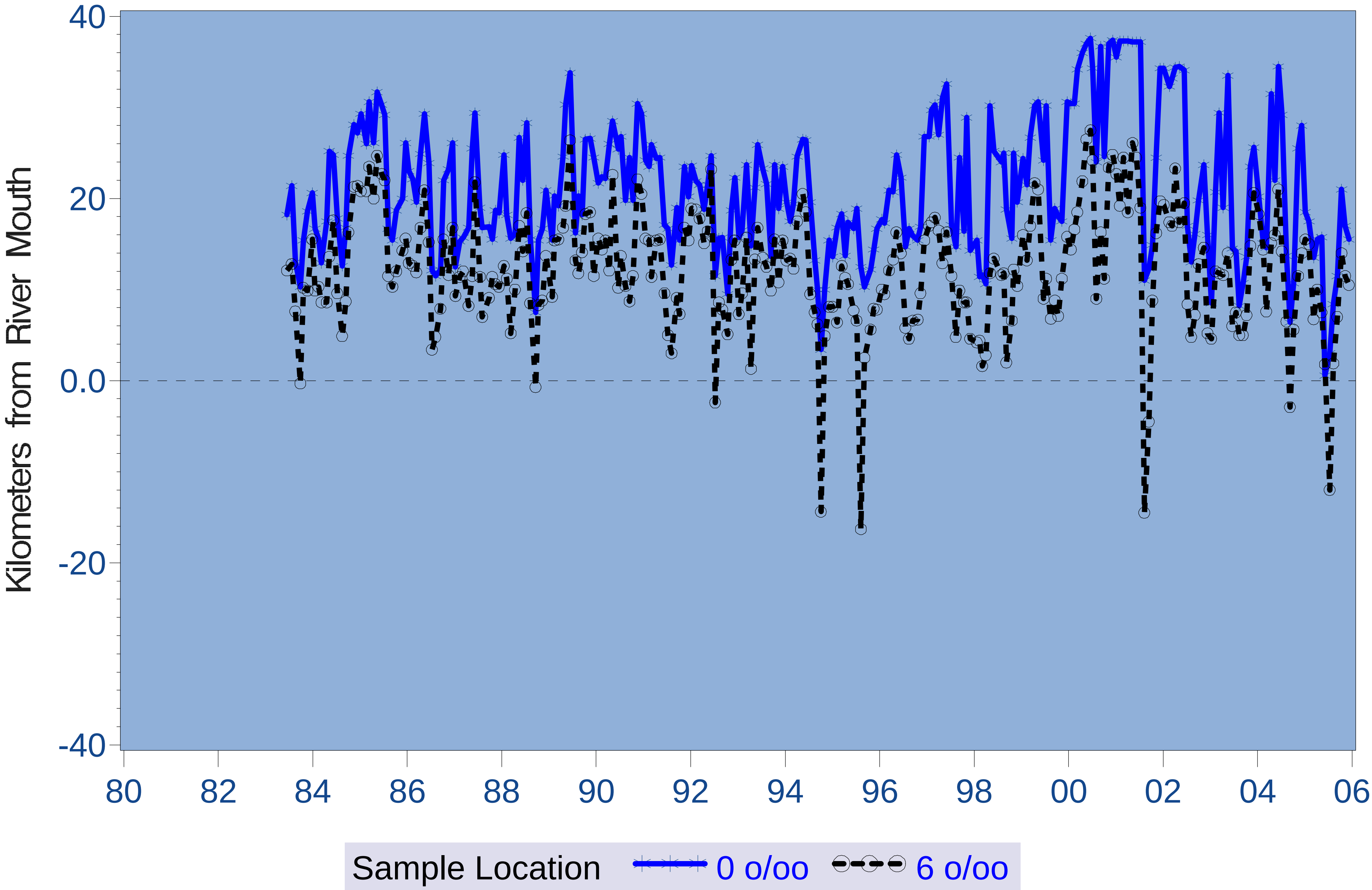


Figure 3.3 Relative distance (km) from the mouth of the river of 0 and 6 ppt salinity sampling zones (1983-2005)

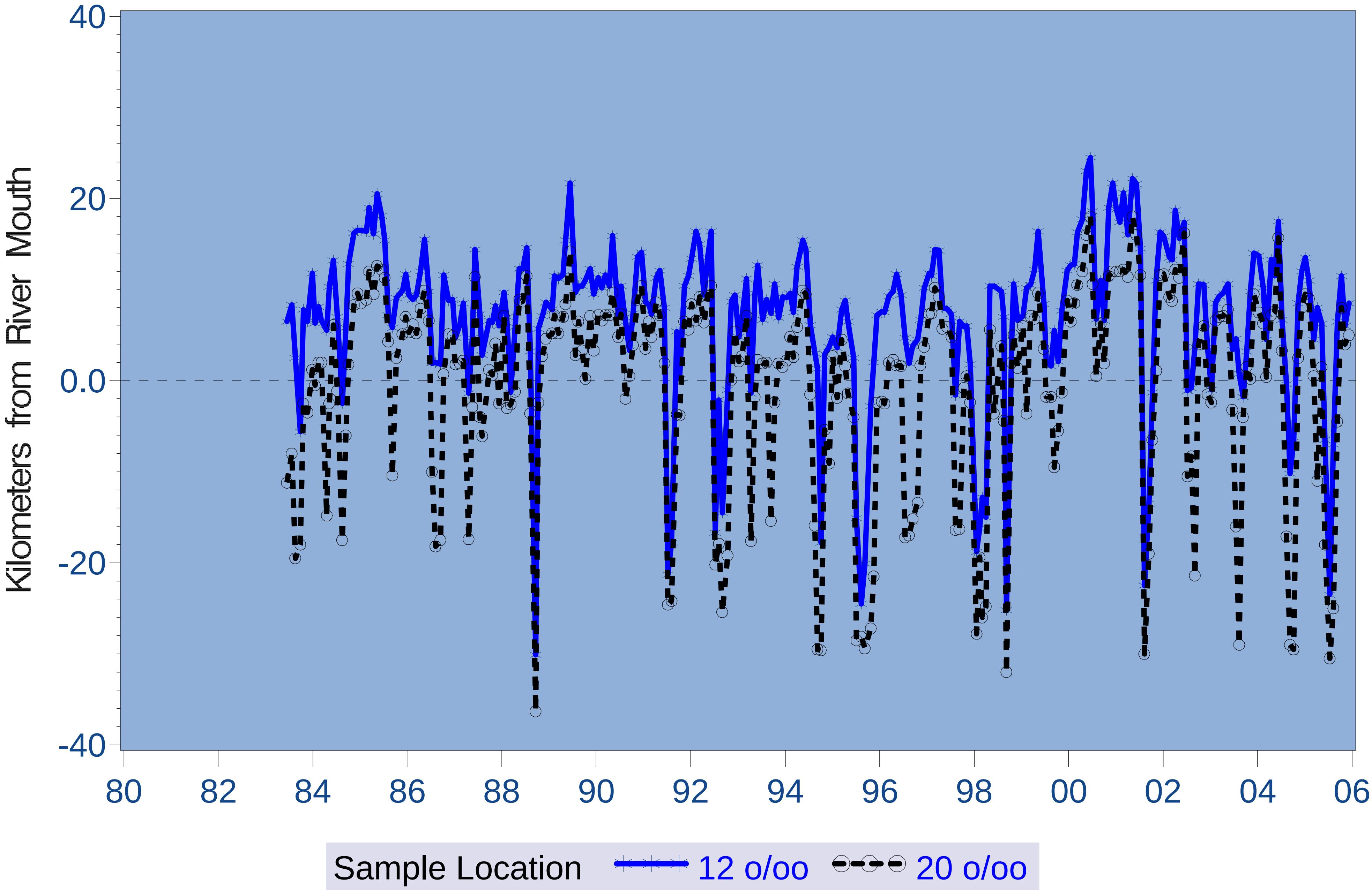


Figure 3.4 Relative distance (km) from the mouth of the river of 12 and 20 ppt salinity sampling zones (1983-2005)

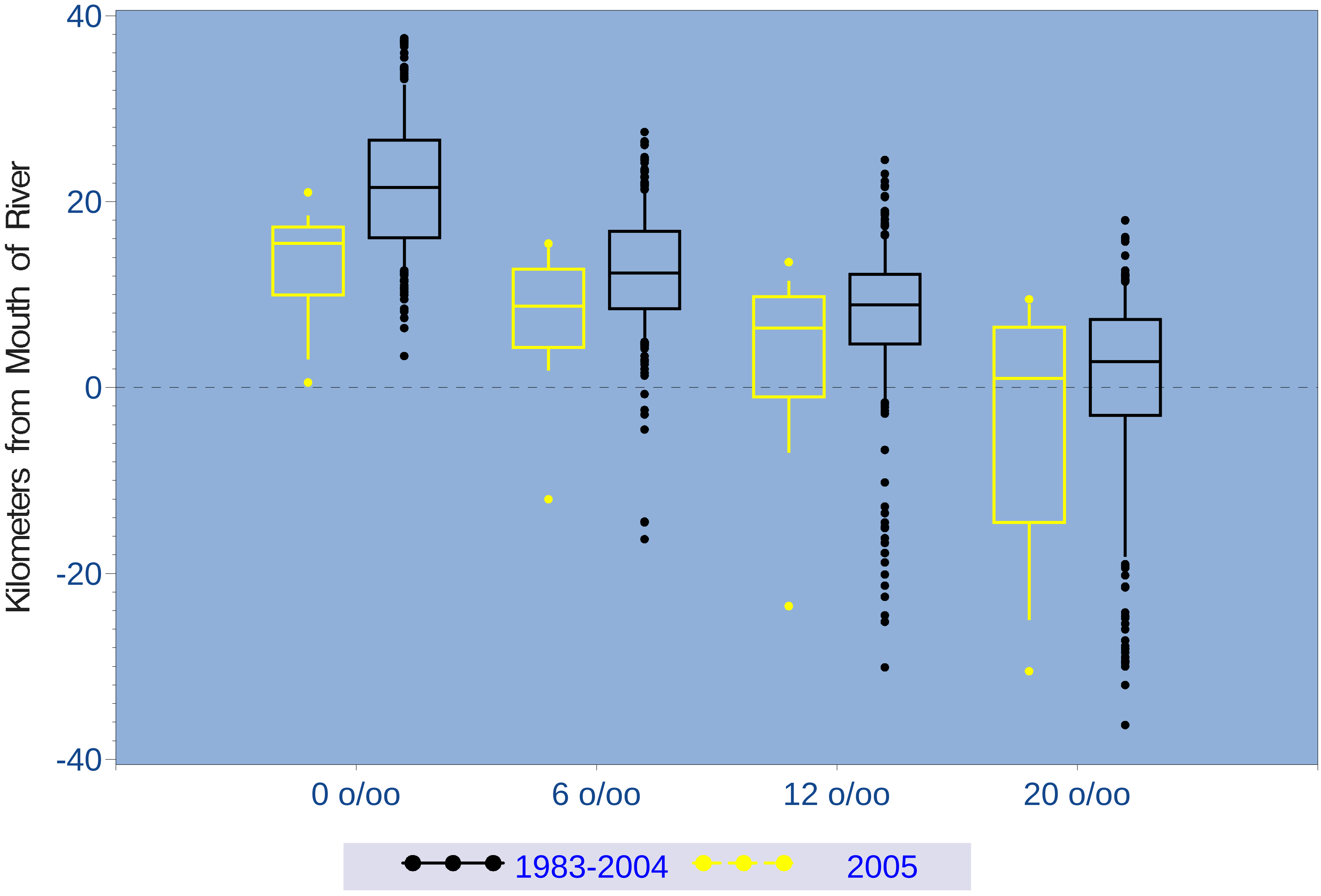


Figure 3.5 Box & whiskers of distance (km) of salinity zones from the mouth of the river

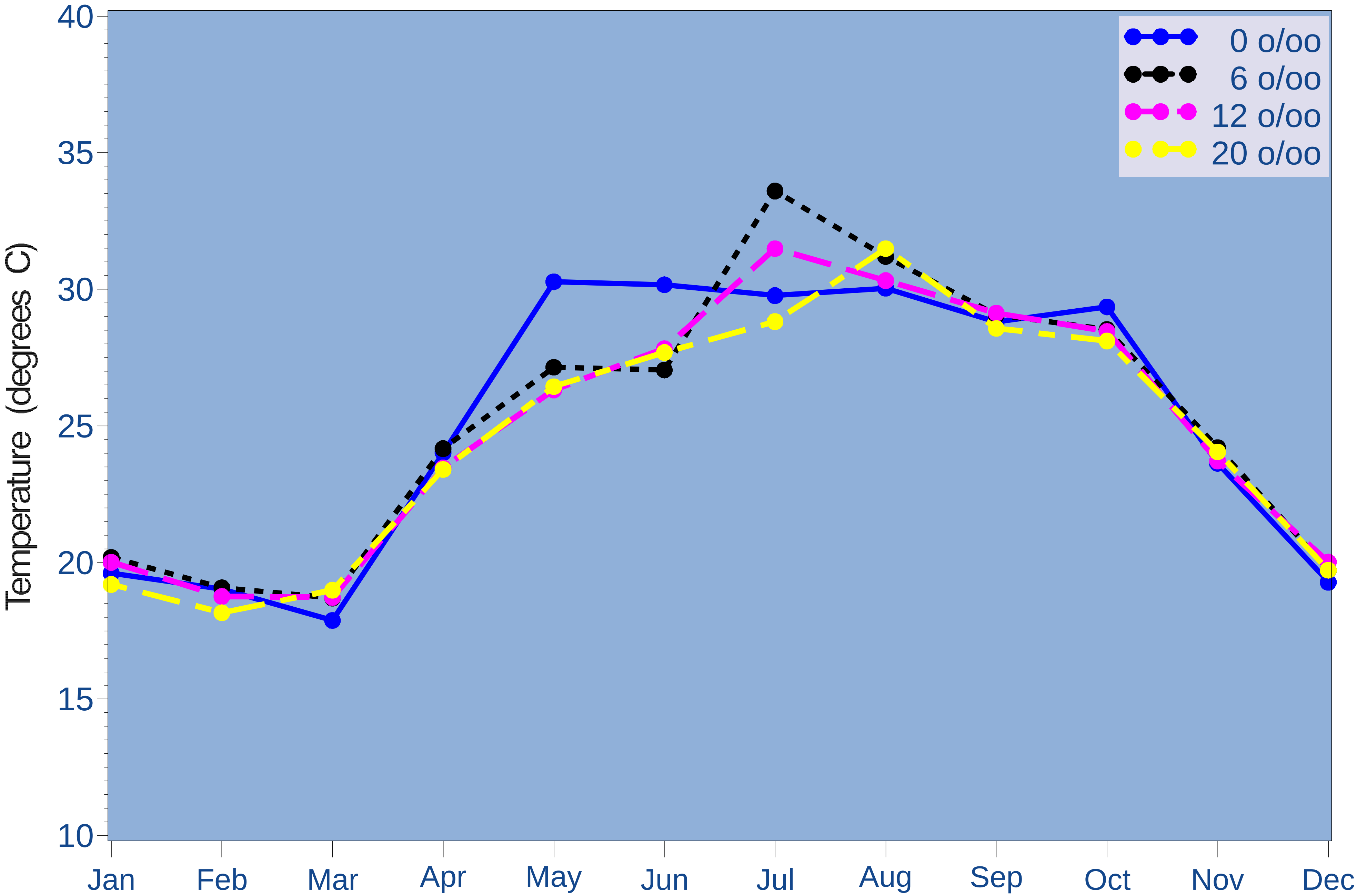


Figure 3.6 Monthly temperature at each of the four salinity based sampling zones (2005)

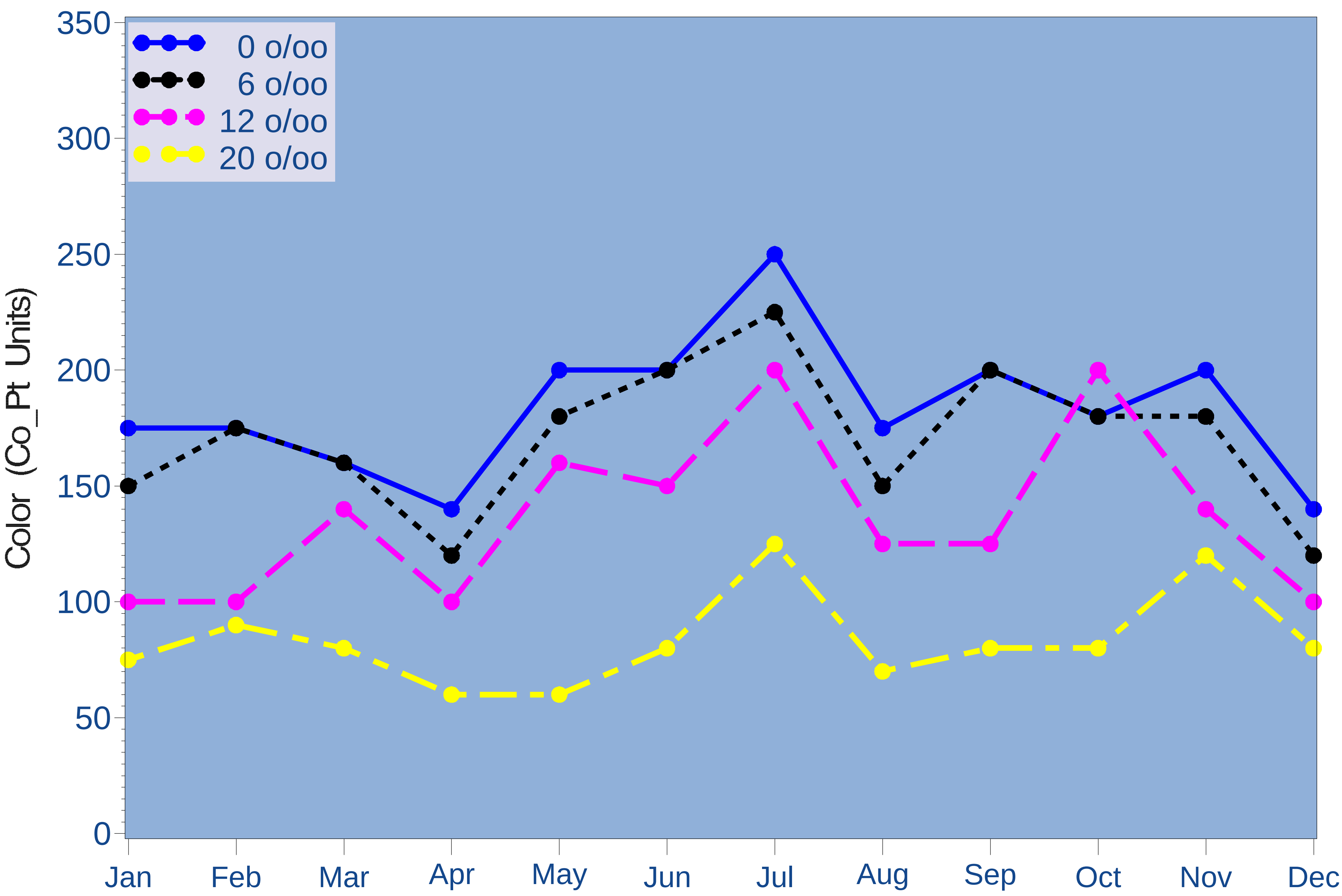


Figure 3.7 Monthly color at each of the four salinity based sampling zones (2005)

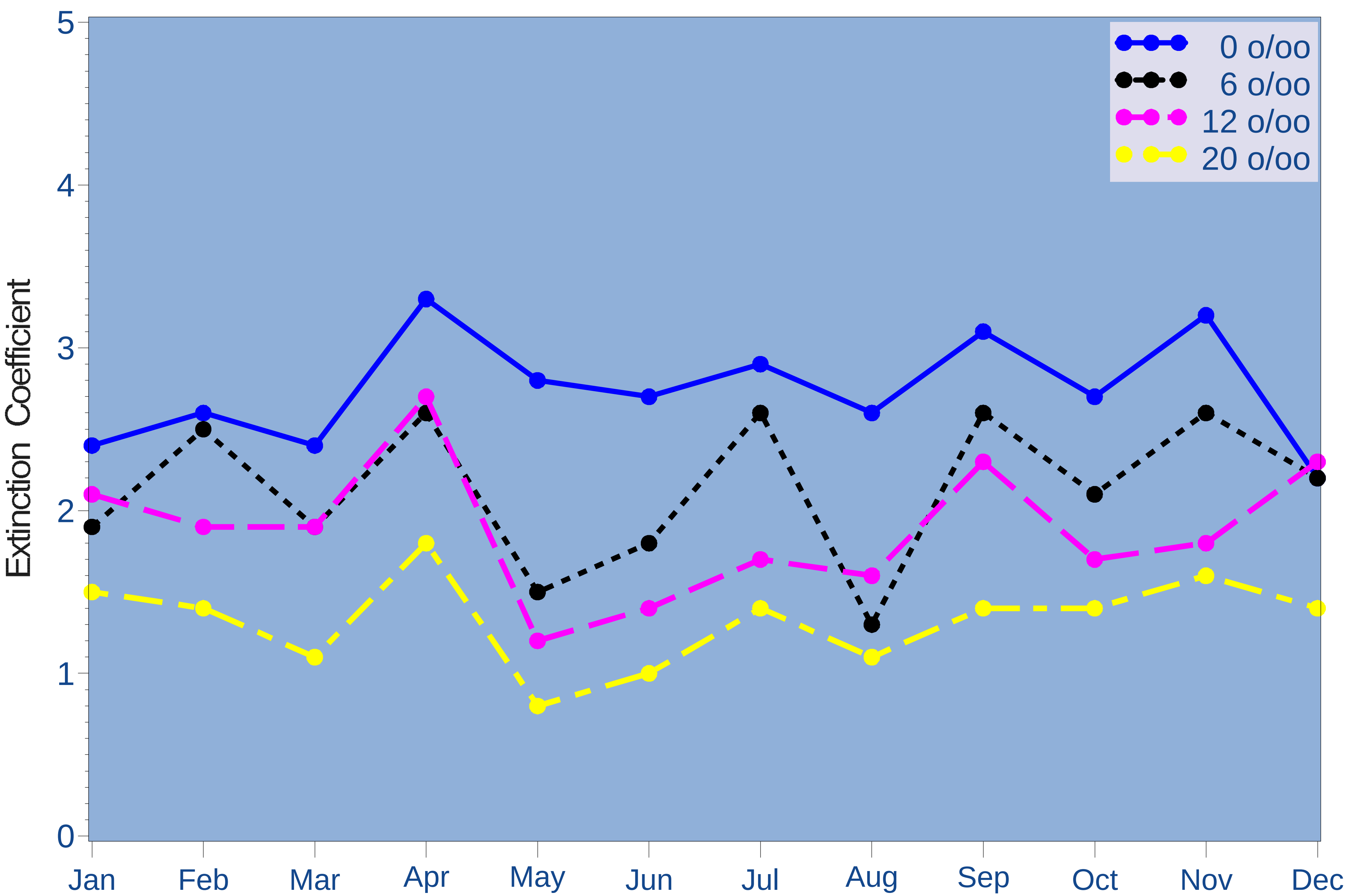


Figure 3.8 Monthly extinction coefficient at each of the salinity based sampling zones (2005)

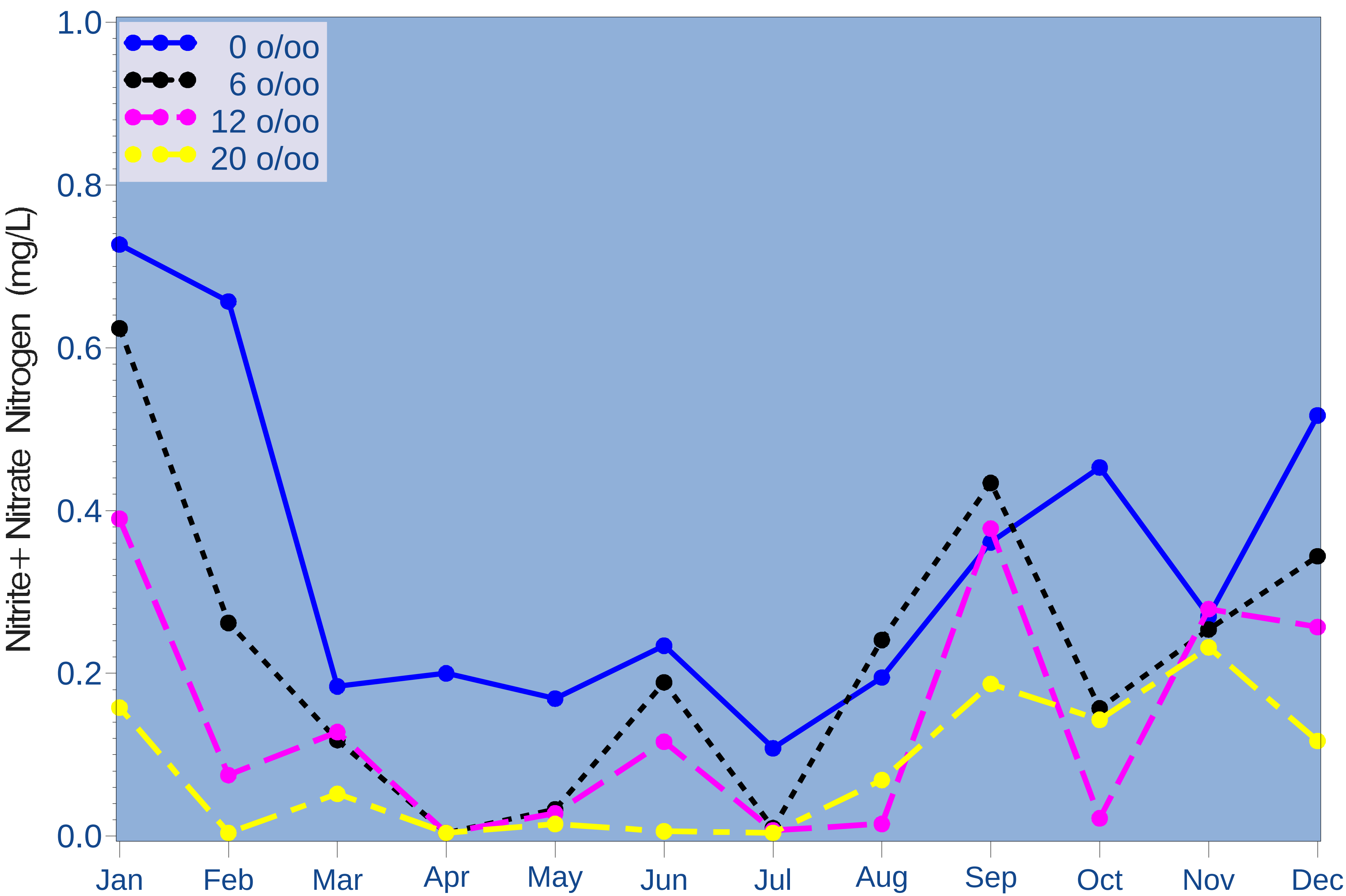


Figure 3.9 Monthly nitrite+nitrate nitrogen at each of the four salinity based sampling zones (2005)

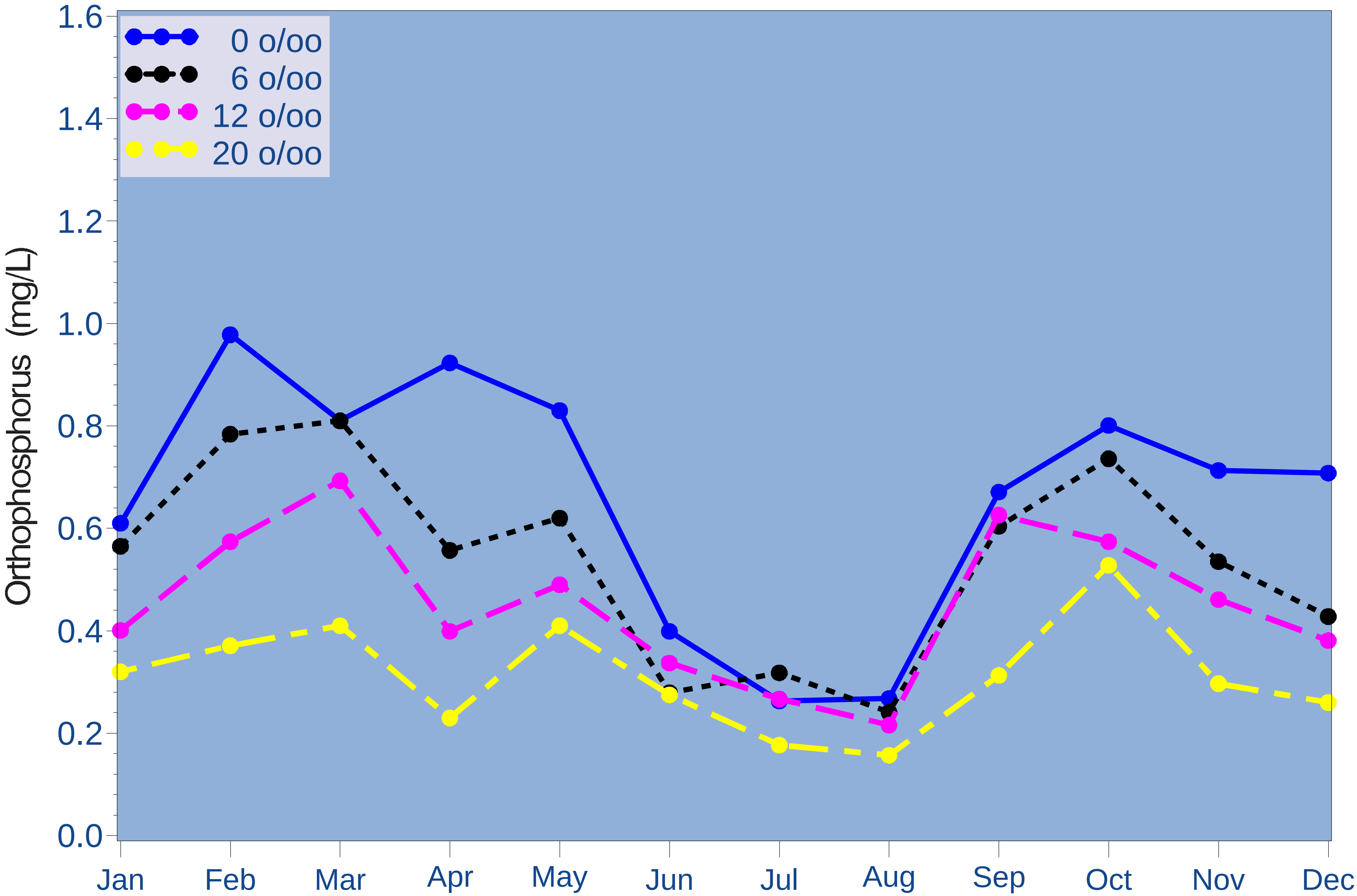


Figure 3.10 Monthly orthophosphorus at each of the four salinity based sampling zones (2005)

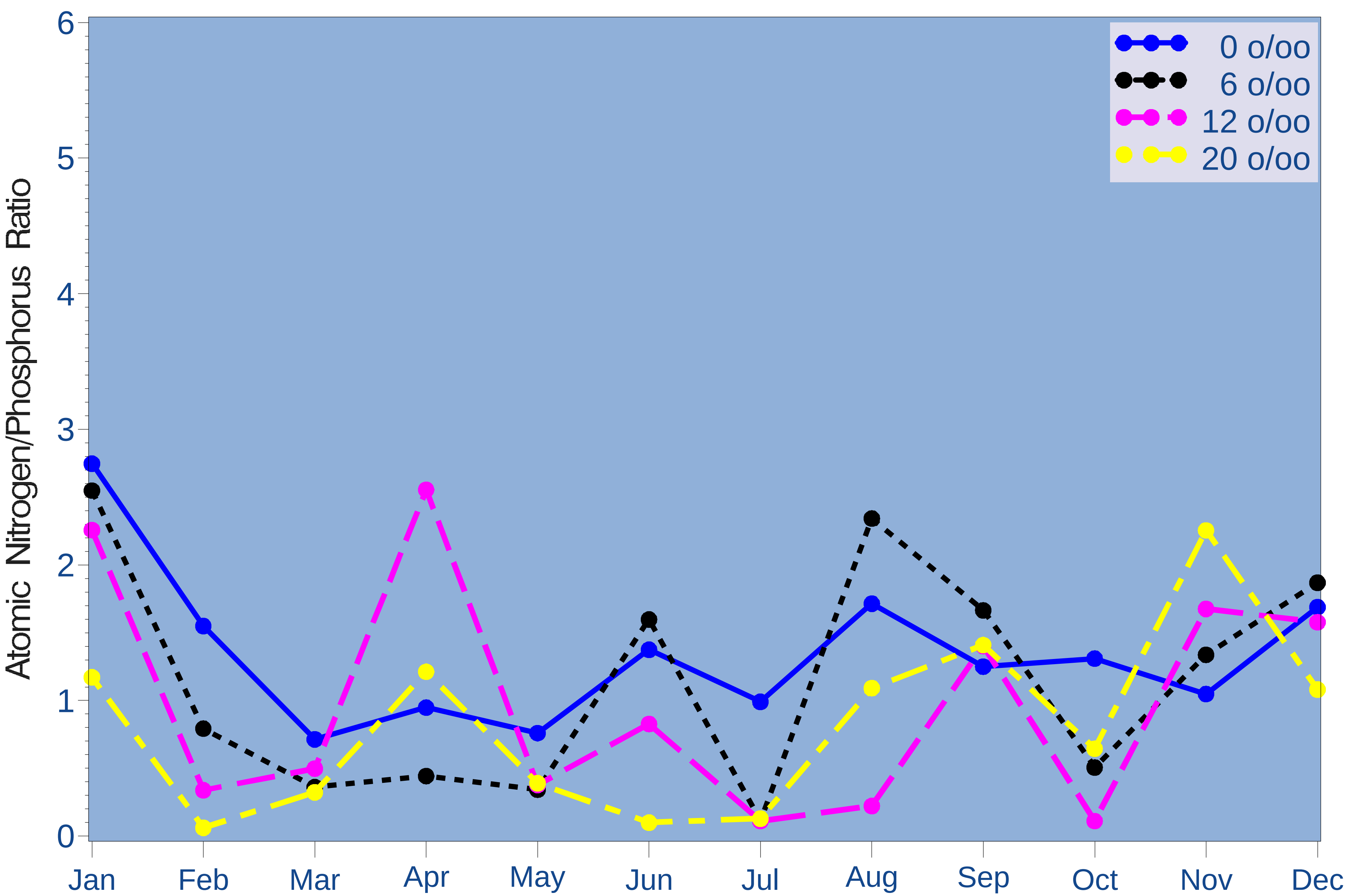


Figure 3.11 Monthly Atomic N/P ratio at each of the four salinity based sampling zones (2005)

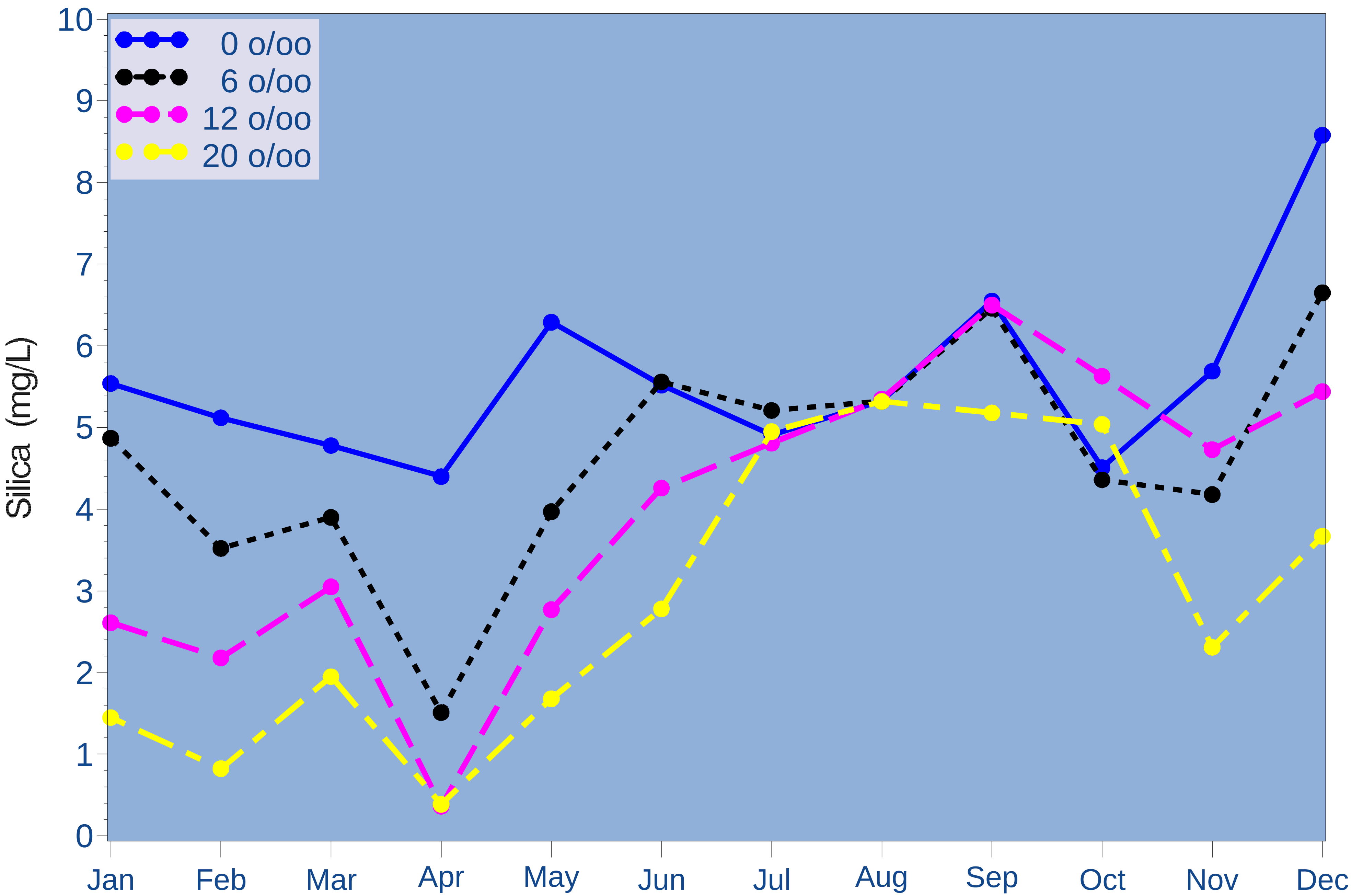


Figure 3.12 Monthly silica at each of the four salinity based sampling zones (2005)

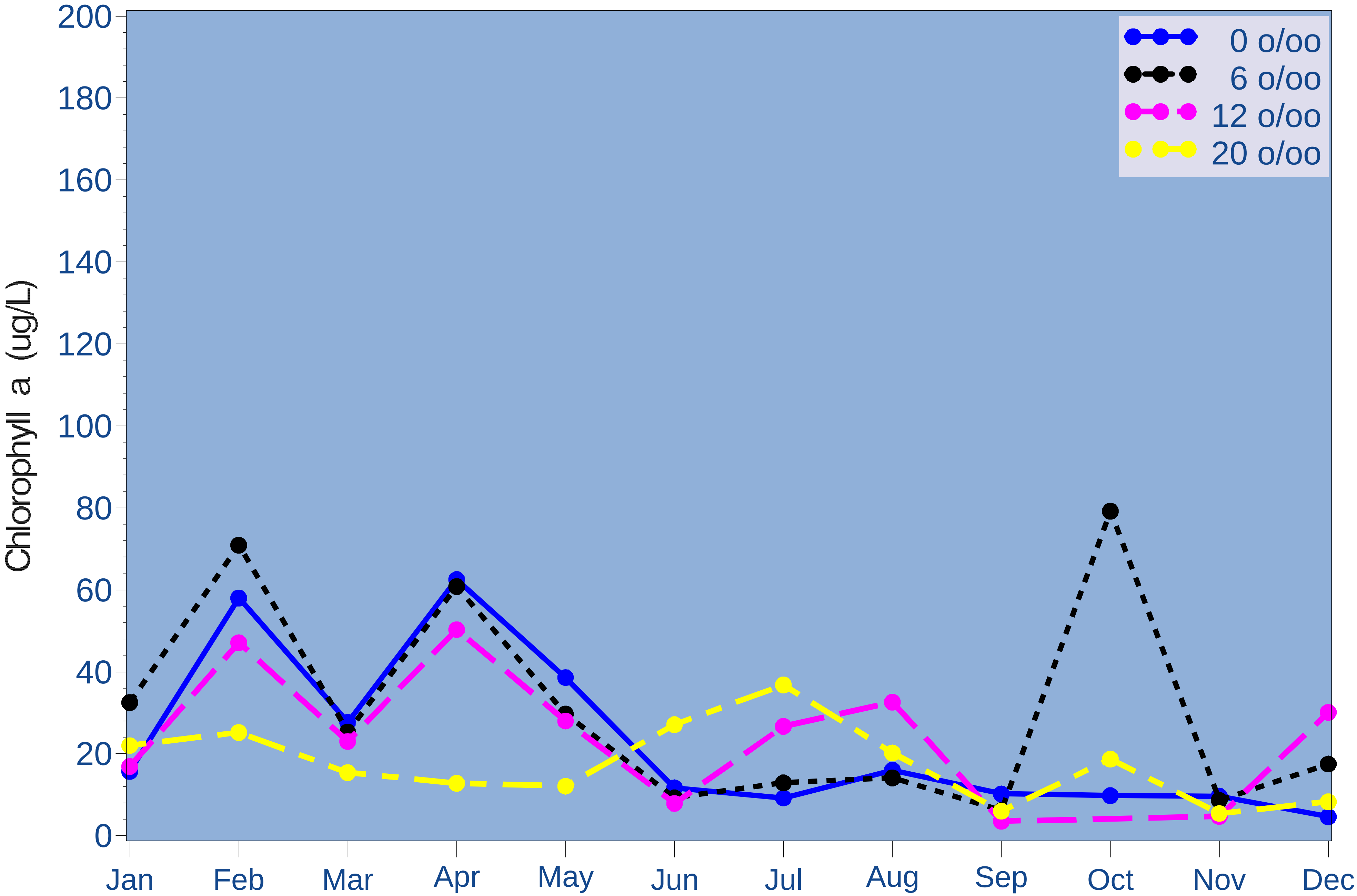


Figure 3.13a Monthly chlorophyll a at each of the four salinity based sampling zones (2005)

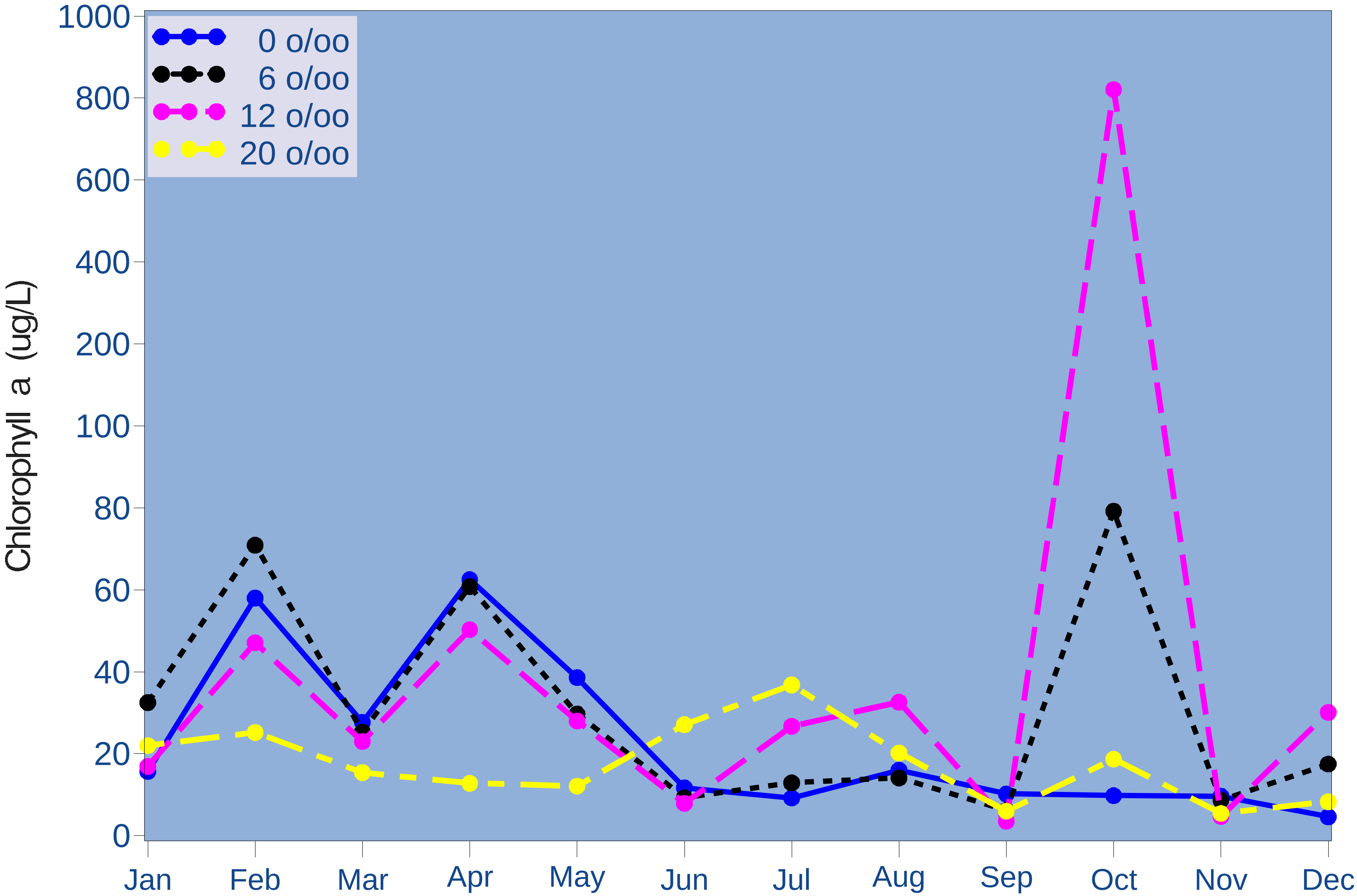


Figure 3.13b Monthly chlorophyll a at each of the four salinity based sampling zones (2005)

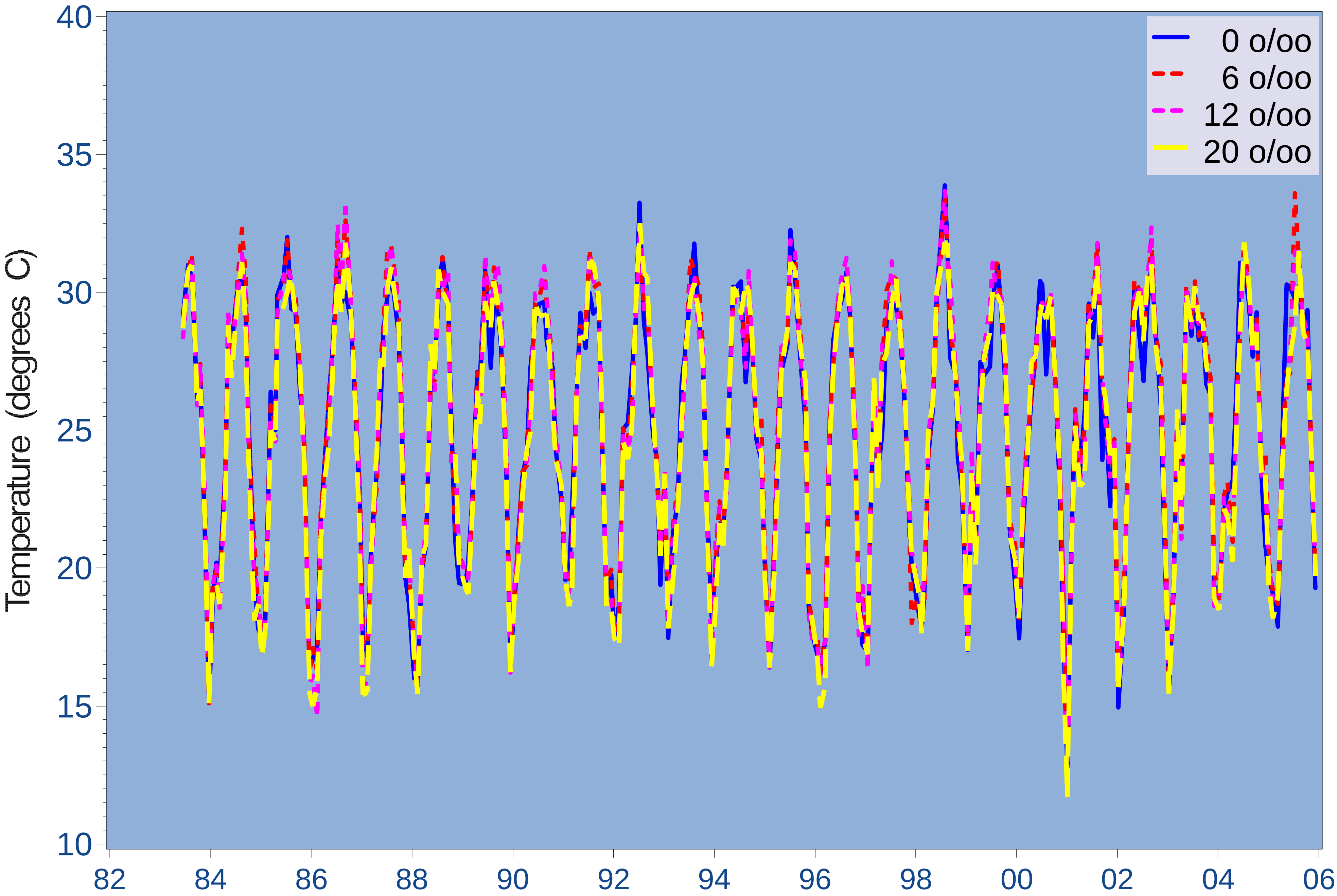


Figure 3.14 Monthly temperature at each isohaline based sampling zone (1983-2005)

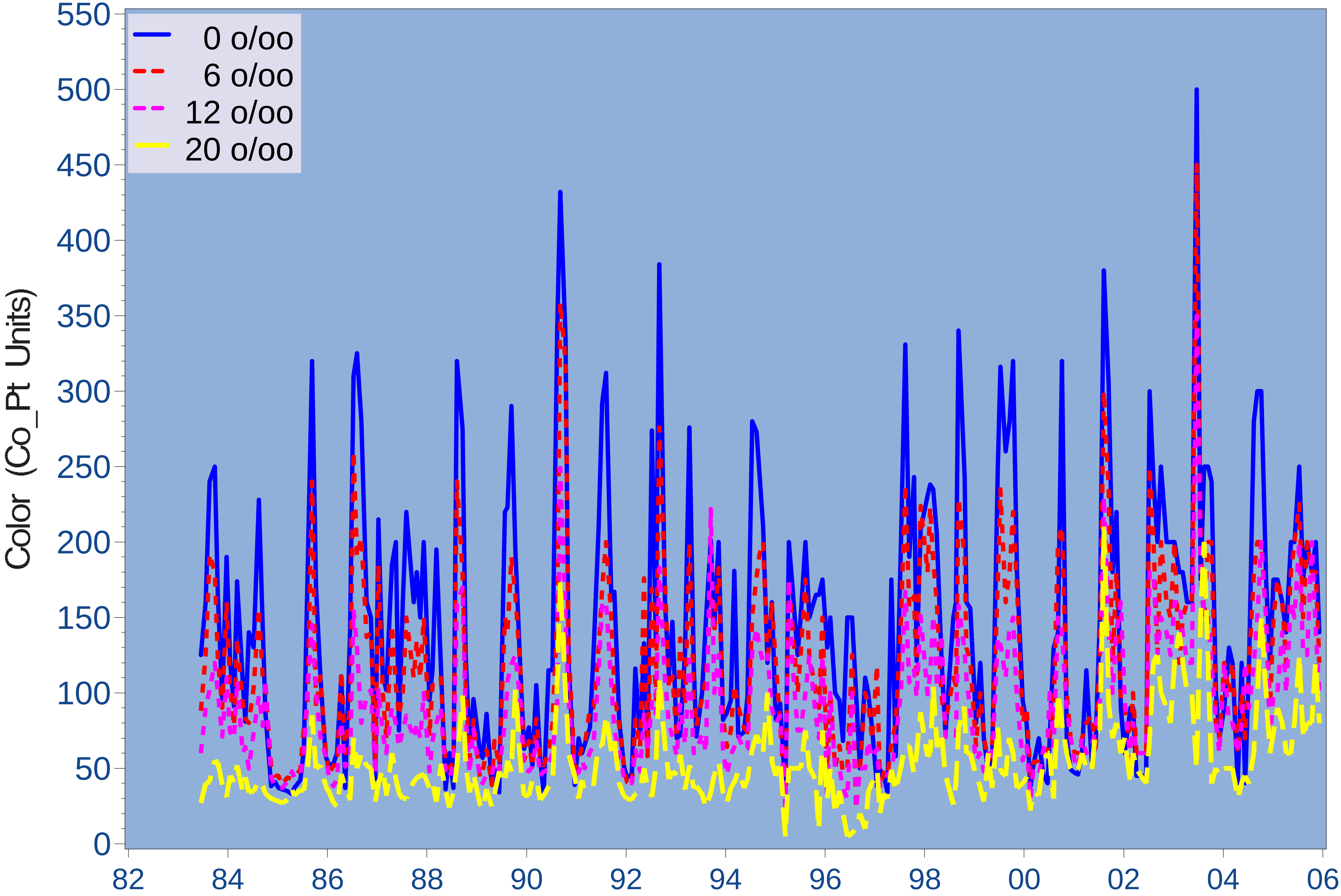


Figure 3.15 Monthly color at each isohaline based sampling zone (1983-2005)

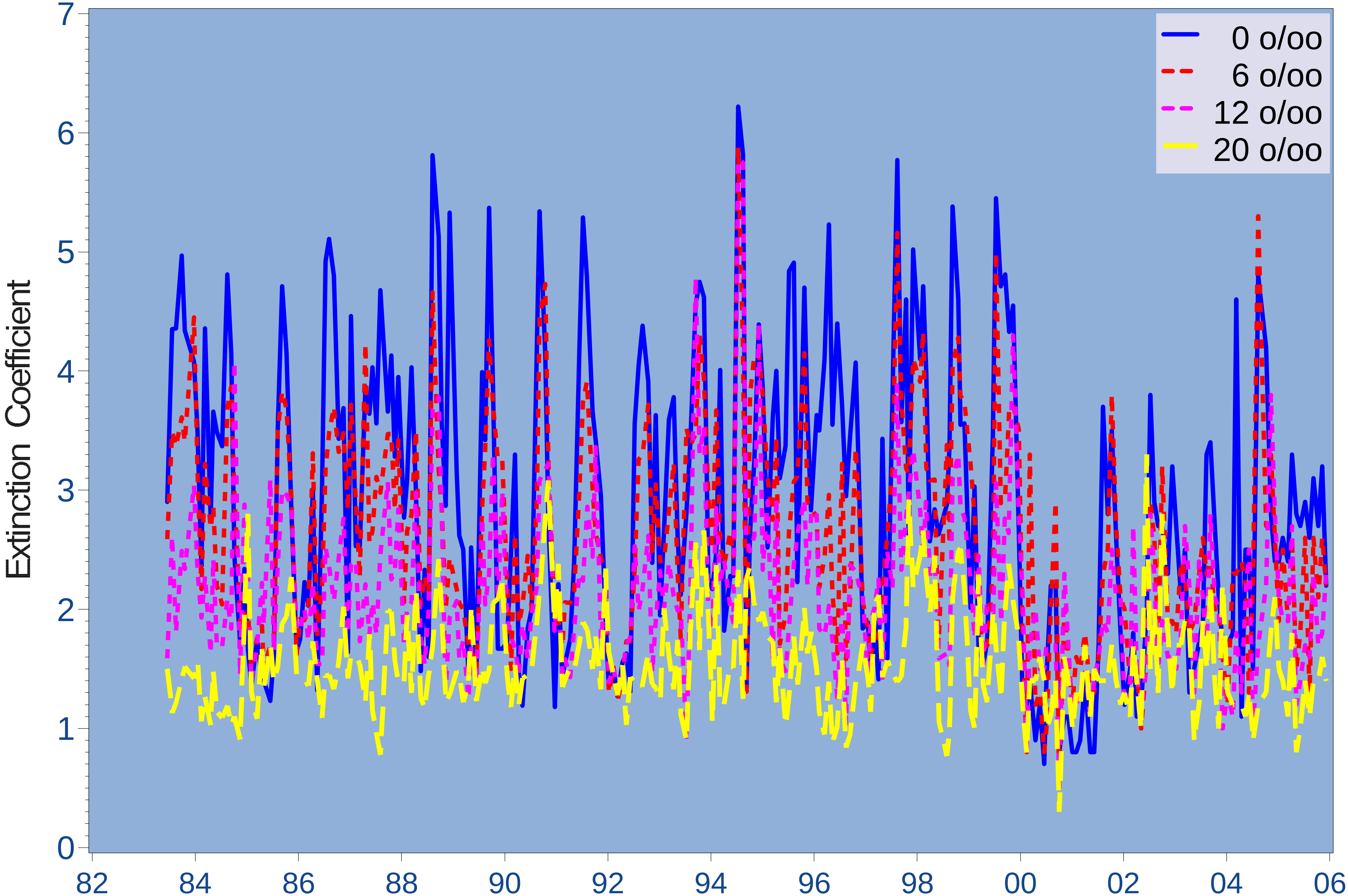


Figure 3.16 Monthly extinction coefficient at each isohaline based sampling zone (1983-2005)

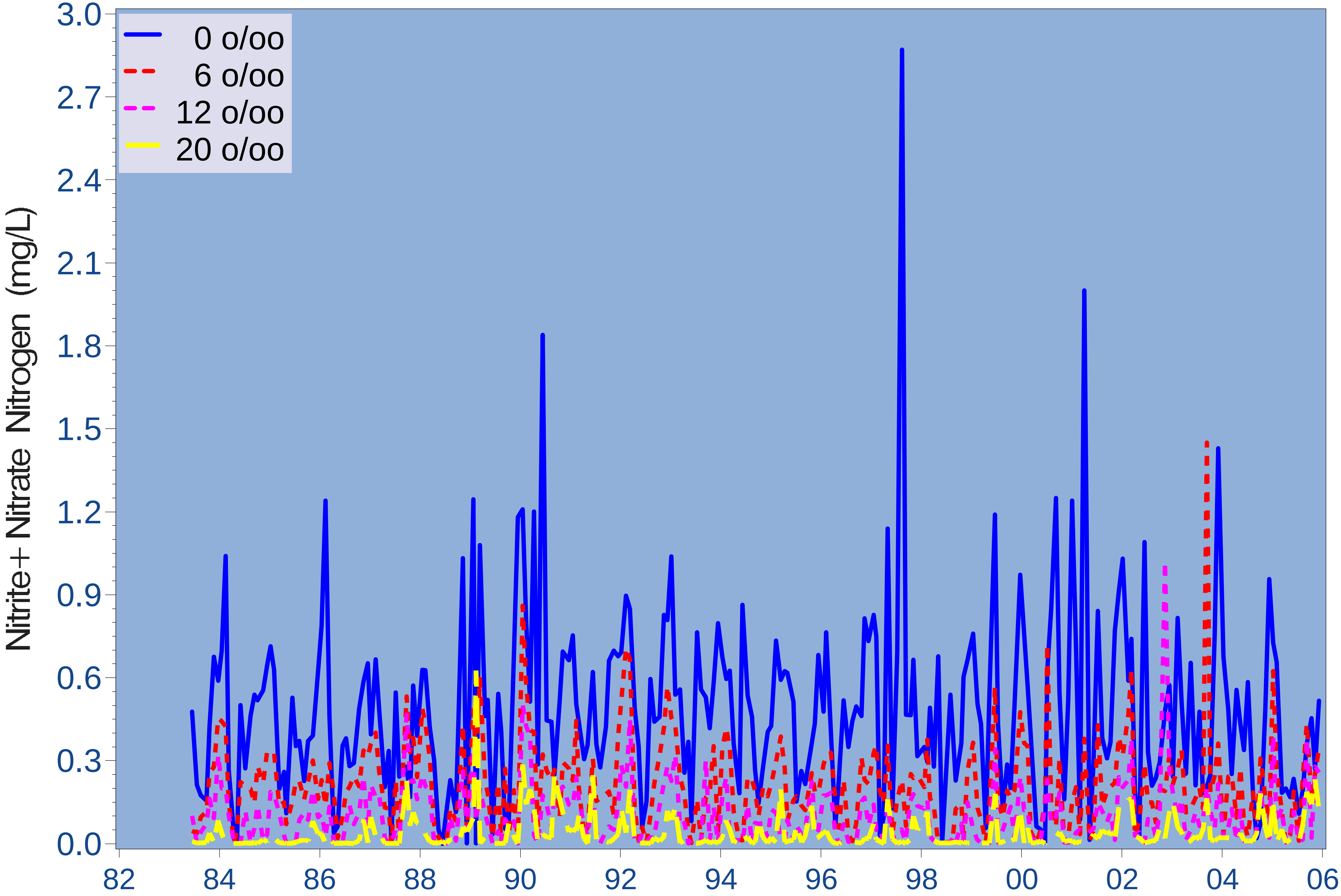


Figure 3.17 Monthly nitrite/nitrate at each isohaline based sampling zone (1983-2005)

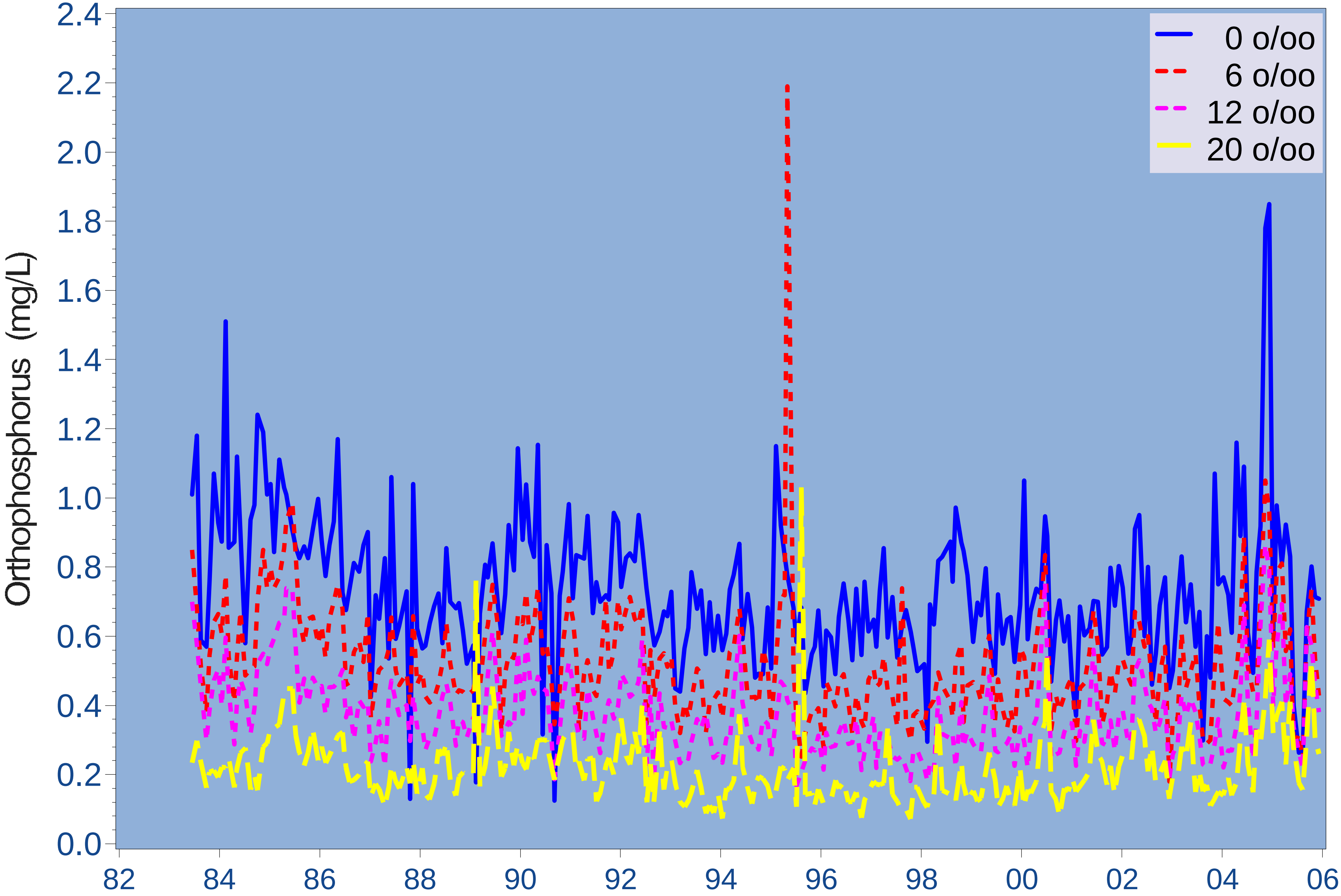


Figure 3.18 Monthly orthophosphorus at each isohaline based sampling zone (1983-2005)

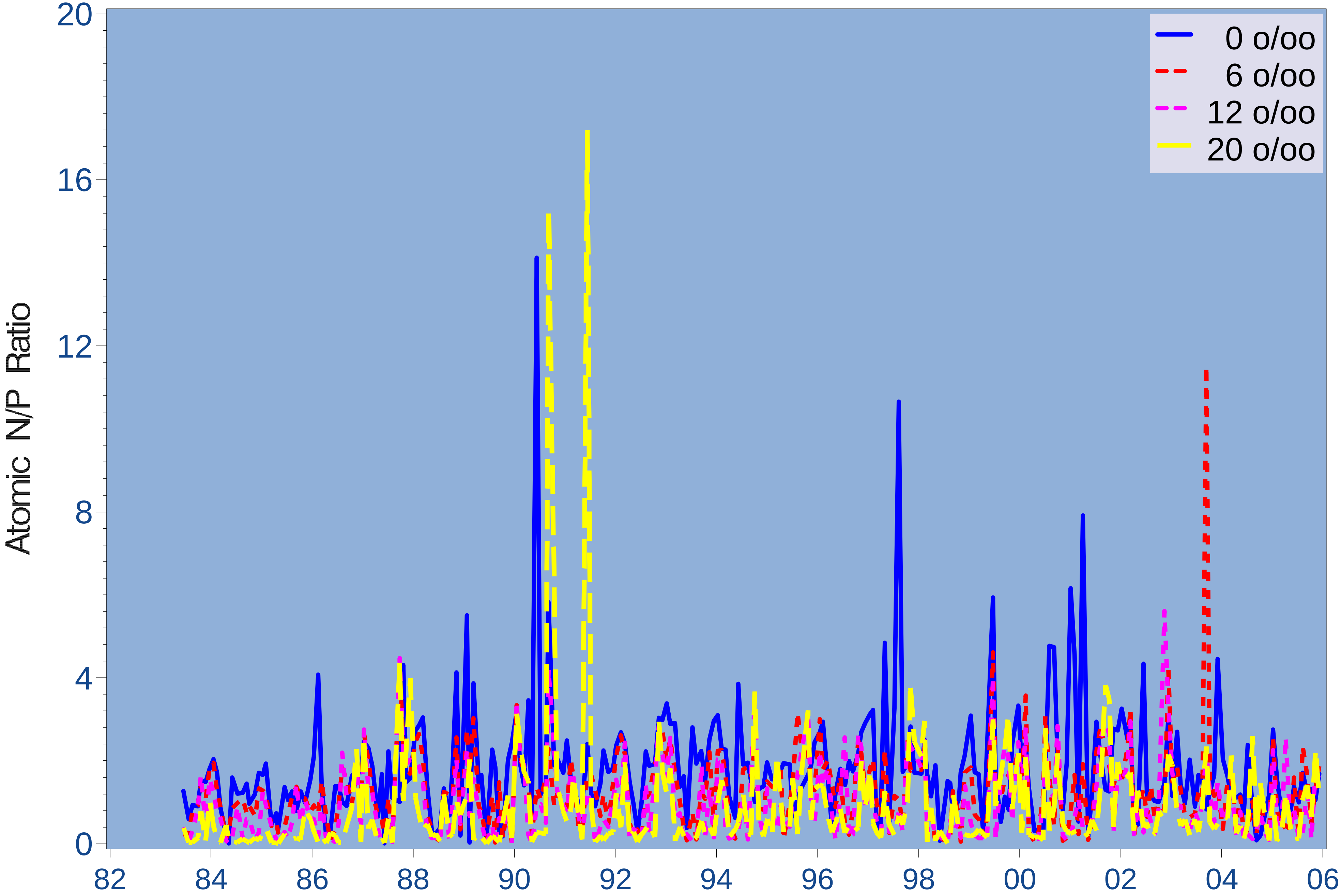


Figure 3.19 Monthly atomic nitrogen/phosphorus ratio at each isohaline based sampling zone (1983-2005)

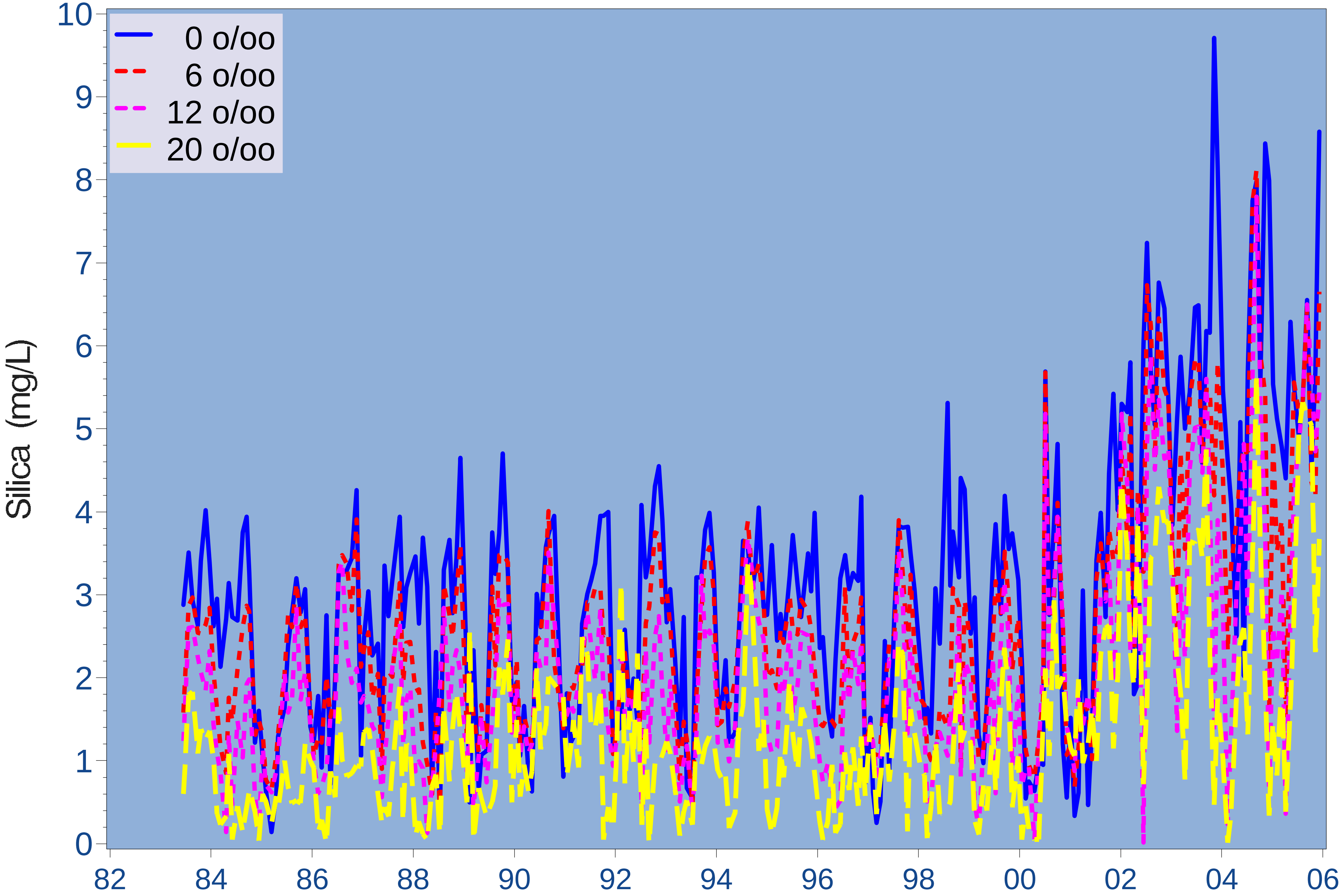


Figure 3.20 Monthly silica at each isohaline based sampling zone (1983-2005)

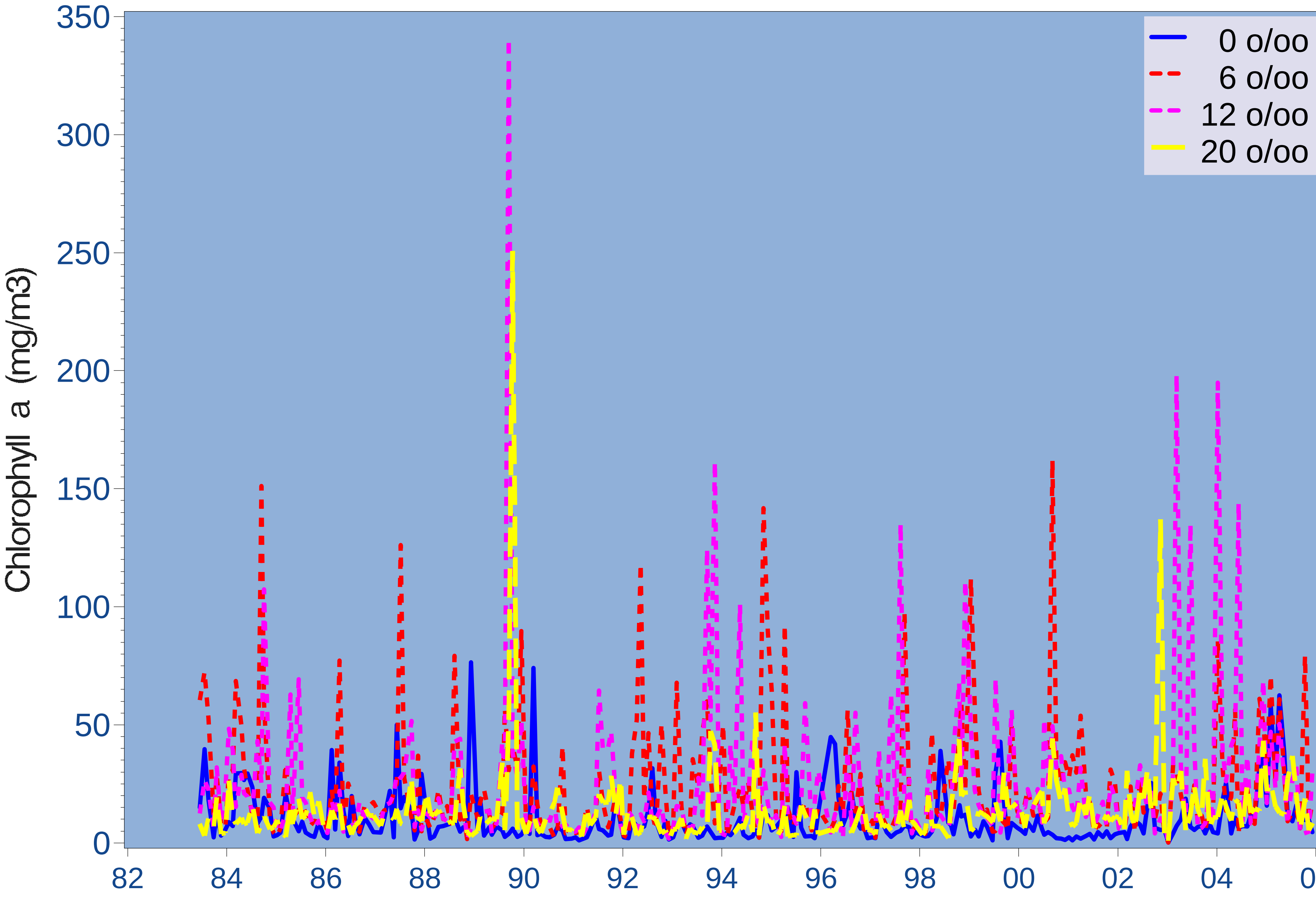


Figure 3.21a Monthly chlorophyll a (mg/m3) at each isohaline based sampling zone (1983-2005)

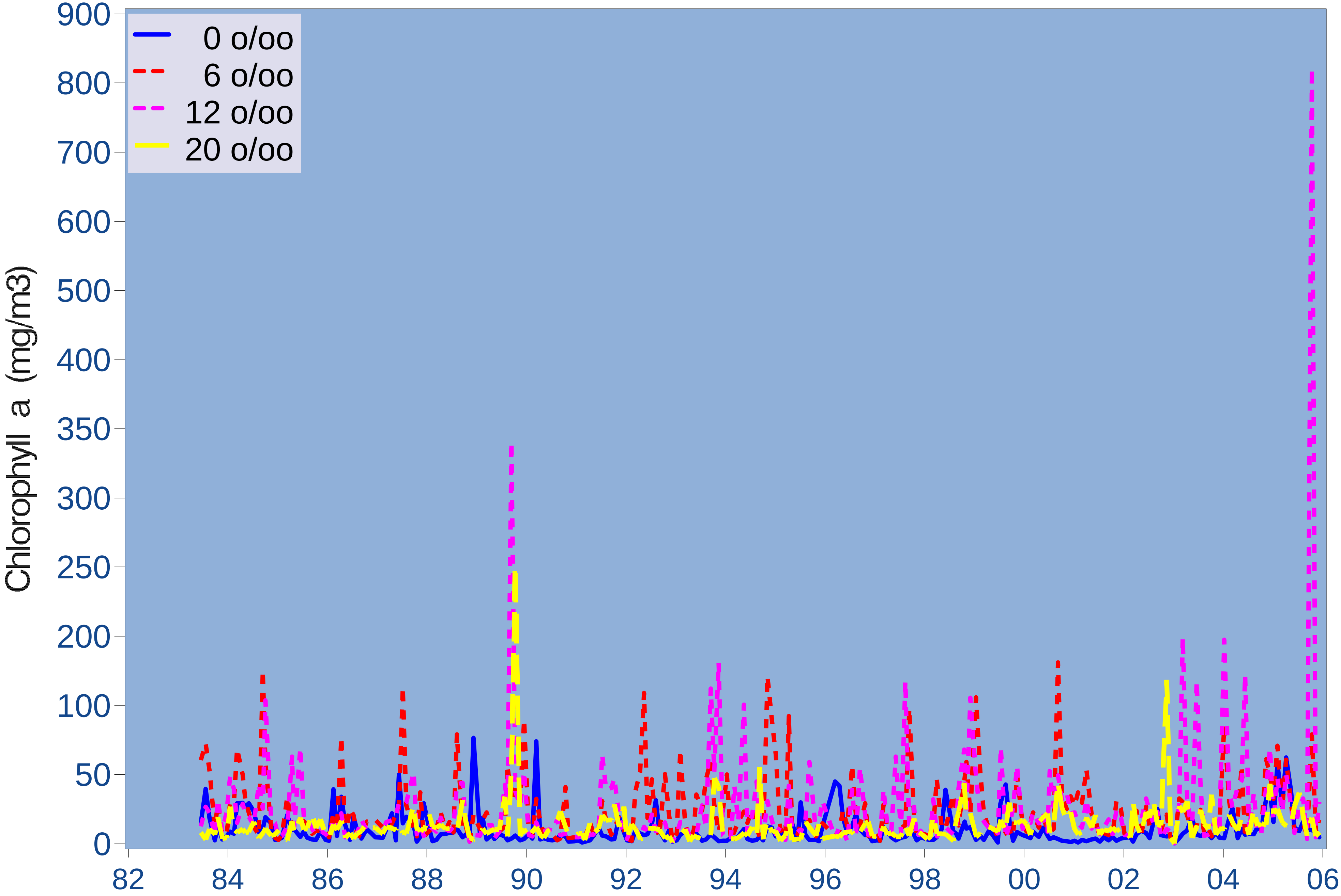


Figure 3.21b Monthly chlorophyll a (mg/m3) at each isohaline based sampling zone (1983-2005)

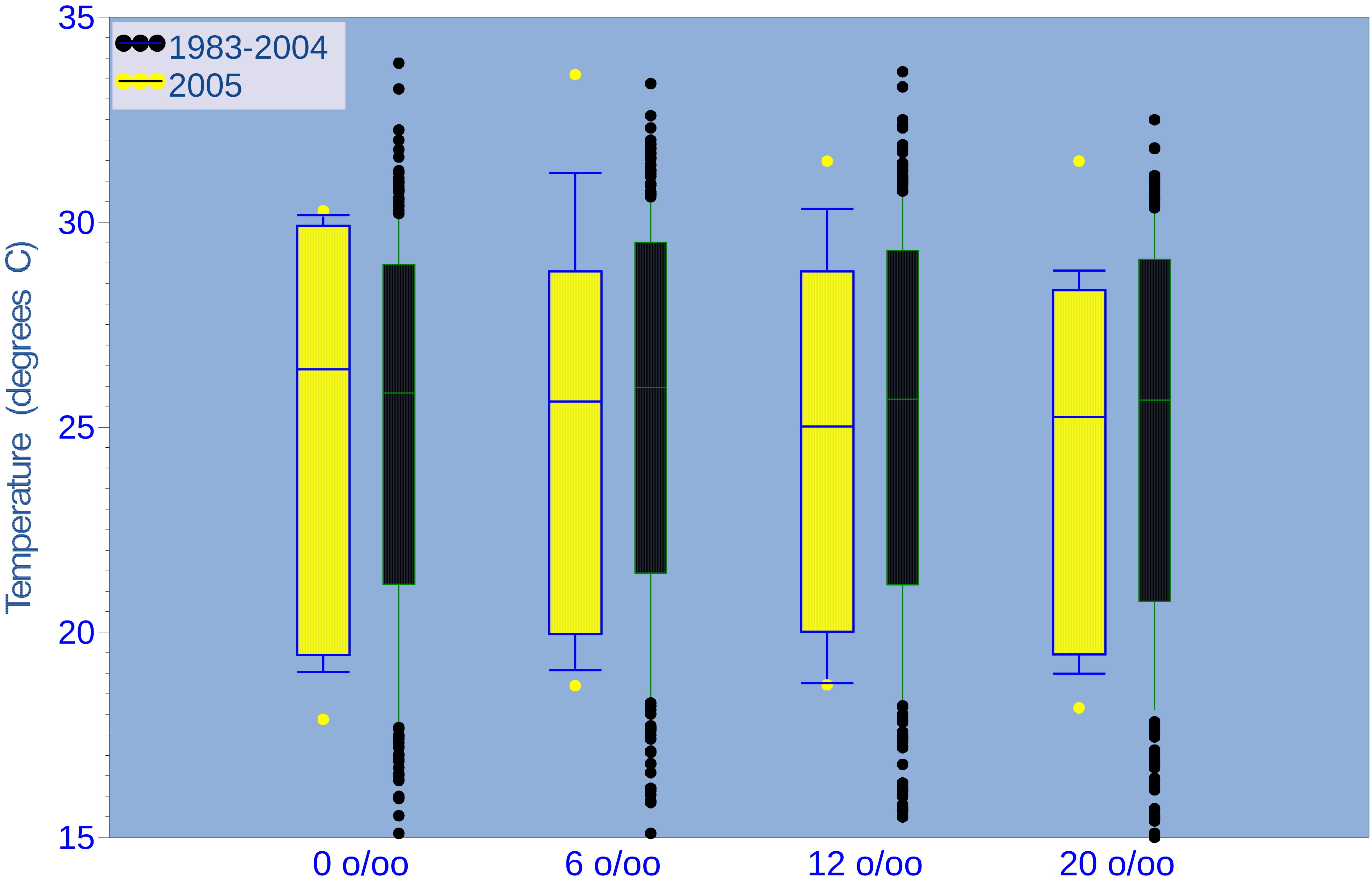


Figure 3.22 Box and whisker plots of temperature at salinity sampling zones

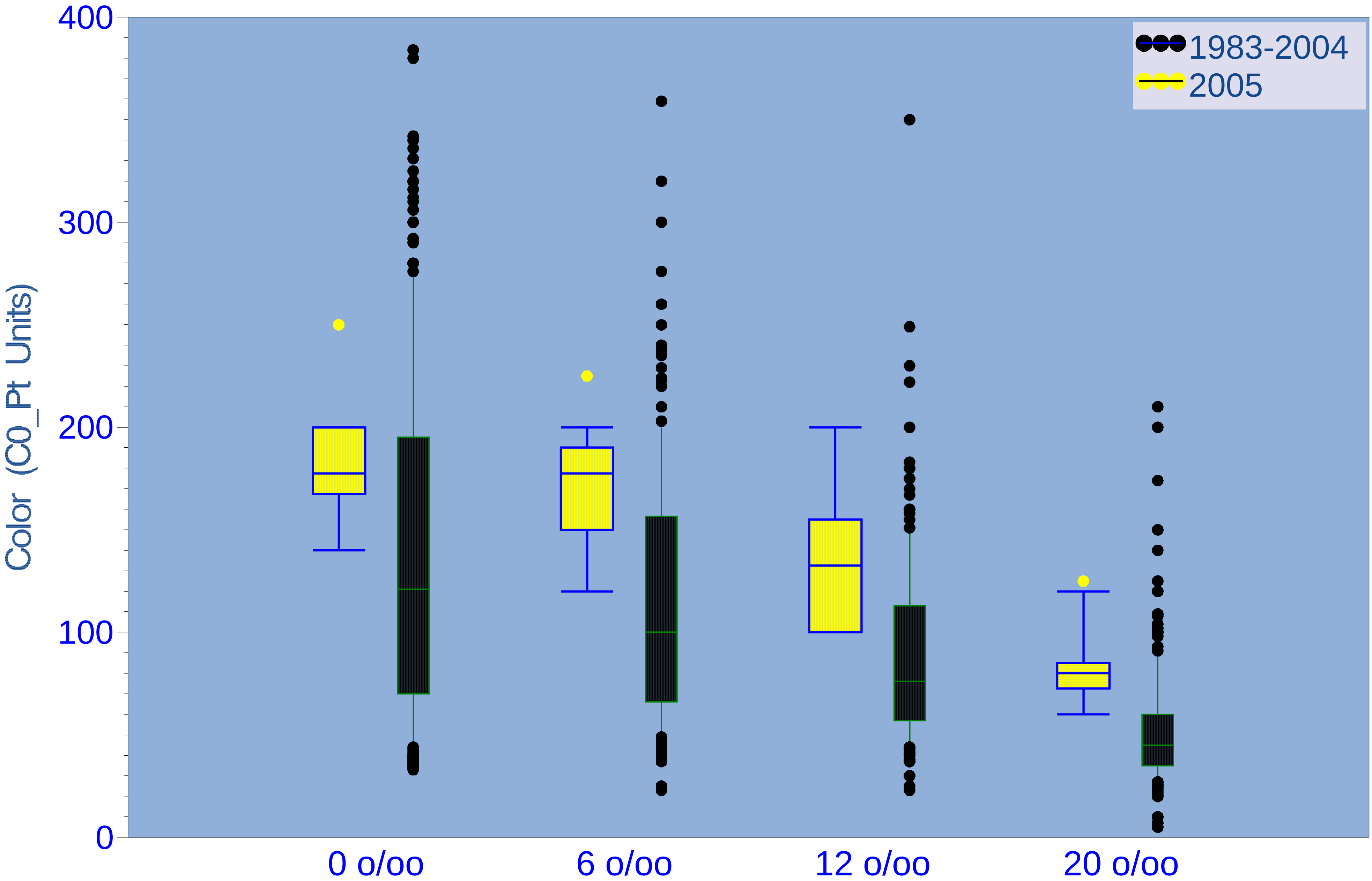


Figure 3.23 Box and whisker plots of Color at salinity sampling zones

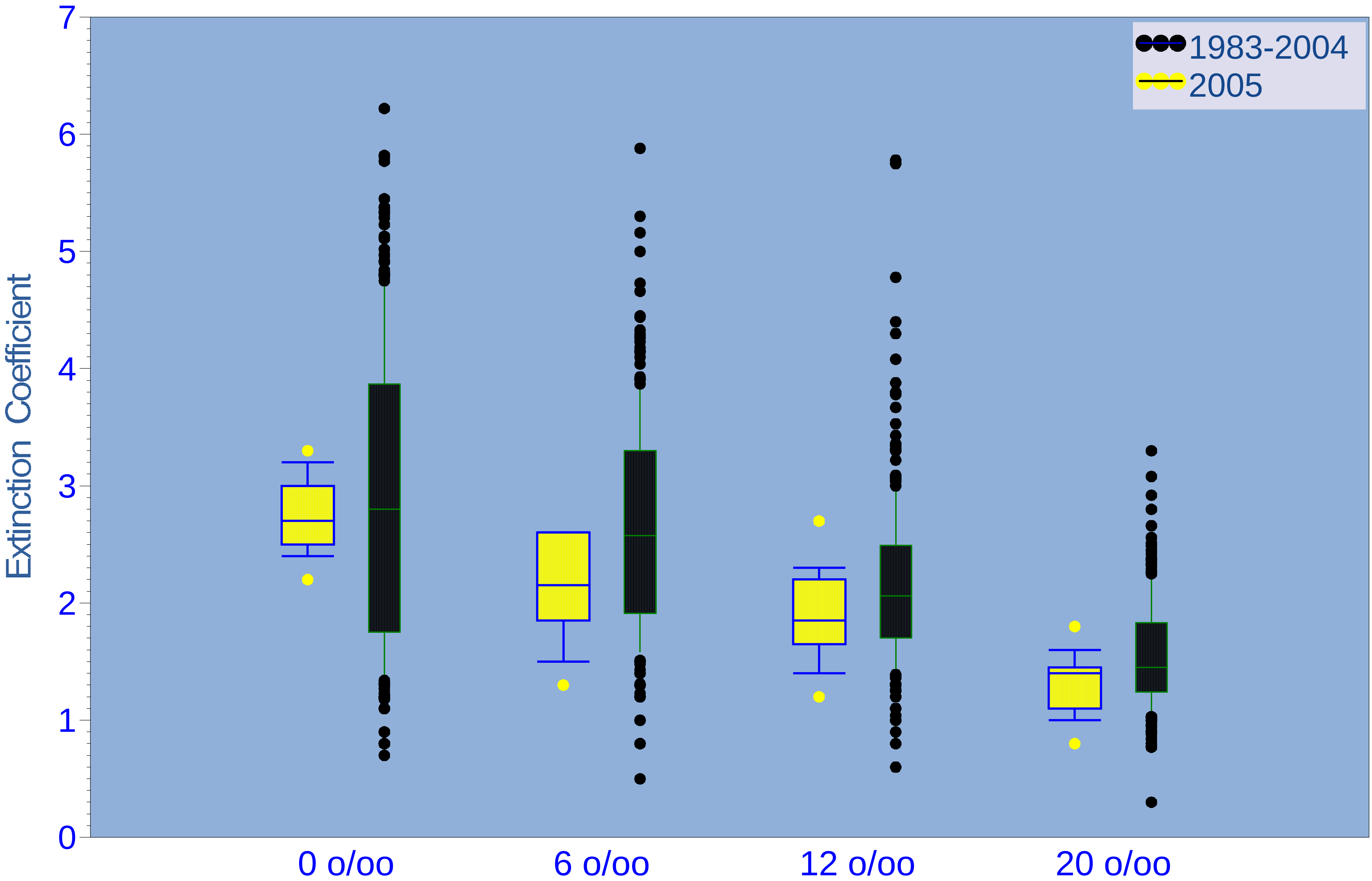


Figure 3.24 Box and whisker plots of extinction coefficient at salinity sampling zones

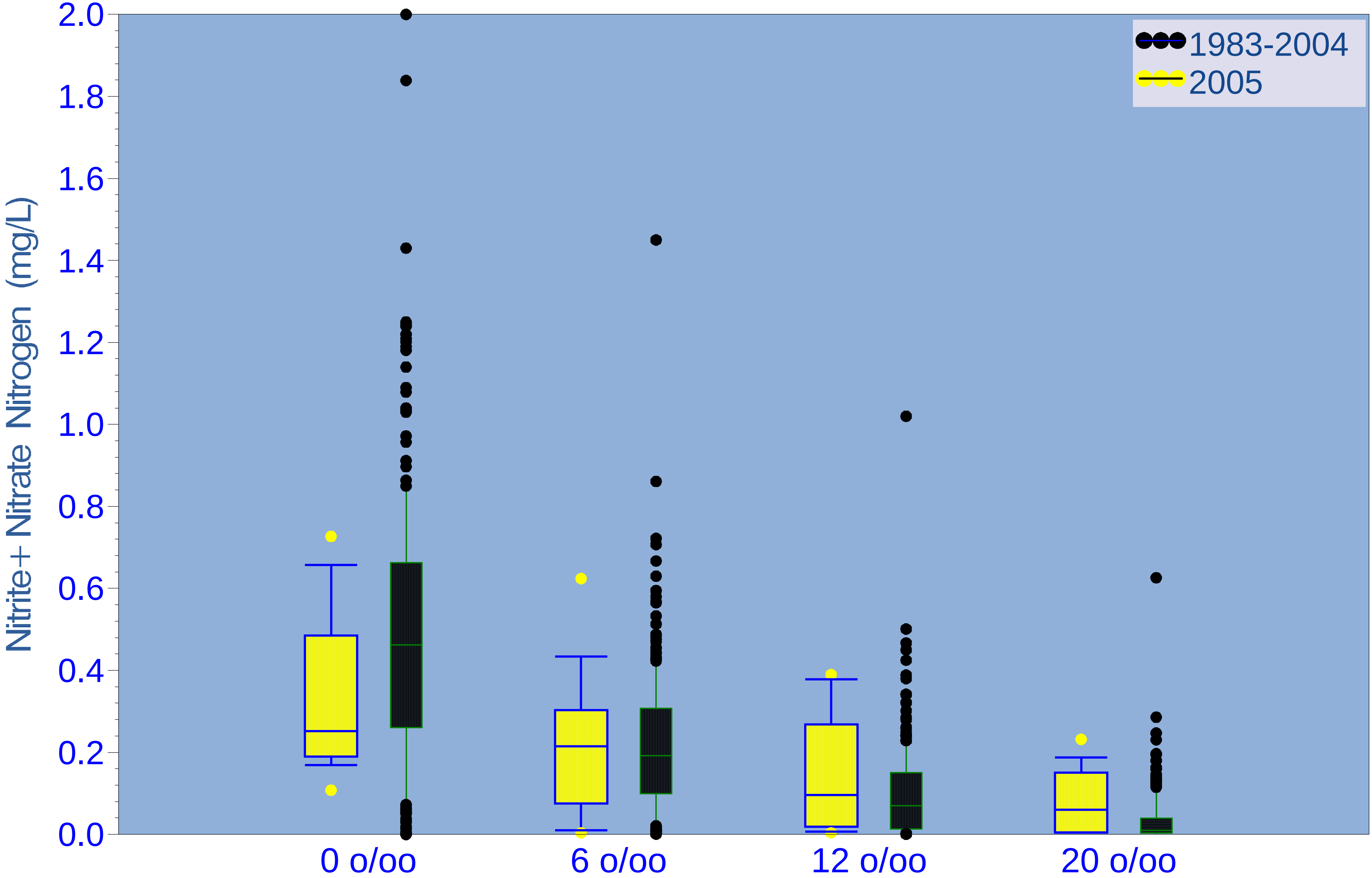


Figure 3.25 Box and whisker plots of nitrite/nitrate at salinity sampling zones

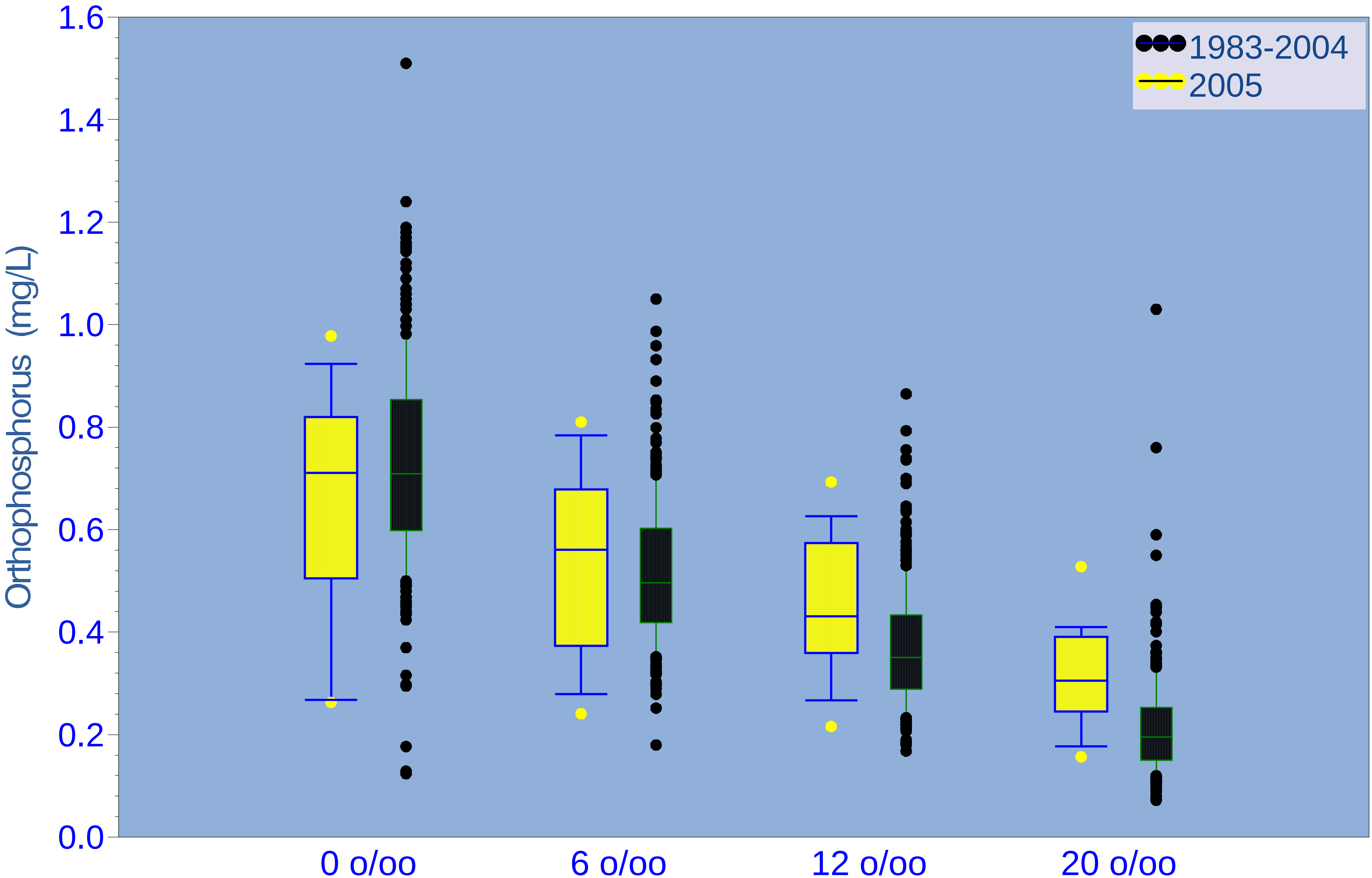


Figure 3.26 Box and whisker plots of ortho-phosphorus at salinity sampling zones

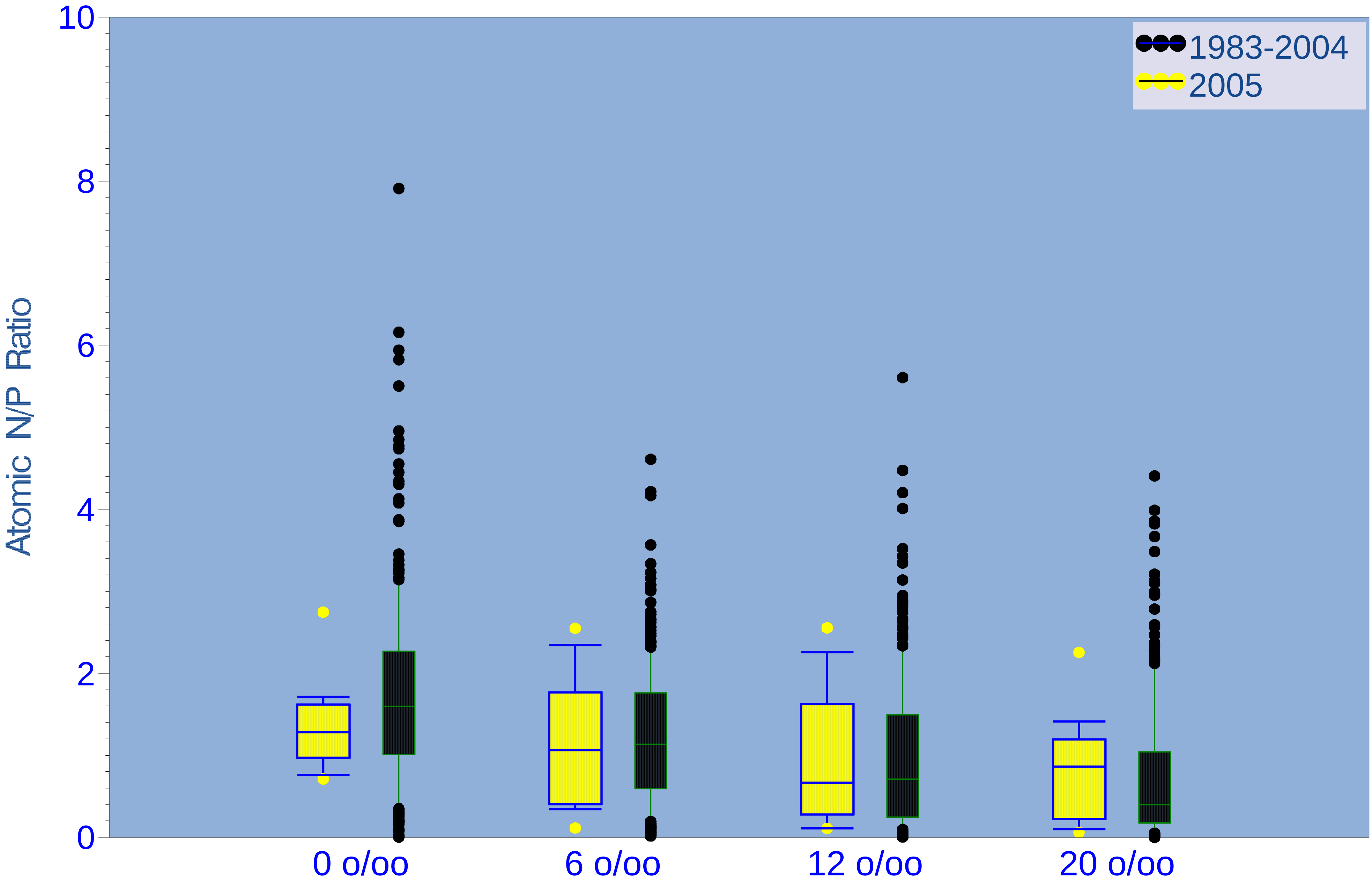


Figure 3.27 Box and whisker plots of atomic N/P ratio at salinity sampling zones

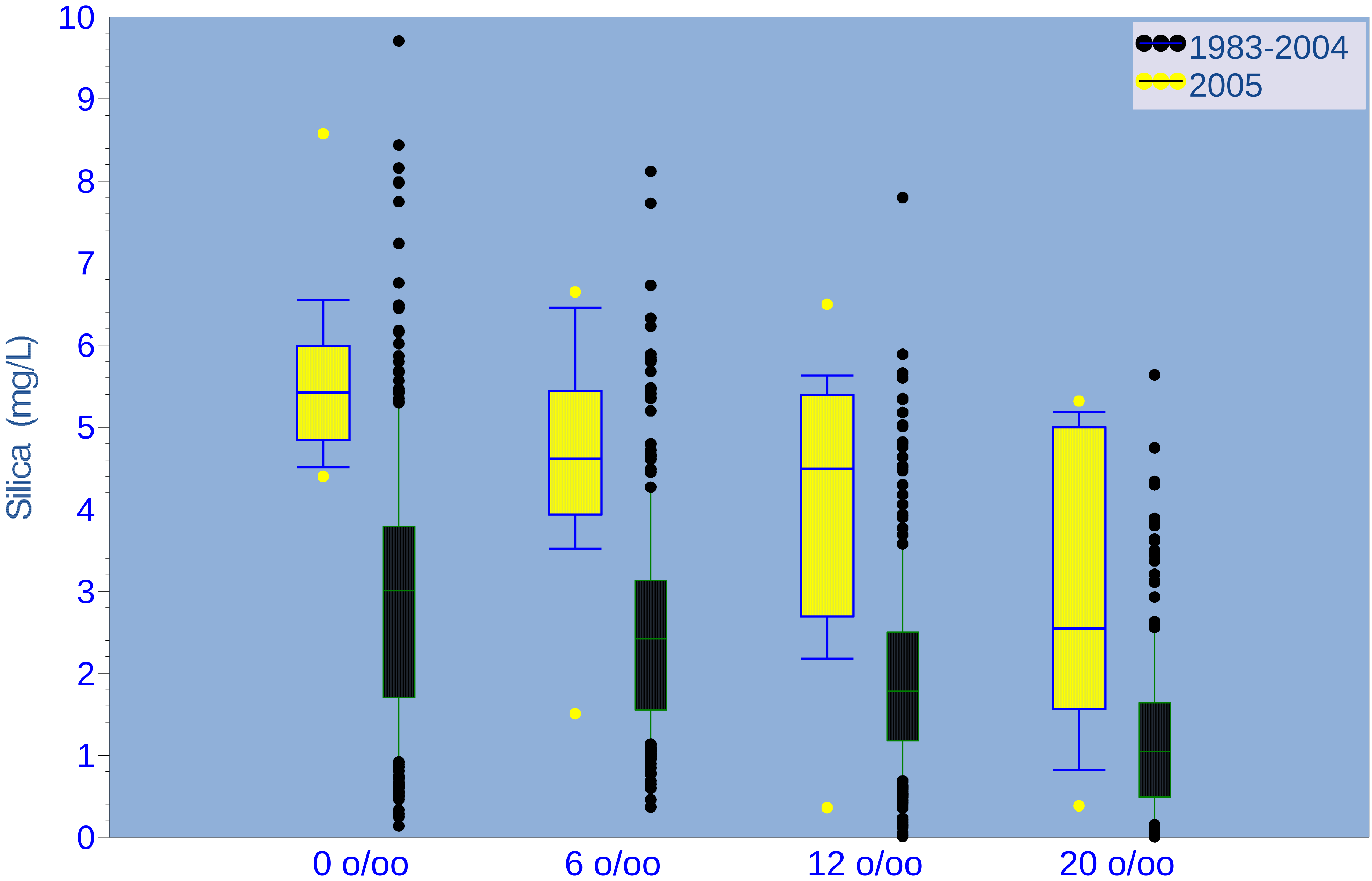


Figure 3.28 Box and whisker plots of silica at salinity sampling zones

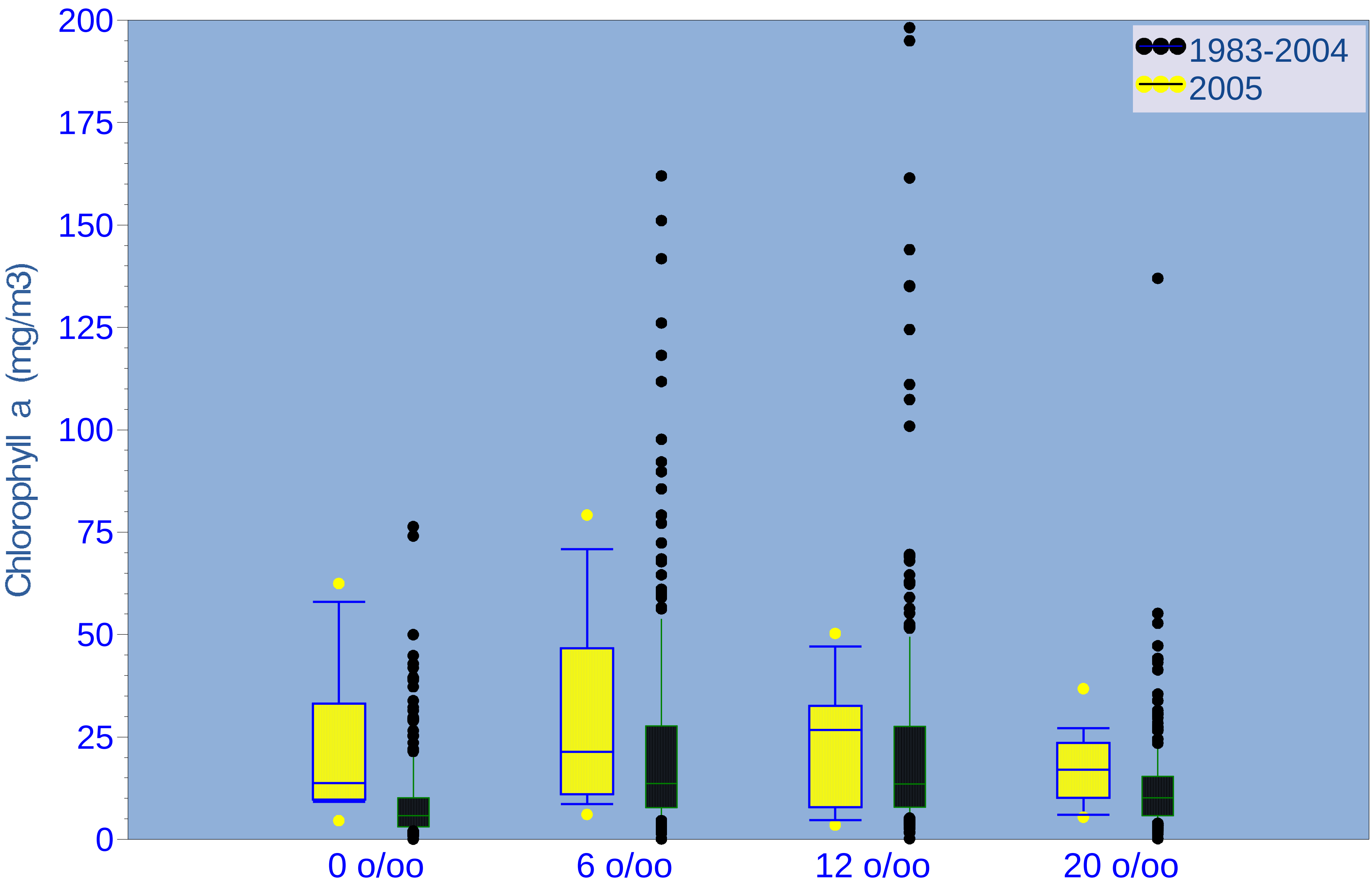


Figure 3.29a Box and whisker plots of chlorophyll a (mg/m3) at salinity sampling zone

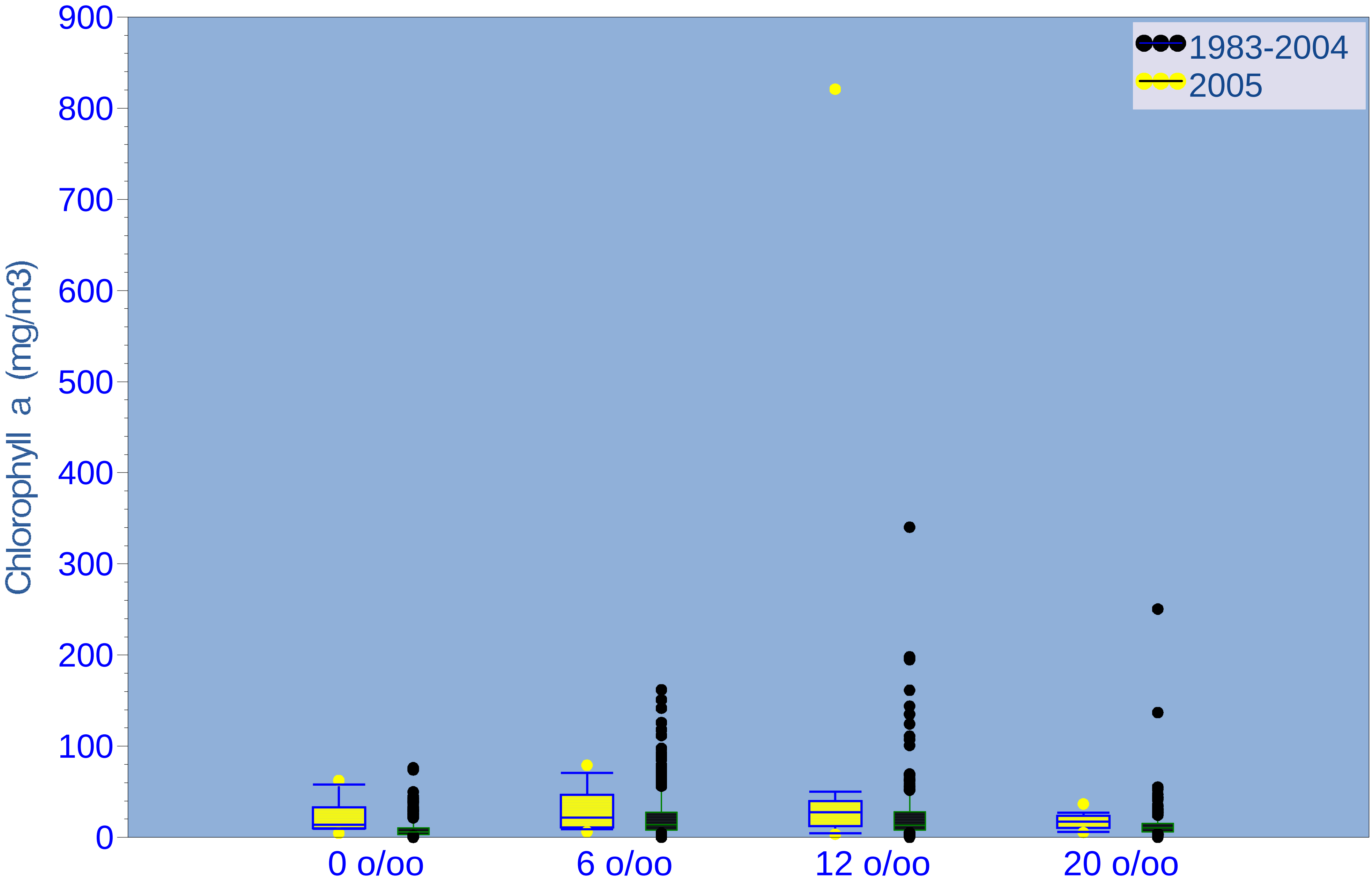


Figure 3.29b Box and whisker plots of chlorophyll a (mg/m3) at salinity sampling zones

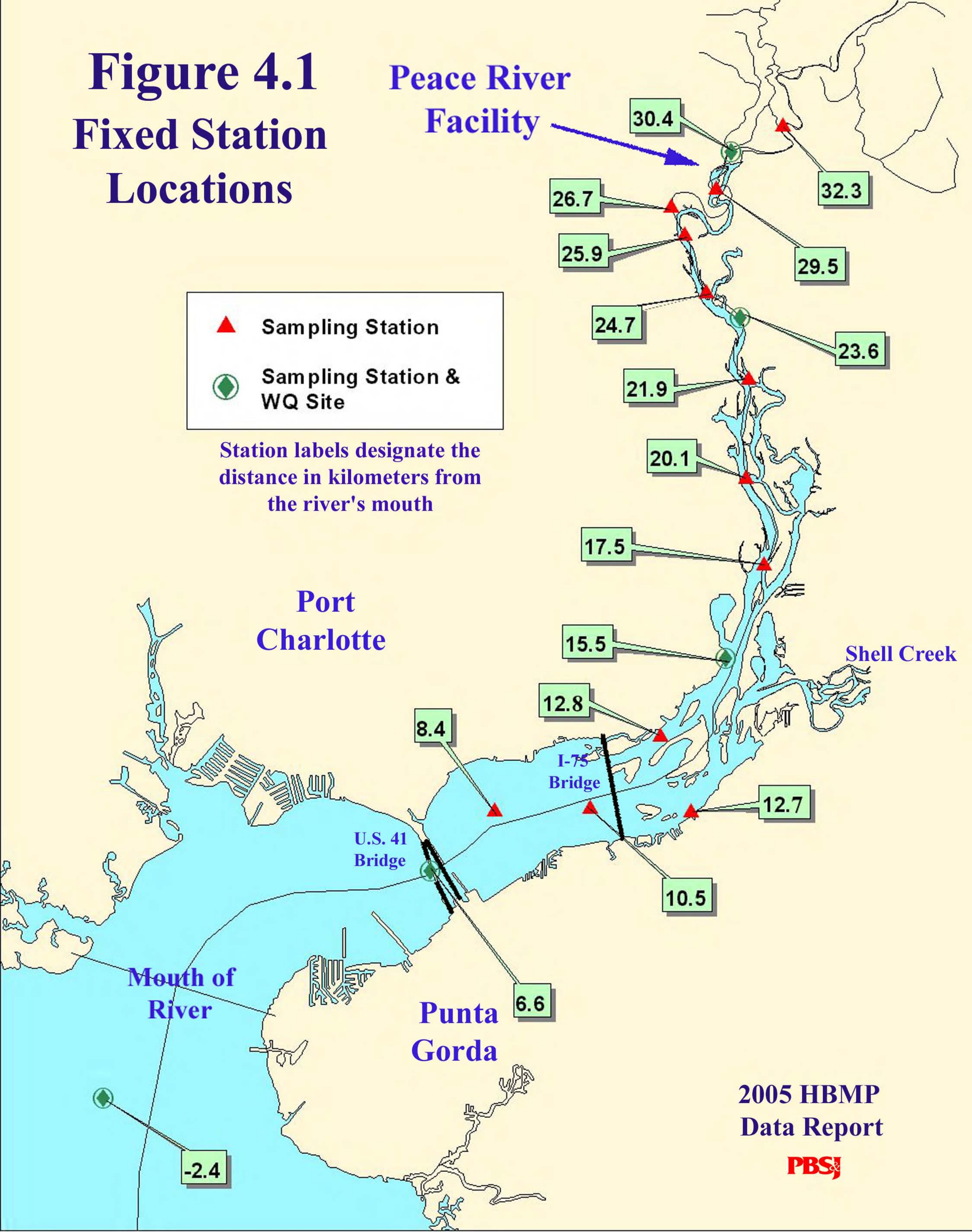


Figure 4.1
Fixed Station
Locations
Peace River
Facility
Sampling Station
Sampling Station &
WQ Site
Station labels designate the
distance in kilometers from
the river's mouth
30.4
32.3
26.7
29.5
25.9
24.7
23.6
21.9
20.1
17.5
15.5
Shell Creek
12.8
8.4
I-75
Bridge
12.7
U.S. 41
Bridge
10.5
Port
Charlotte
Mouth of
River
6.6
Punta
Gorda
-2.4
2005 HBMP
Data Report
PBSJ

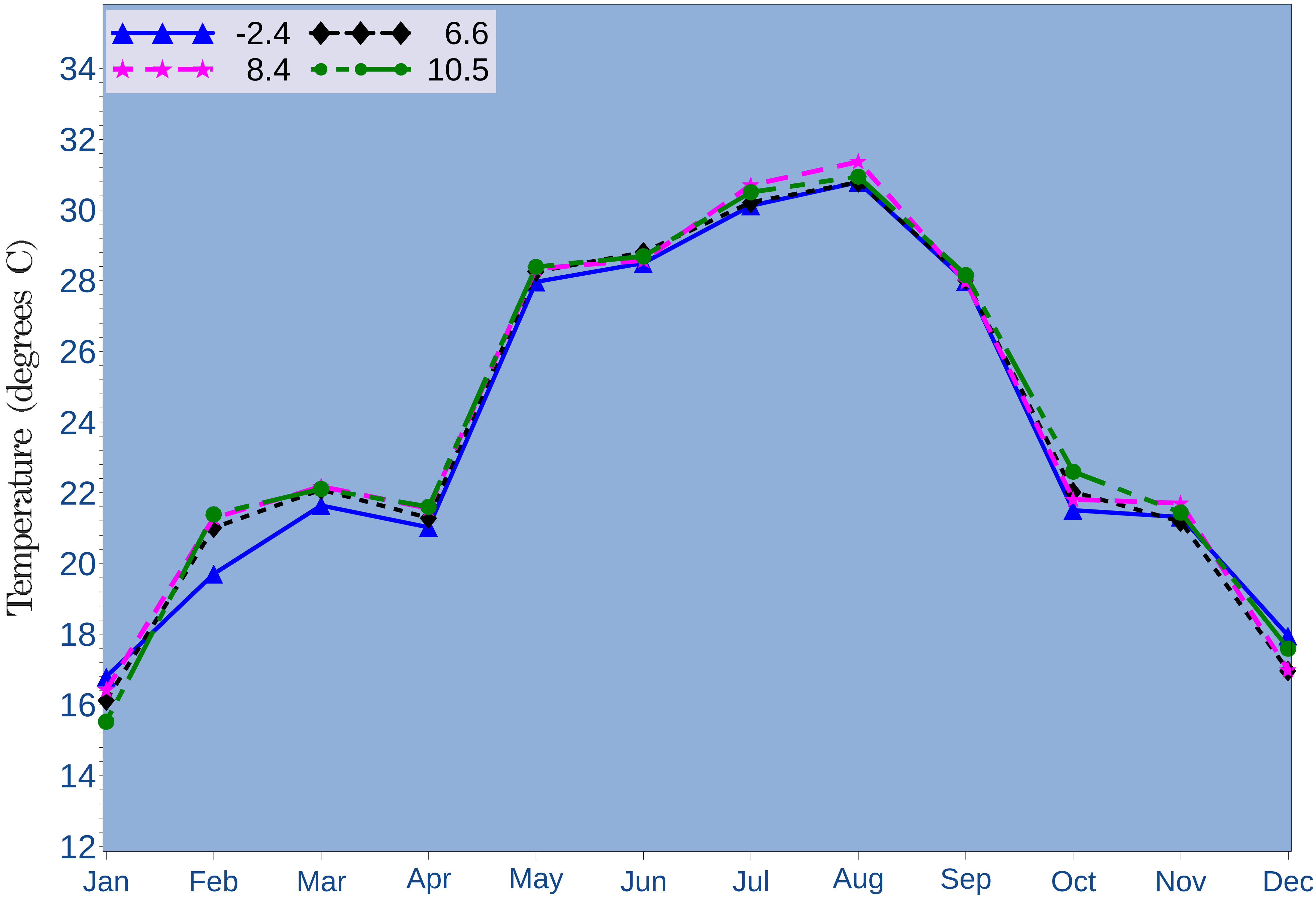


Figure 4.2a 2005 Mean monthly Mean monthly temperature at river kilometers -2.4, 6.6, 8.4 and 10.5

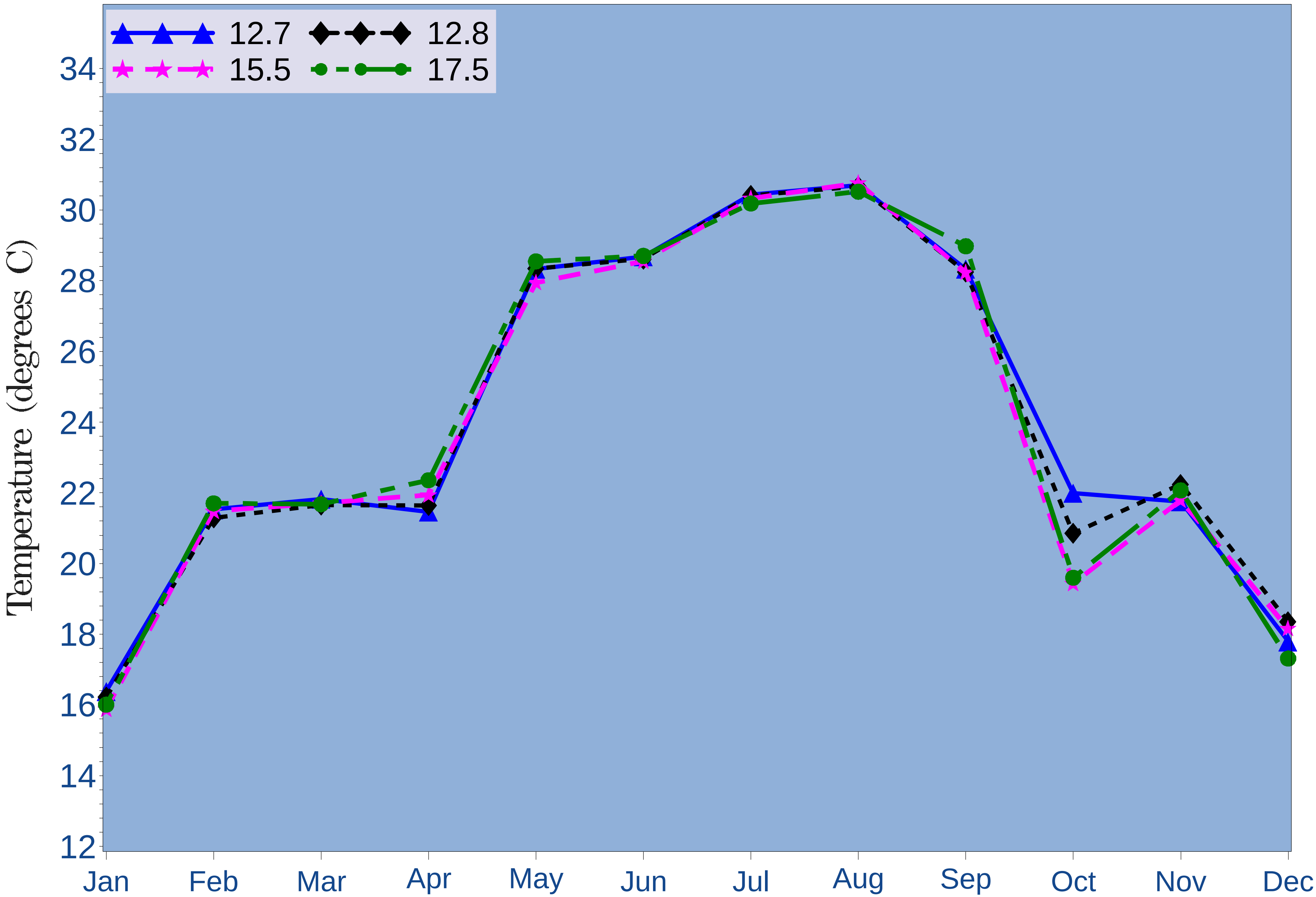


Figure 4.2b 2005 Mean monthly temperature at river kilometers 12.7, 12.8, 15.5 and 17.5

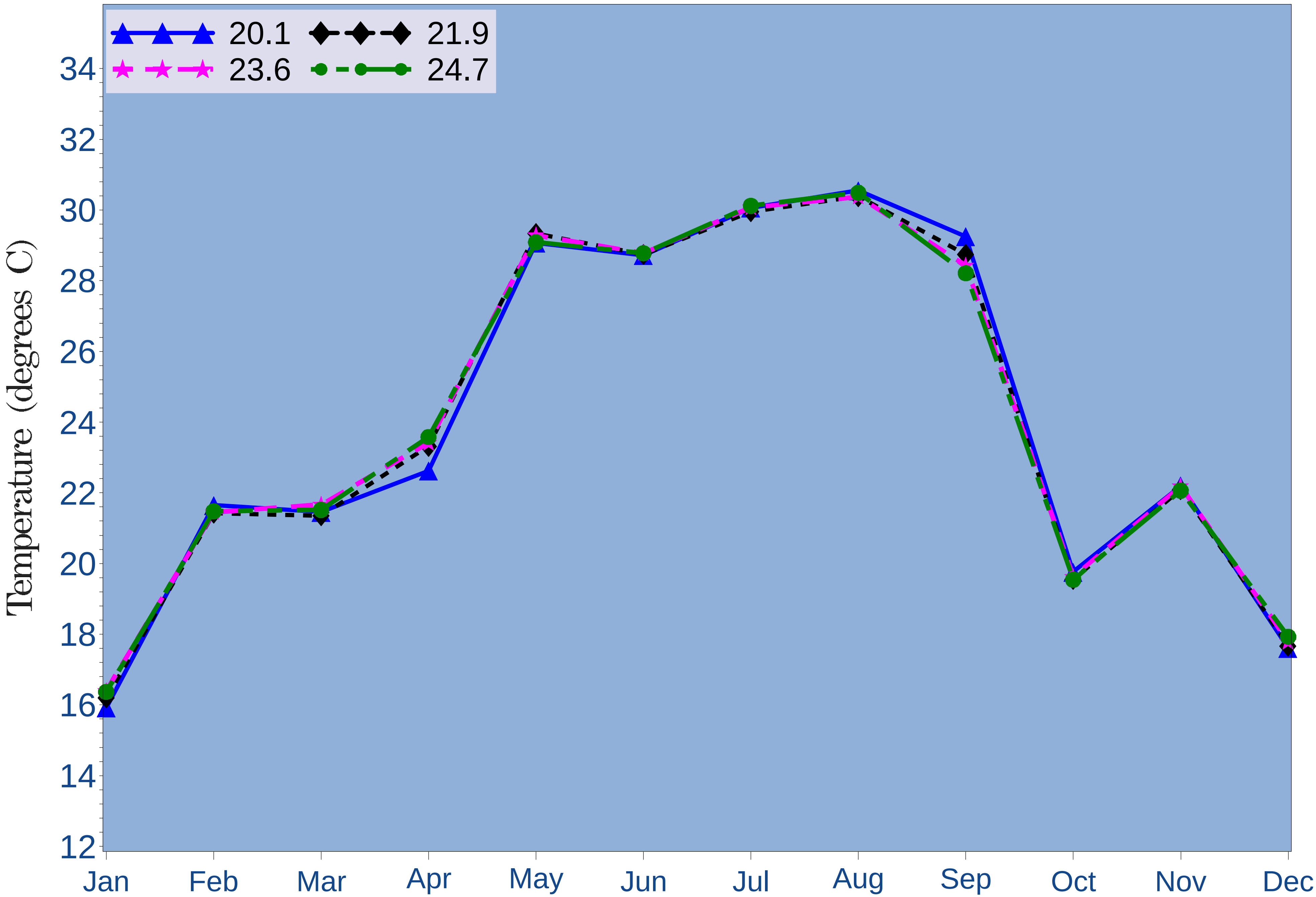


Figure 4.2c 2005 Mean monthly temperature at river kilometers 20.1, 21.9, 23.6 and 24.7

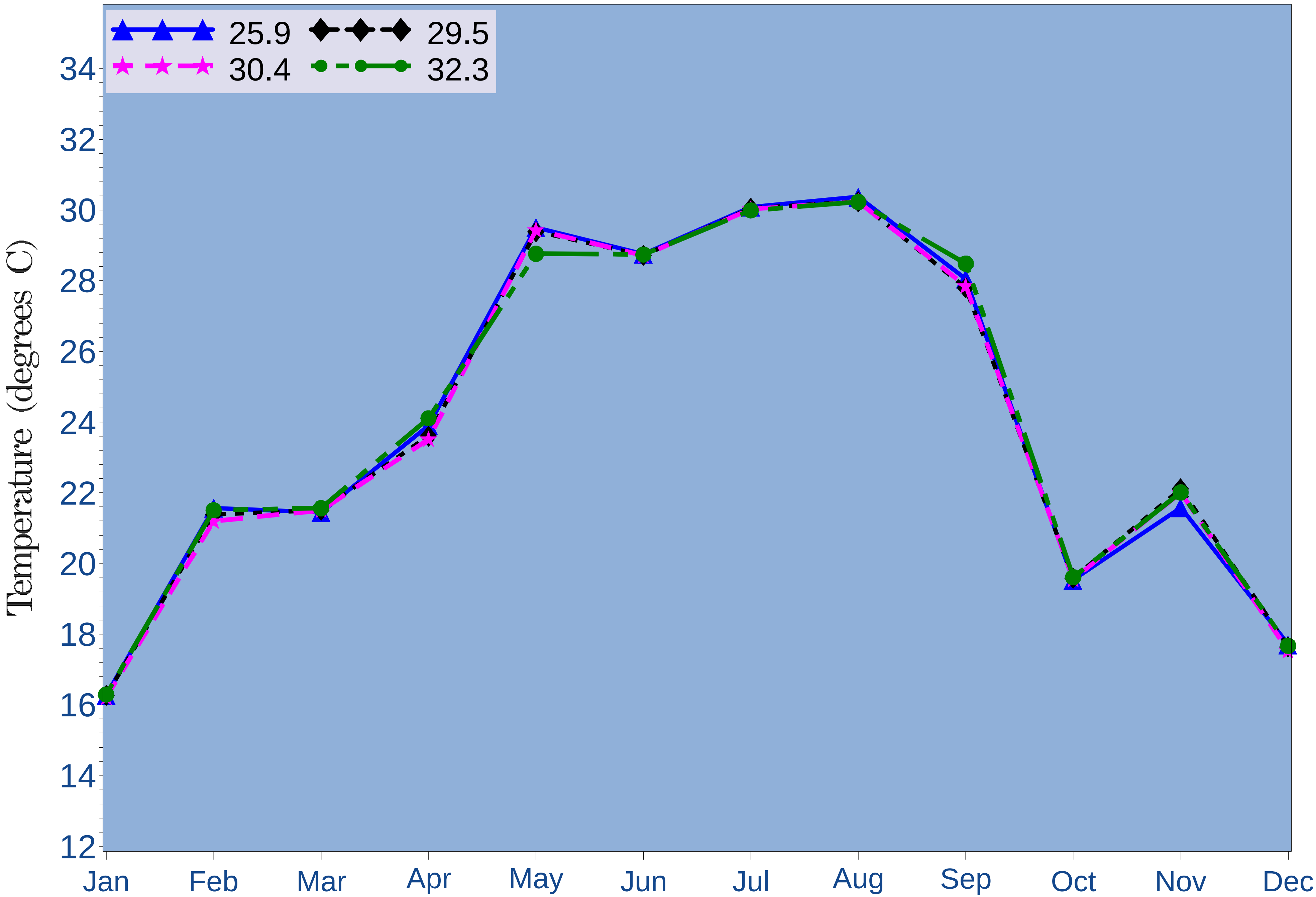


Figure 4.2d 2005 Mean monthly temperature at river kilometers 25.9, 29.5, 30.4 and 32.3

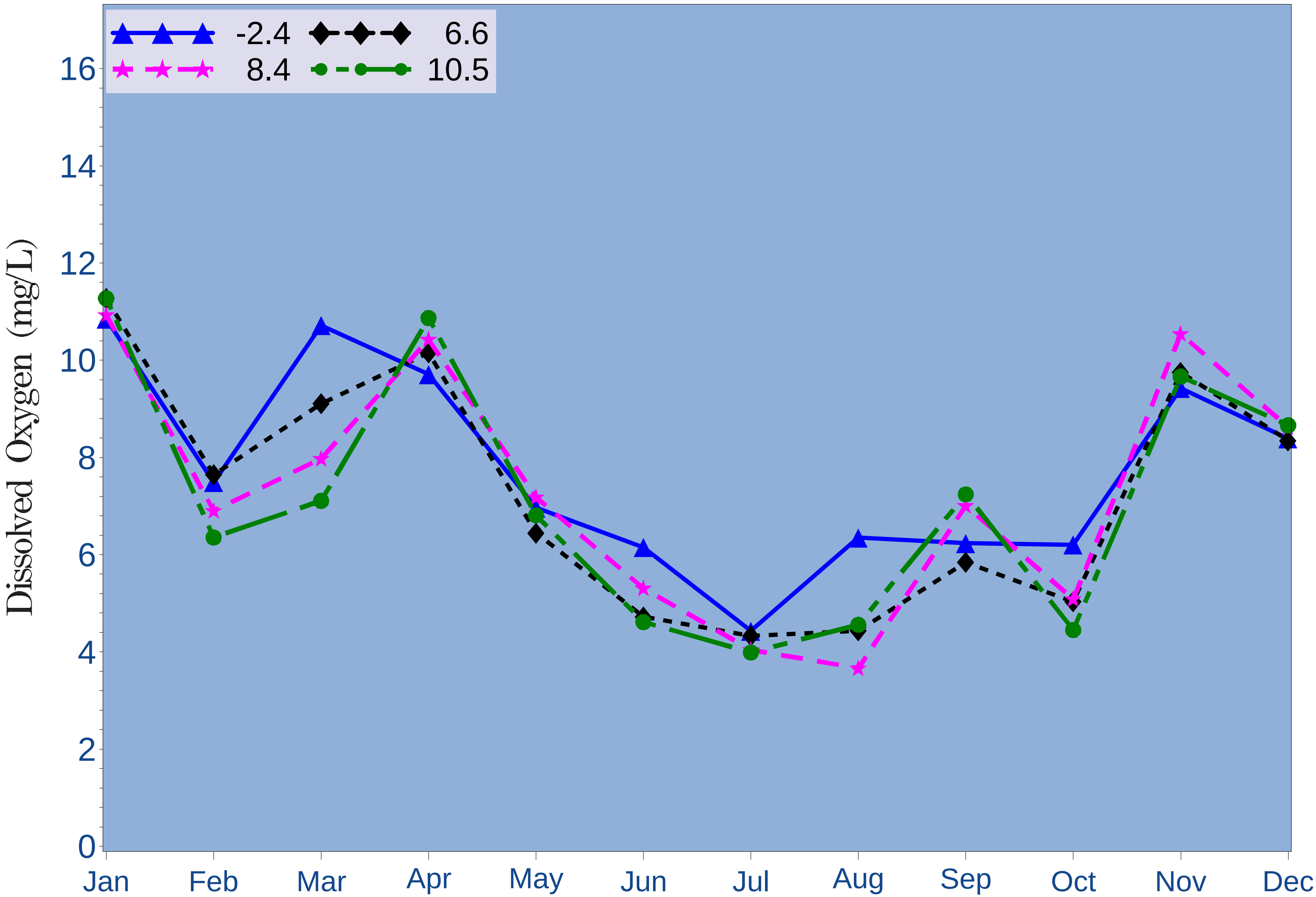


Figure 4.3a 2005 Mean monthly dissolved oxygen at river kilometers -2.4, 6.6, 8.4 and 10.5

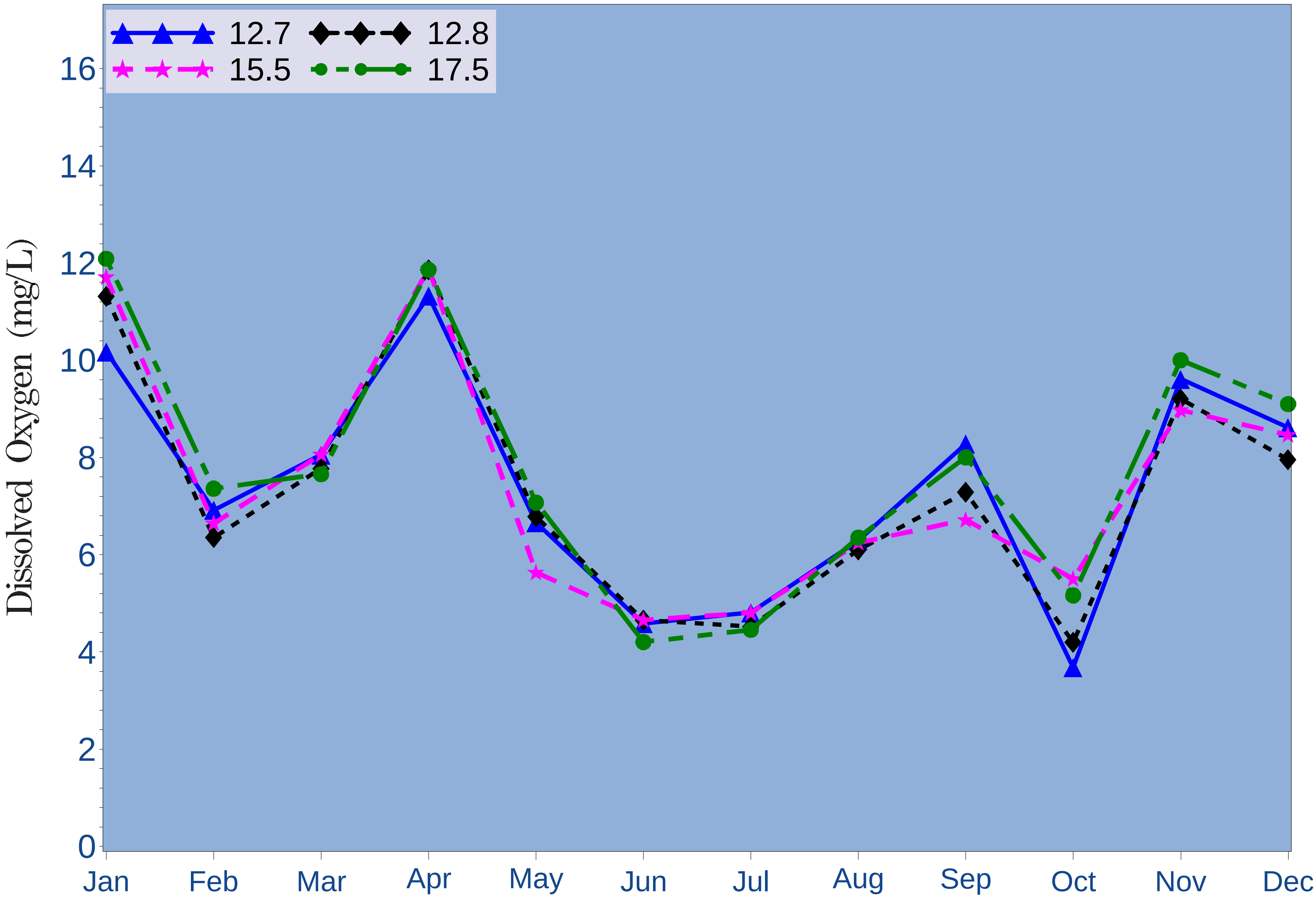


Figure 4.3b 2005 Mean monthly dissolved oxygen at river kilometers 12.7, 12.8, 15.5 and 17.5

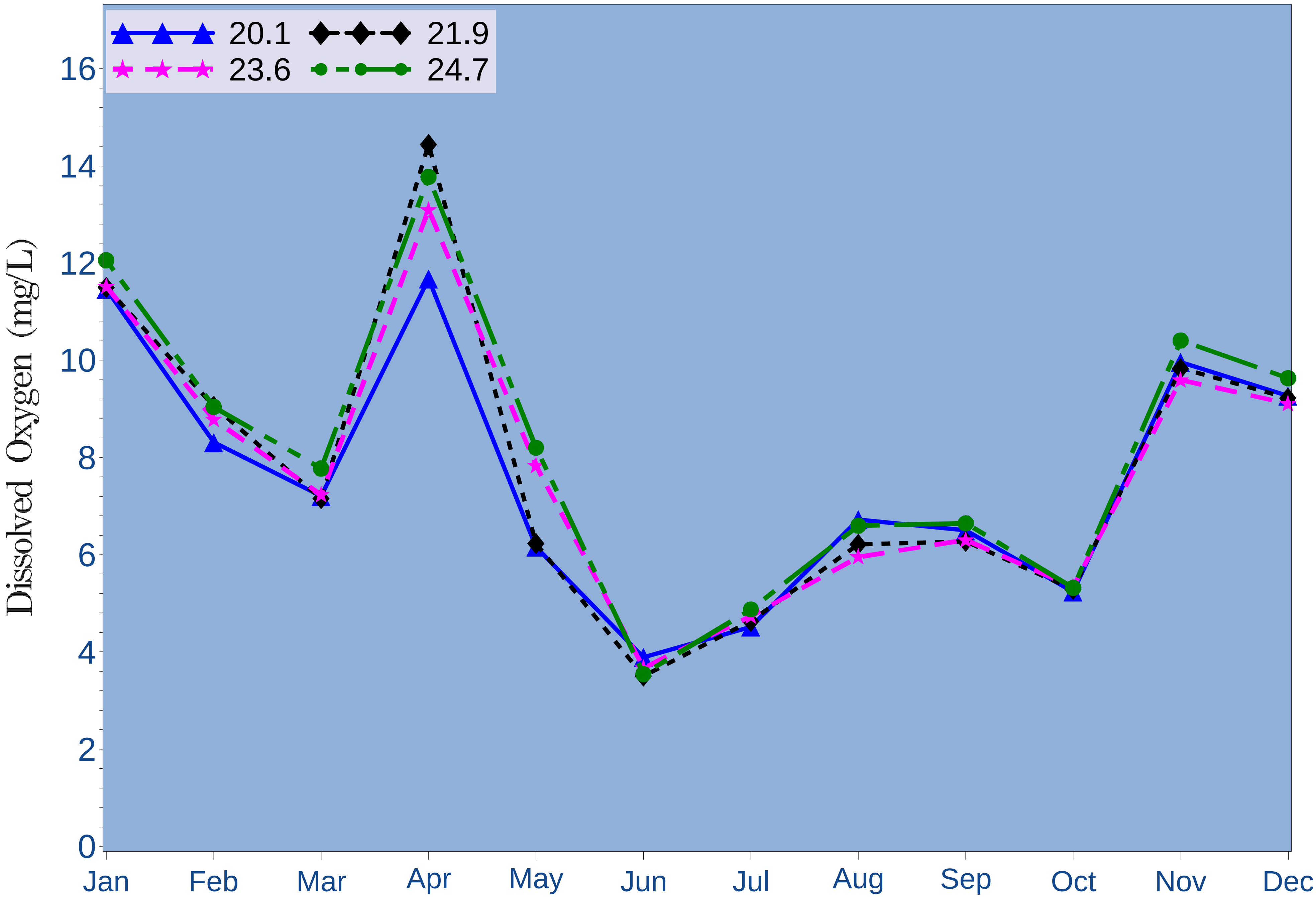


Figure 4.3c 2005 Mean monthly dissolved oxygen at river kilometers 20.1, 21.9, 23.6 and 24.7

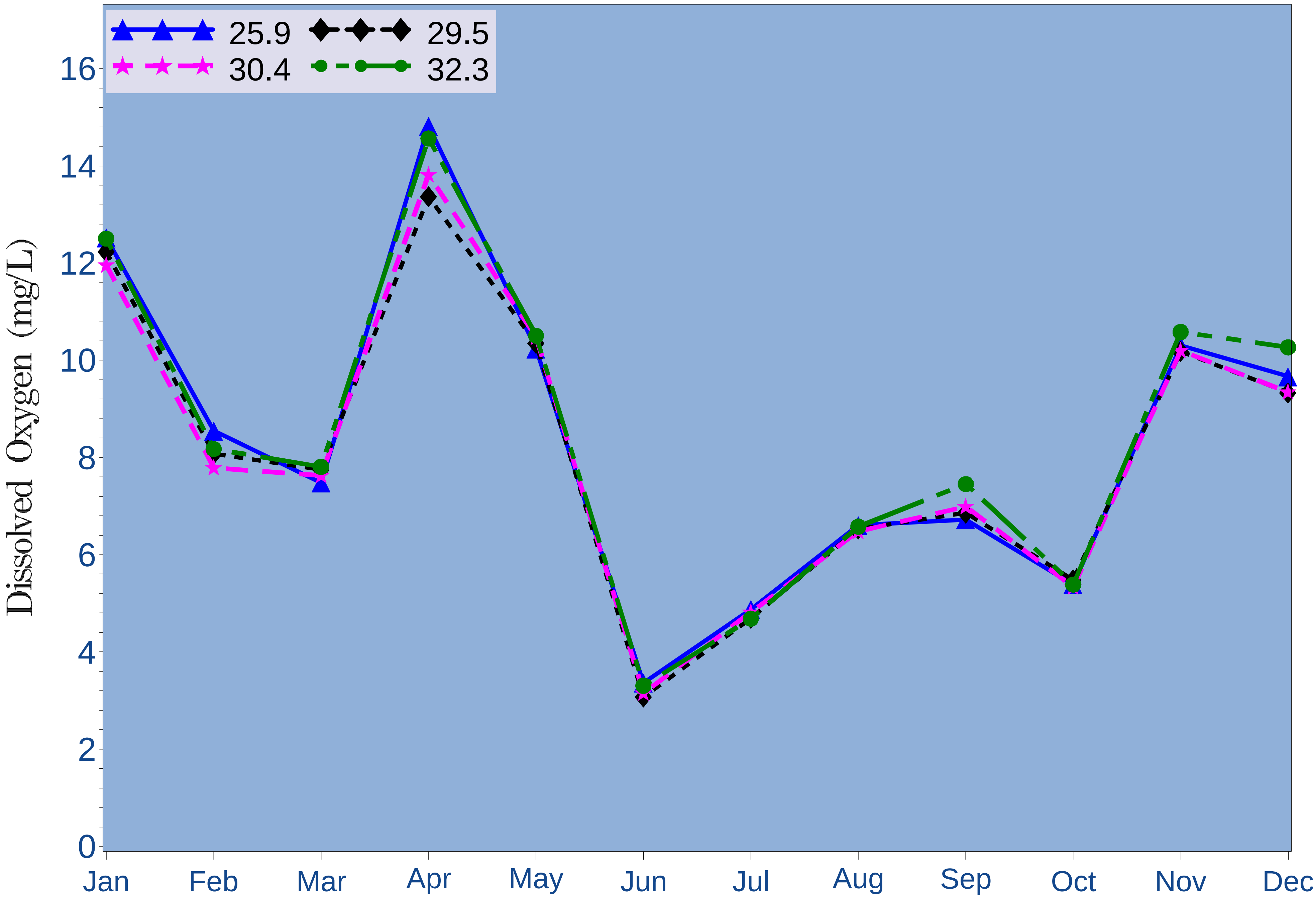


Figure 4.3d 2005 Mean monthly dissolved oxygen at river kilometers 25.9, 29.5, 30.4 and 32.3

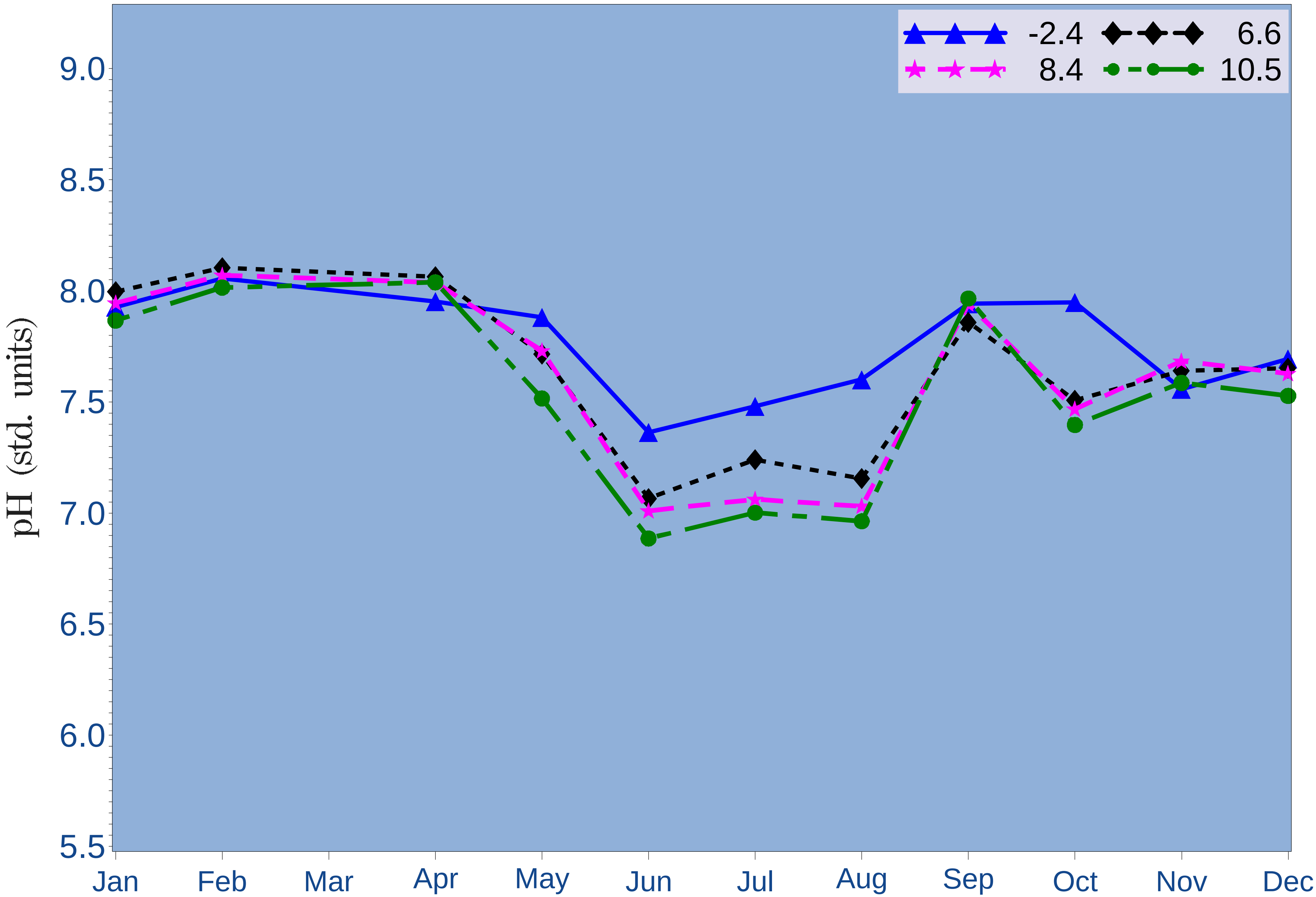


Figure 4.4a 2005 Mean monthly pH at river kilometers -2.4, 6.6, 8.4 and 10.5

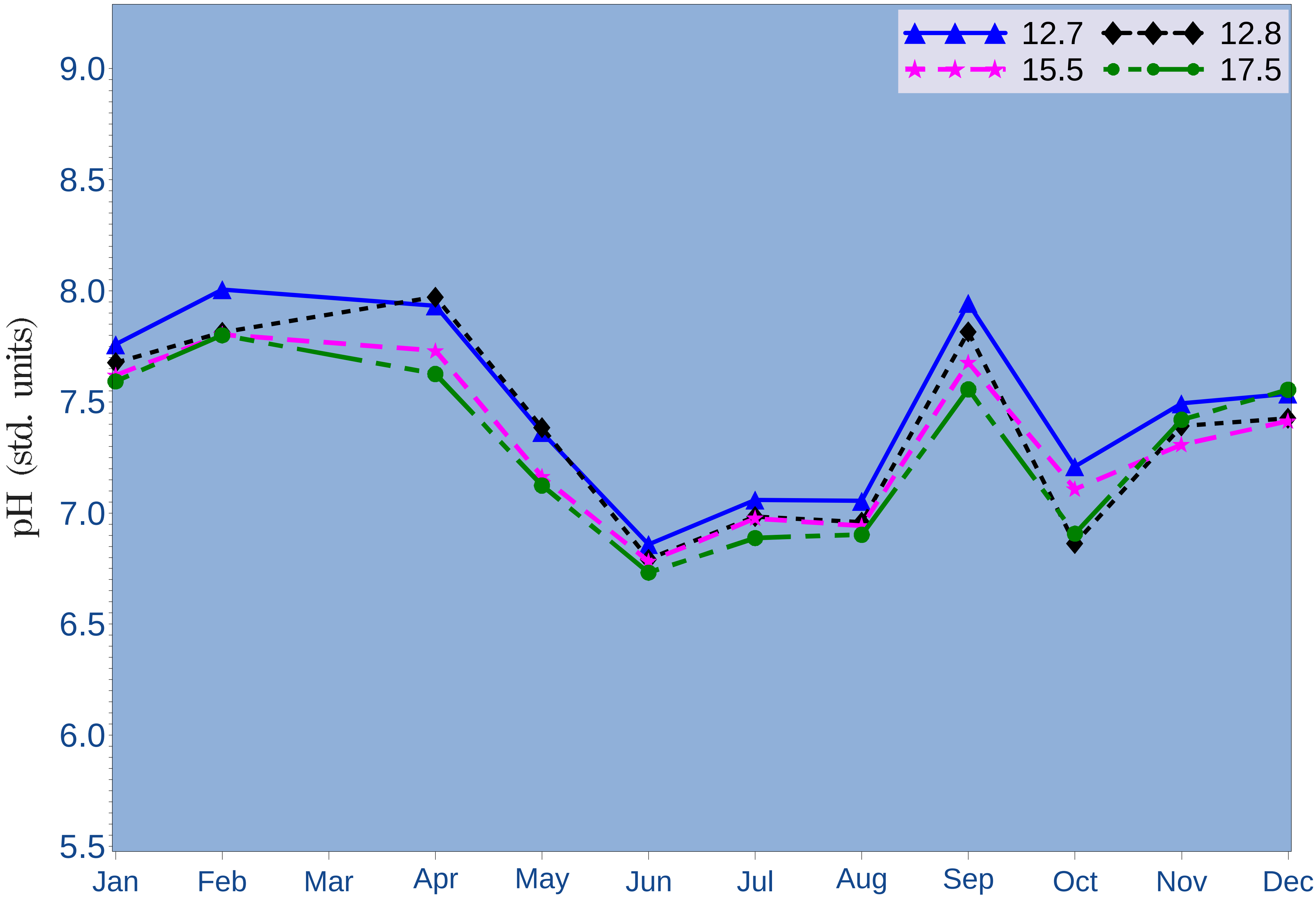


Figure 4.4b 2005 Mean monthly pH at river kilometers 12.7, 12.8, 15.5 and 17.5

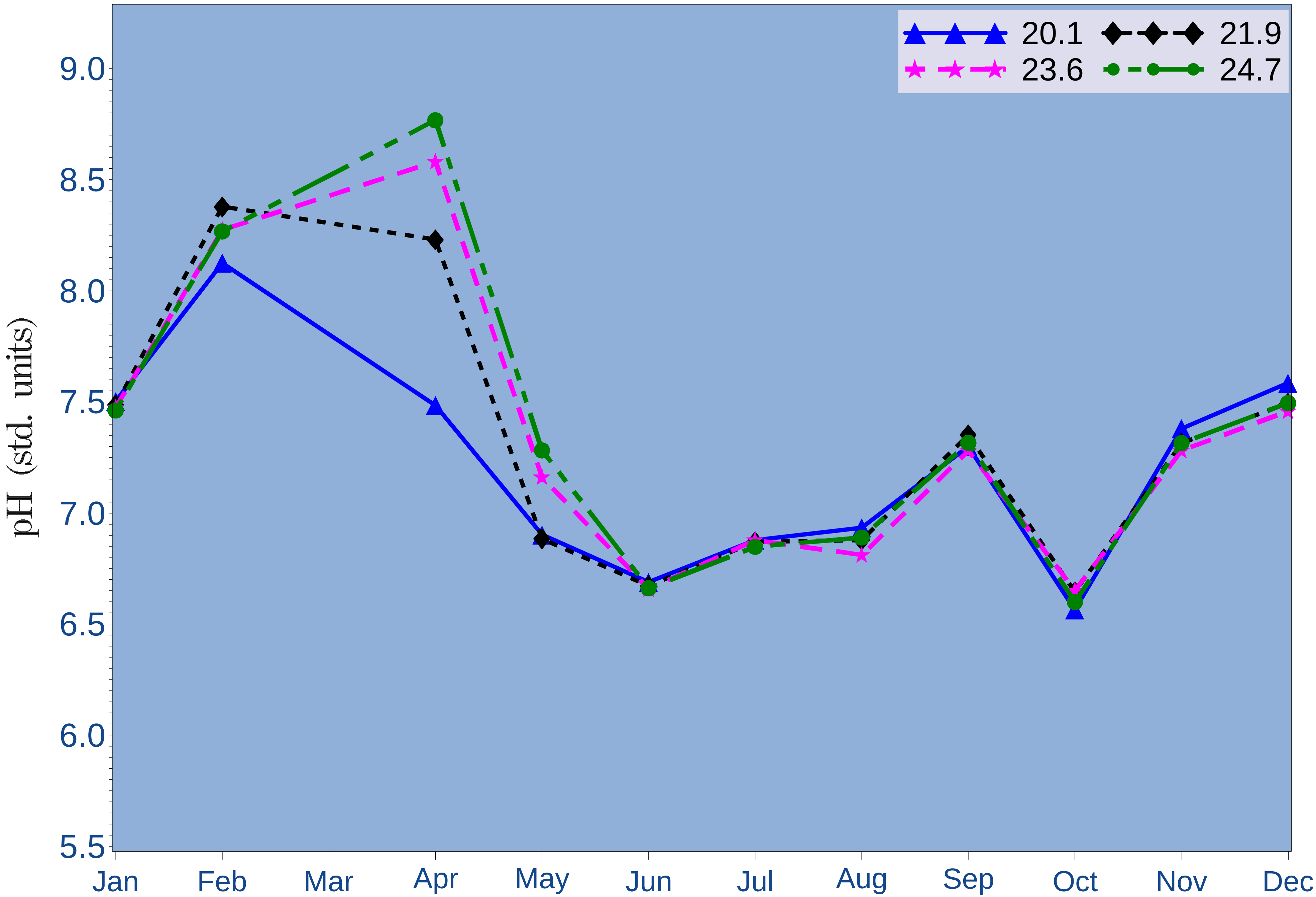


Figure 4.4c 2005 Mean monthly pH at river kilometers 20.1, 21.9, 23.6 and 24.7

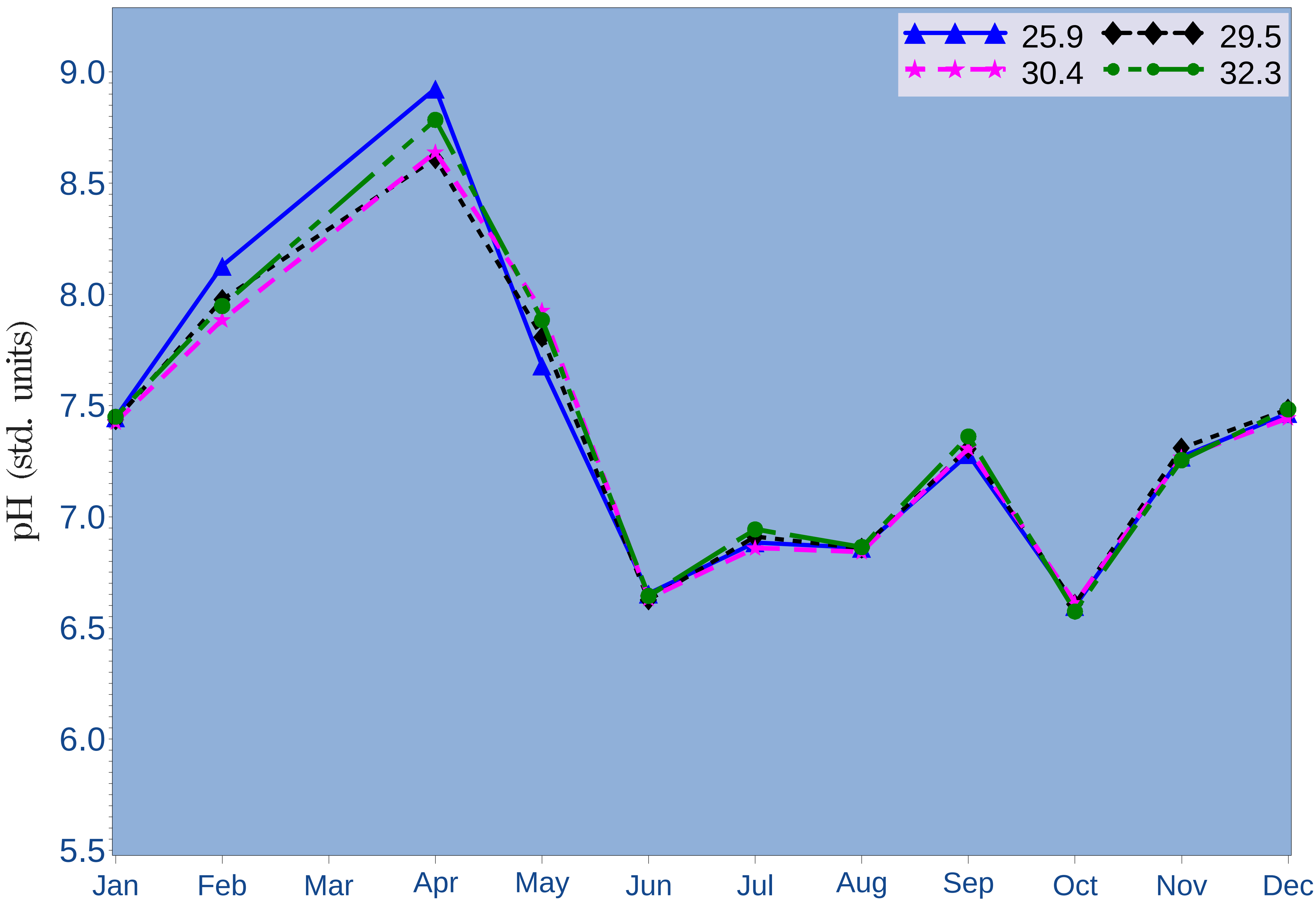


Figure 4.4d 2005 Mean monthly pH at river kilometers 25.9, 29.5, 30.4 and 32.3

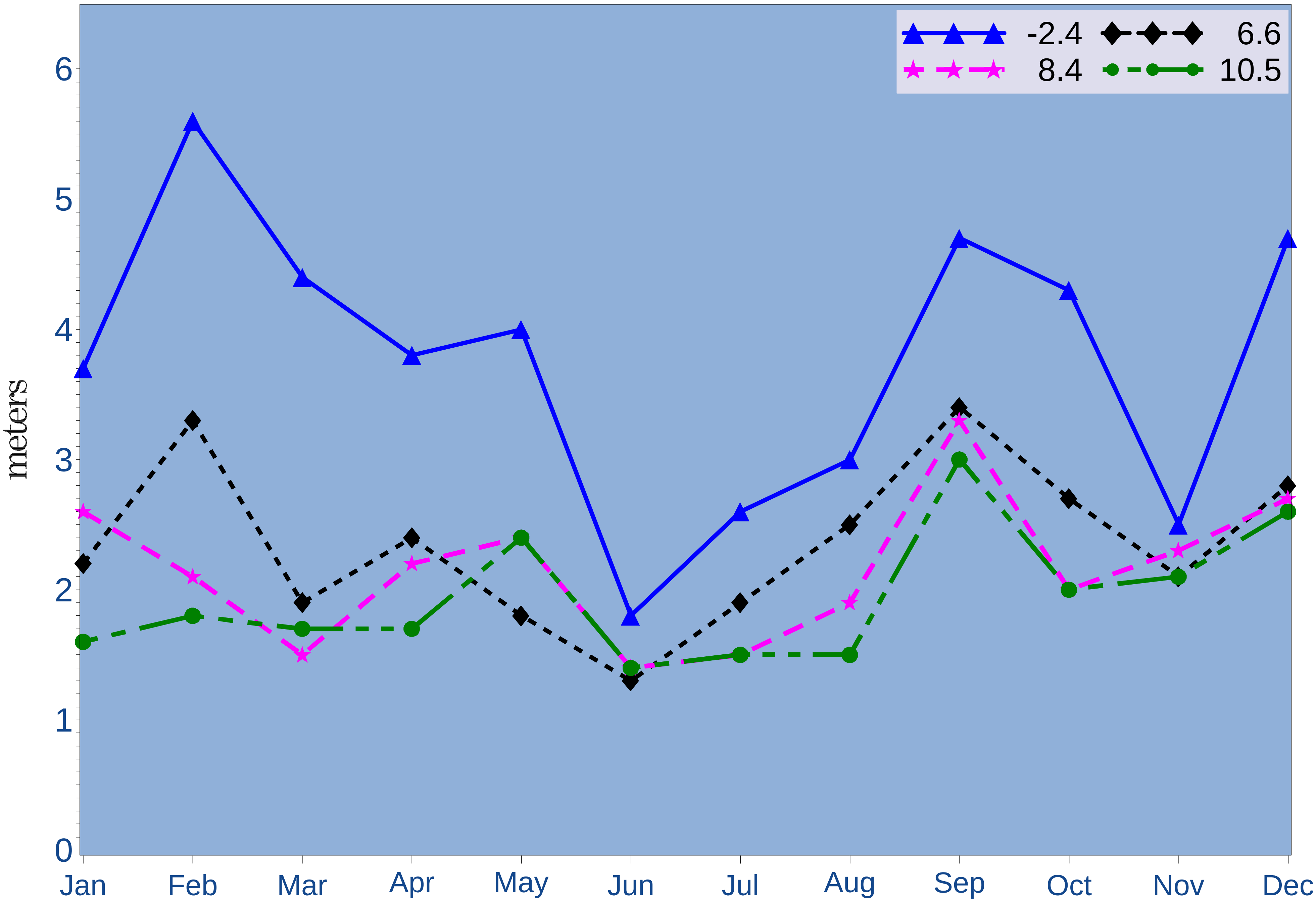


Figure 4.5a 2005 Monthly 1% light depth at river kilometers -2.4, 6.6, 8.4 and 10.5

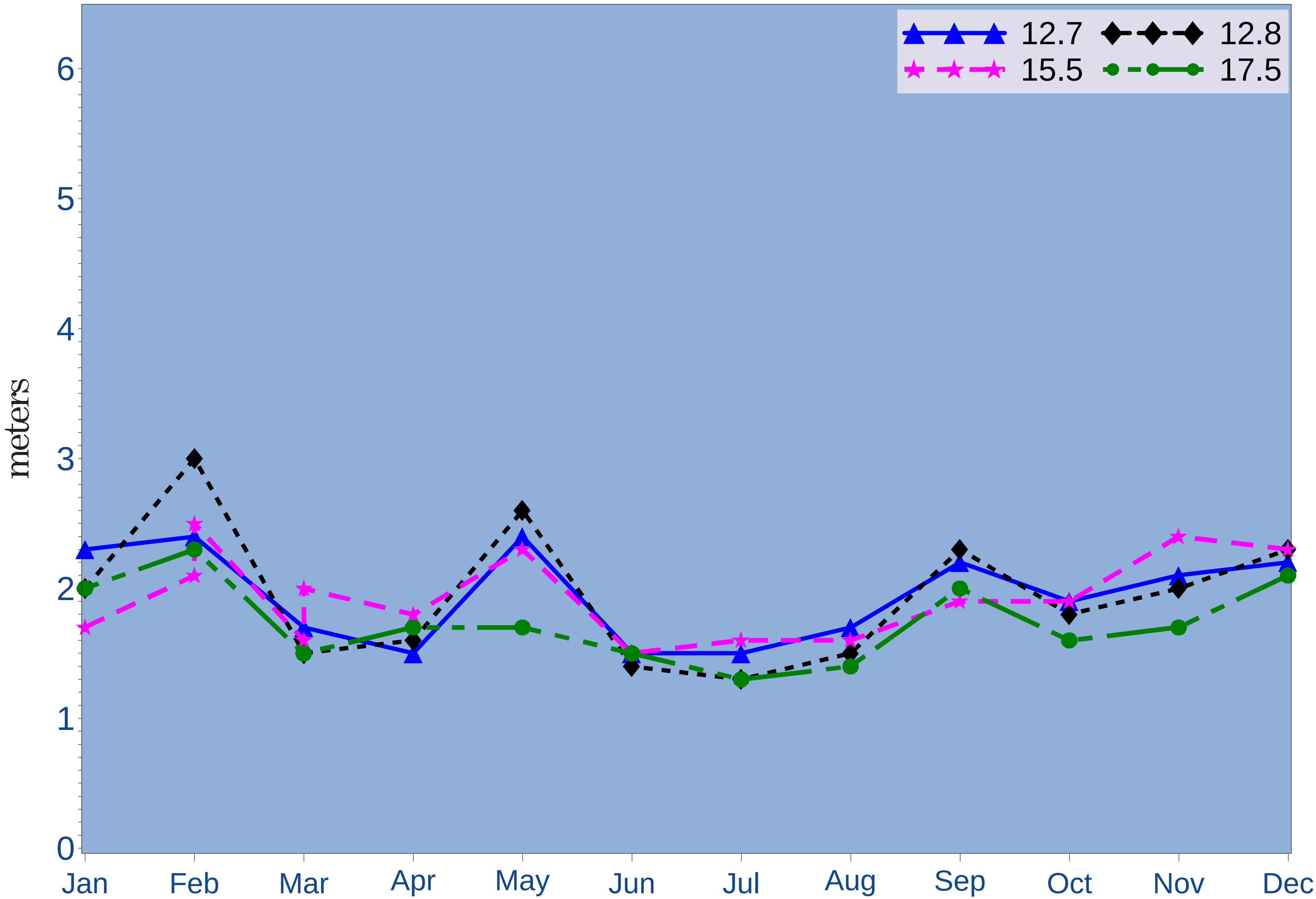


Figure 4.5b 2005 Monthly 1% light depth at river kilometers 12.7, 12.8, 15.5 and 17.5

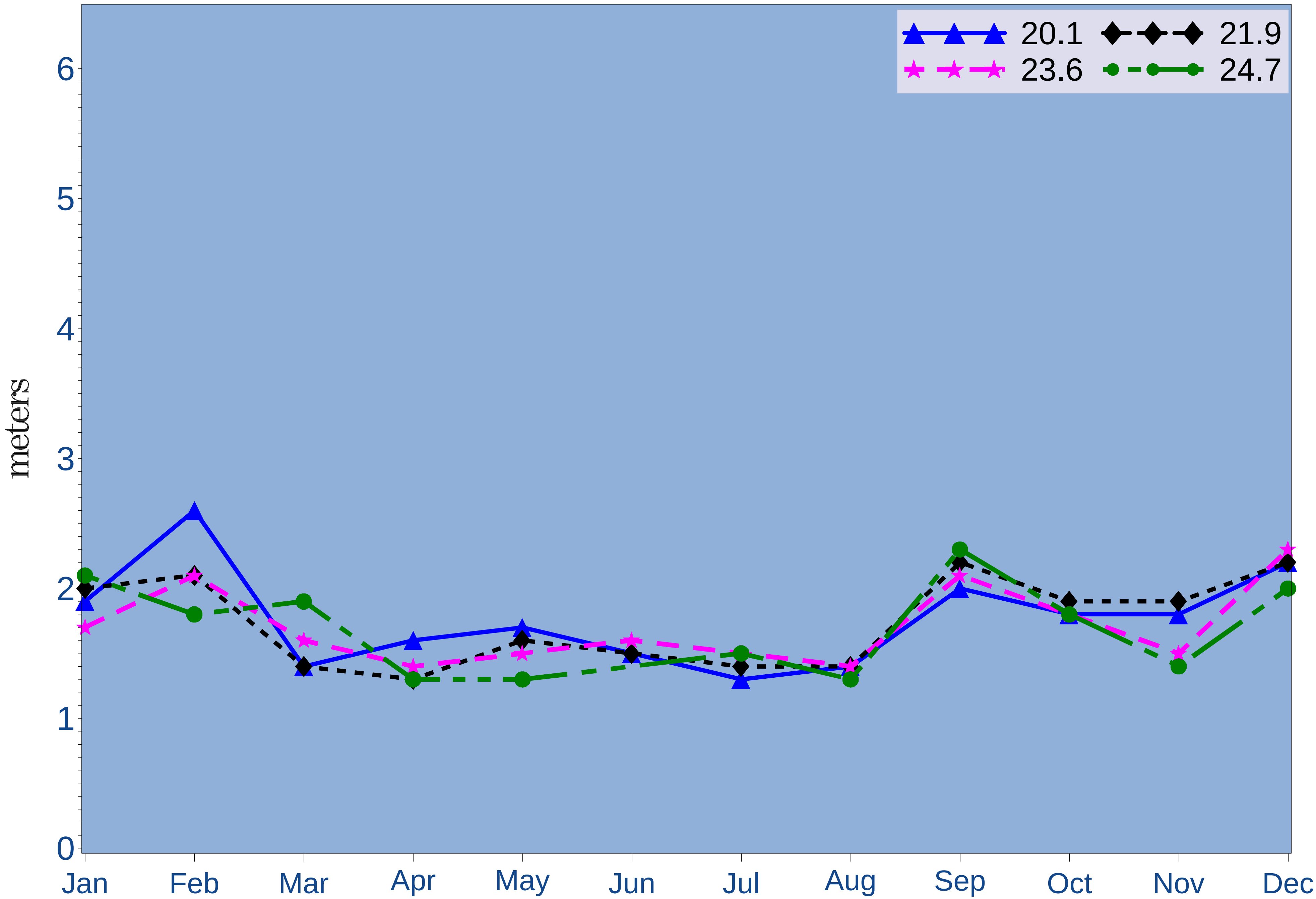


Figure 4.5c 2005 Monthly 1% light depth at river kilometers 20.1, 21.9, 23.6 and 24.7

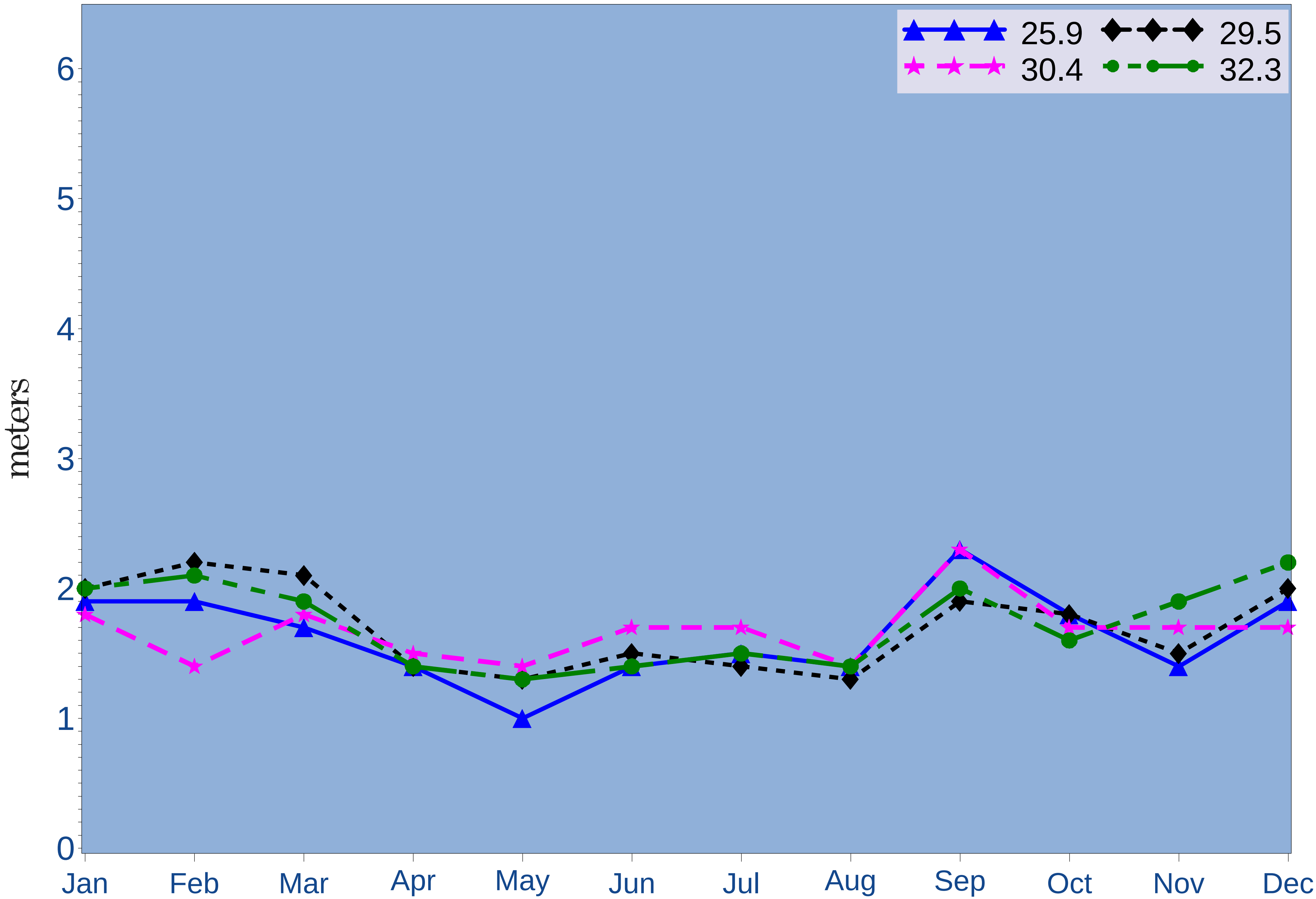


Figure 4.5d 2005 Monthly 1% light depth at river kilometers 25.9, 29.5, 30.4 and 32.3

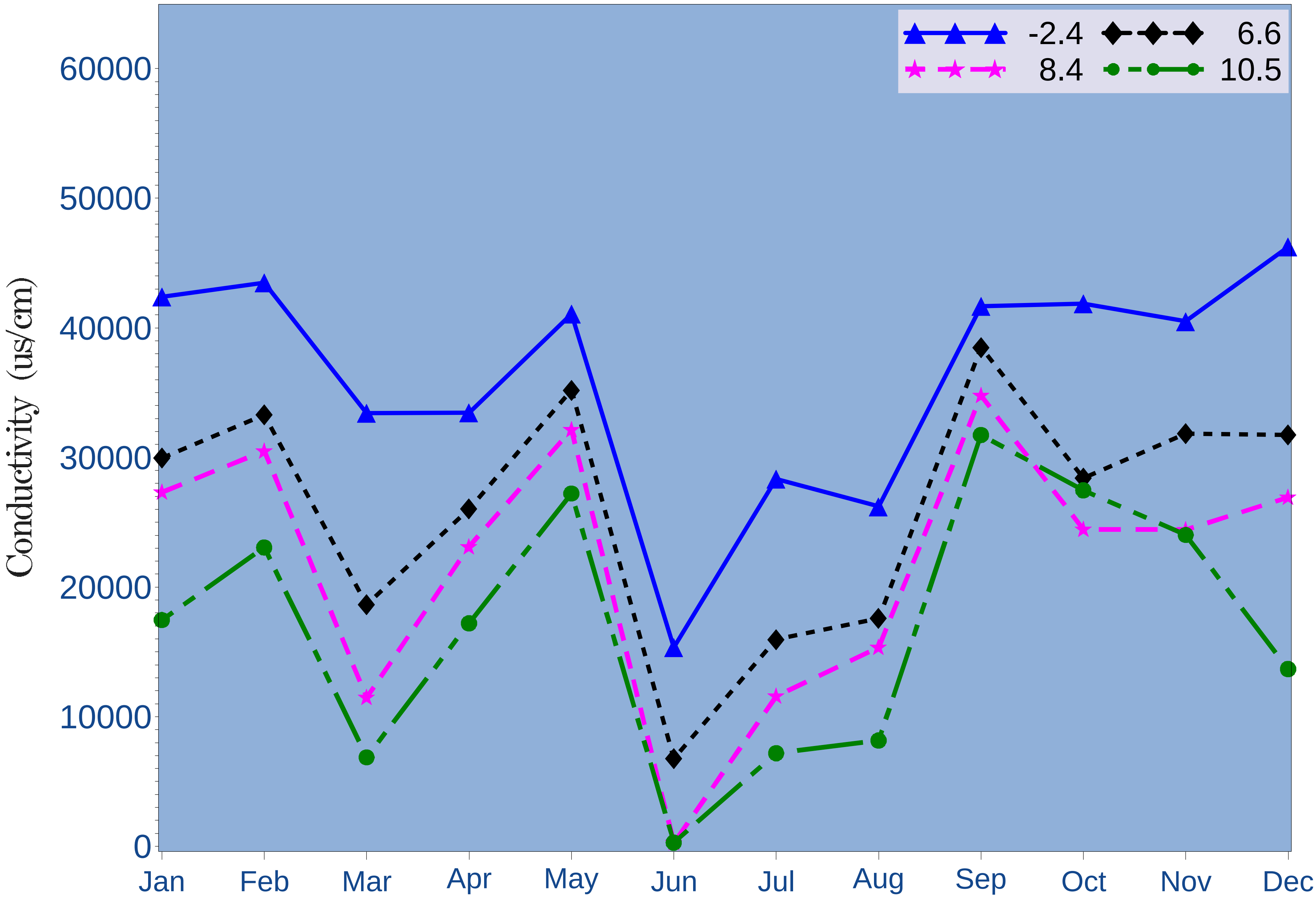


Figure 4.6a 2005 Mean monthly specific conductance at river kilometers -2.4, 6.6, 8.4 and 10.5

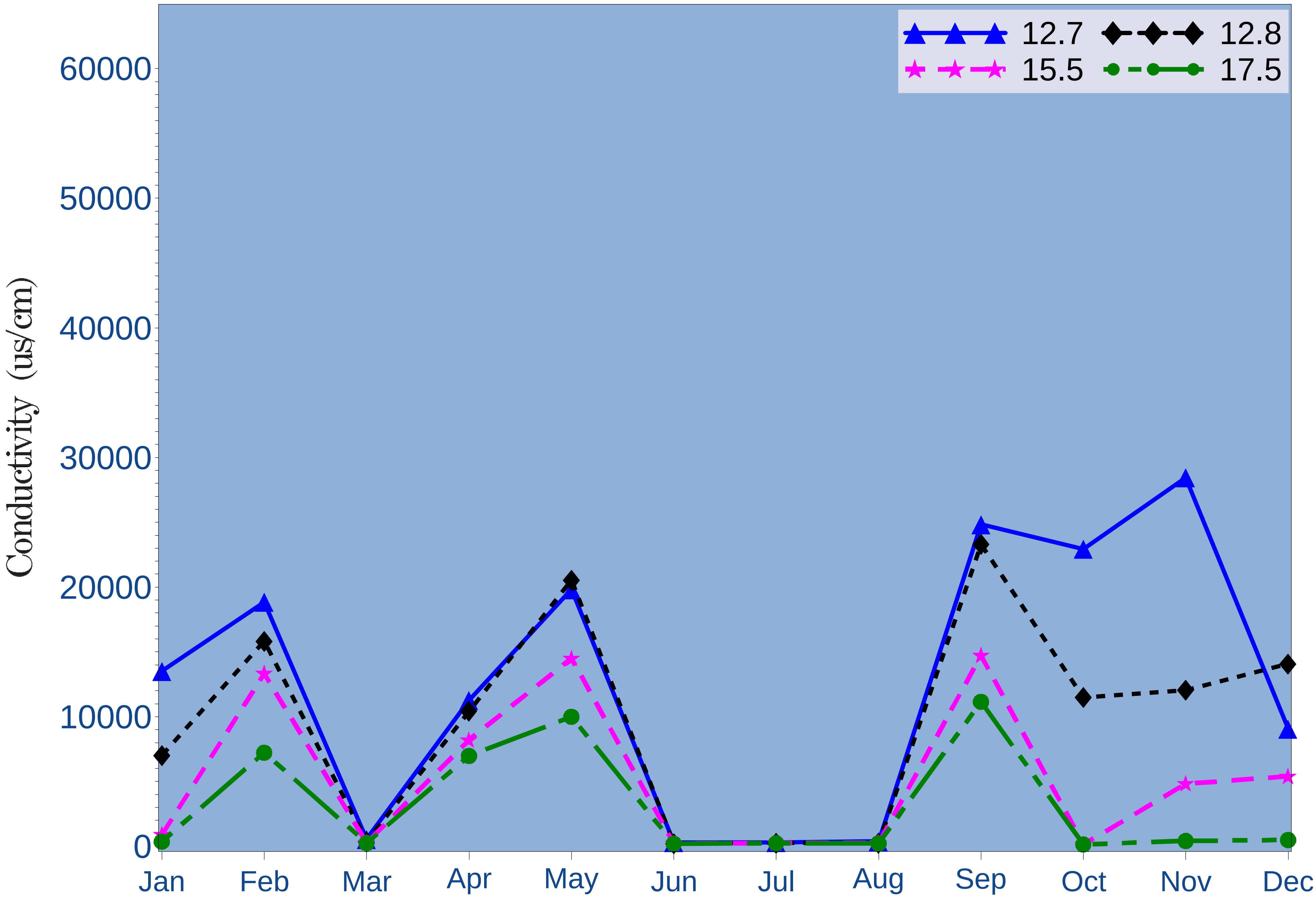


Figure 4.6b 2005 Mean monthly specific conductance at river kilometers 12.7, 12.8, 15.5 and 17.5

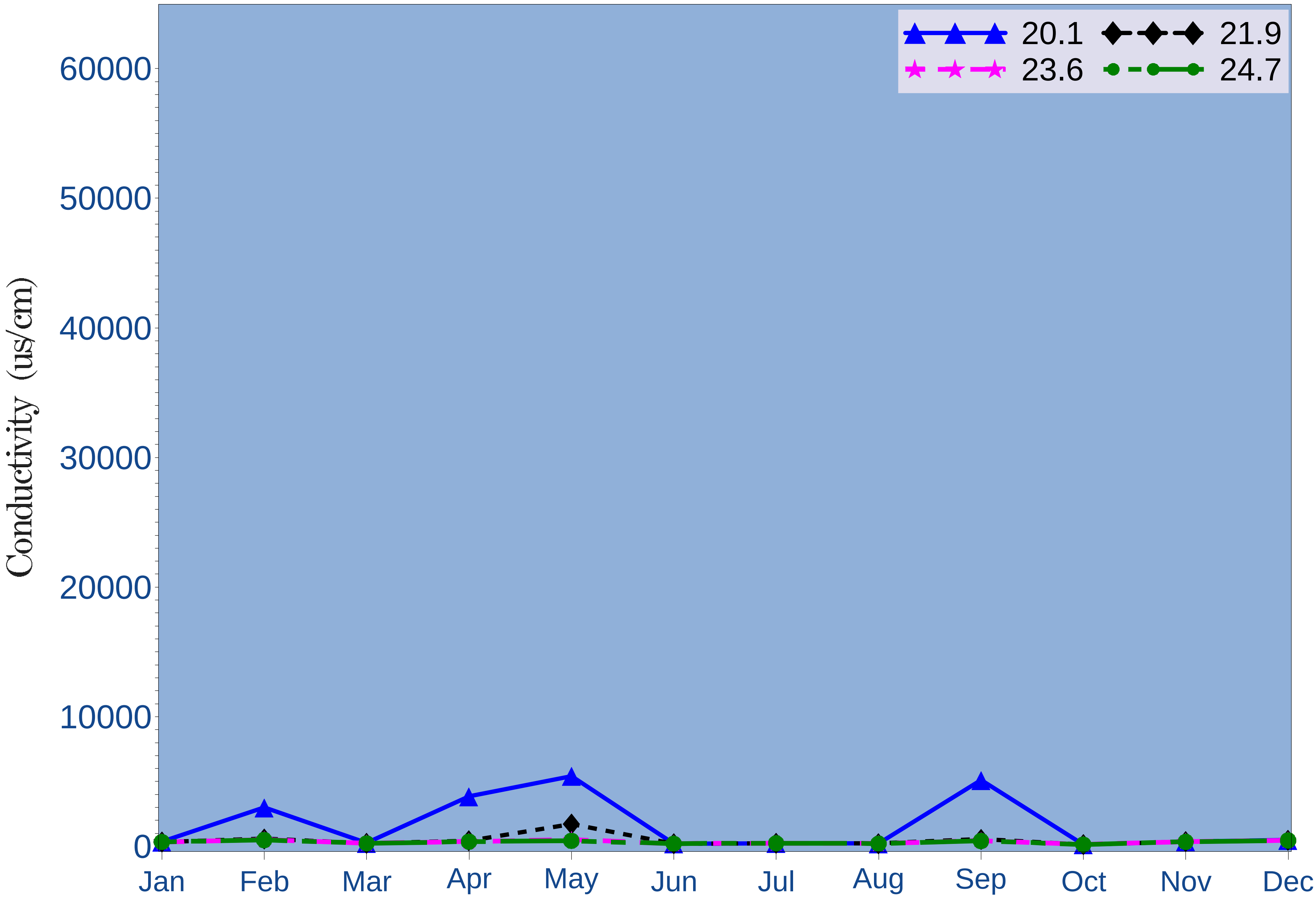


Figure 4.6c 2005 Mean monthly specific conductance at river kilometers 20.1, 21.9, 23.6 and 24.7

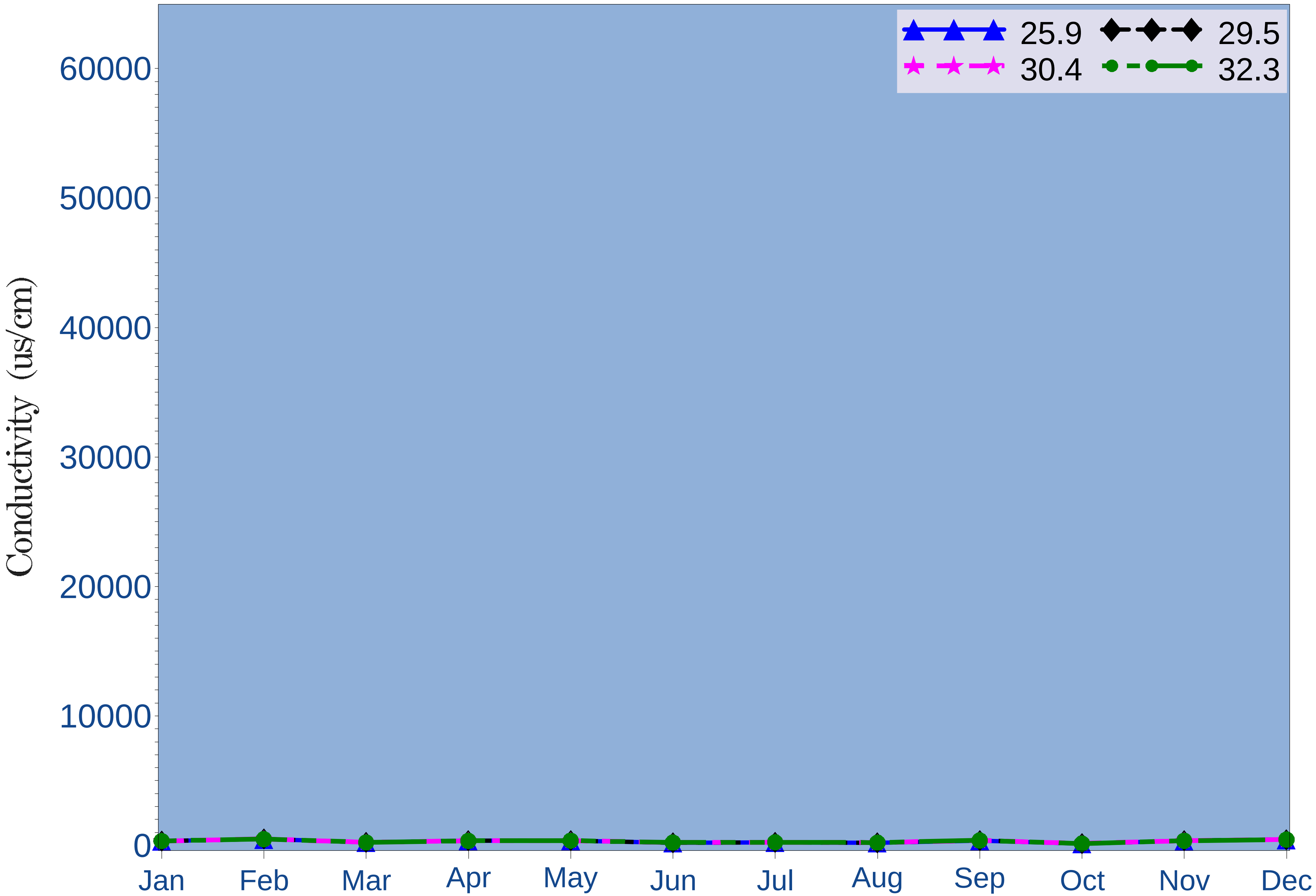


Figure 4.6d 2005 Mean monthly specific conductance at river kilometers 25.9, 29.5, 30.4 and 32.3

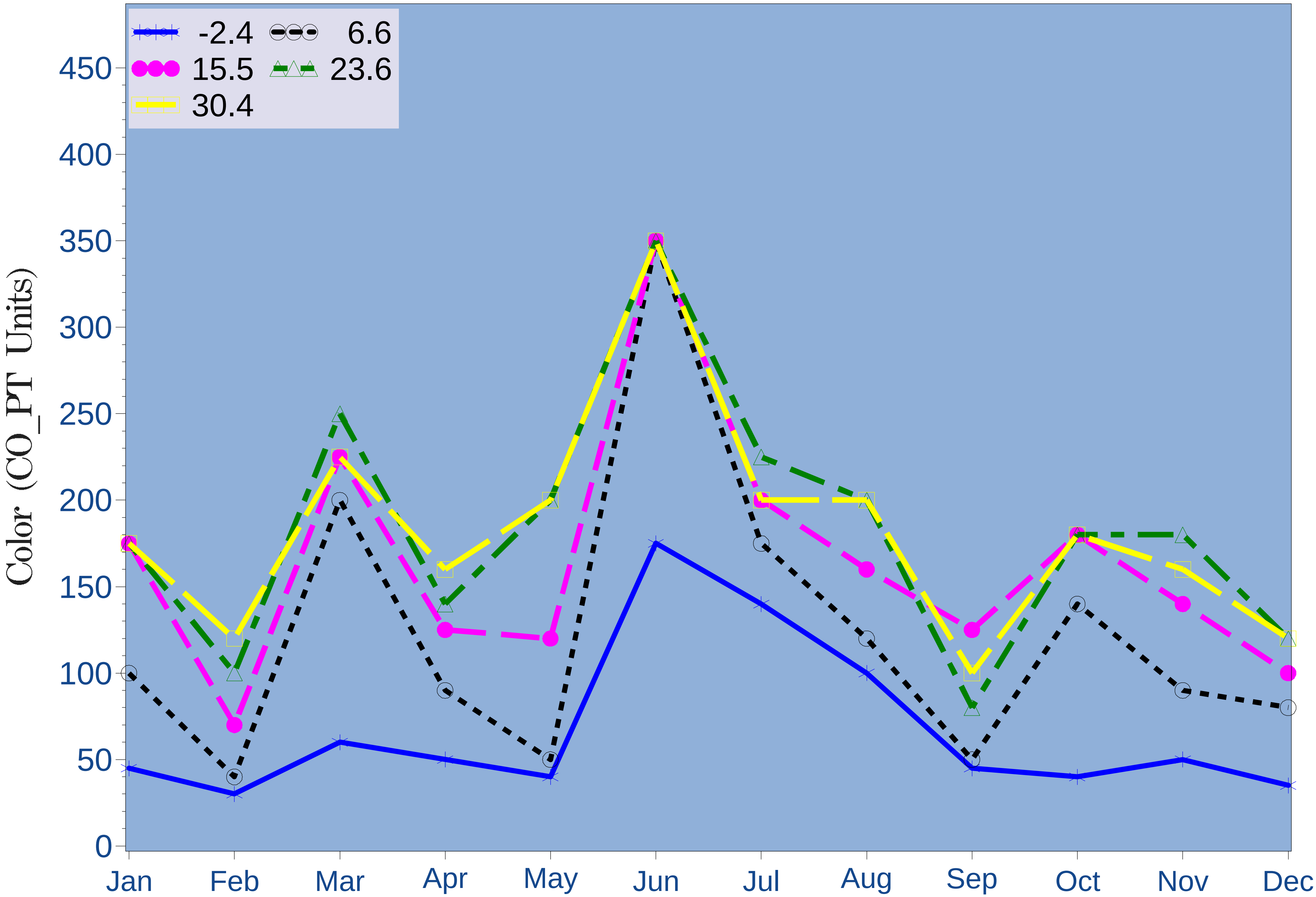


Figure 4.7a Surface color at fixed sampling stations (2005)

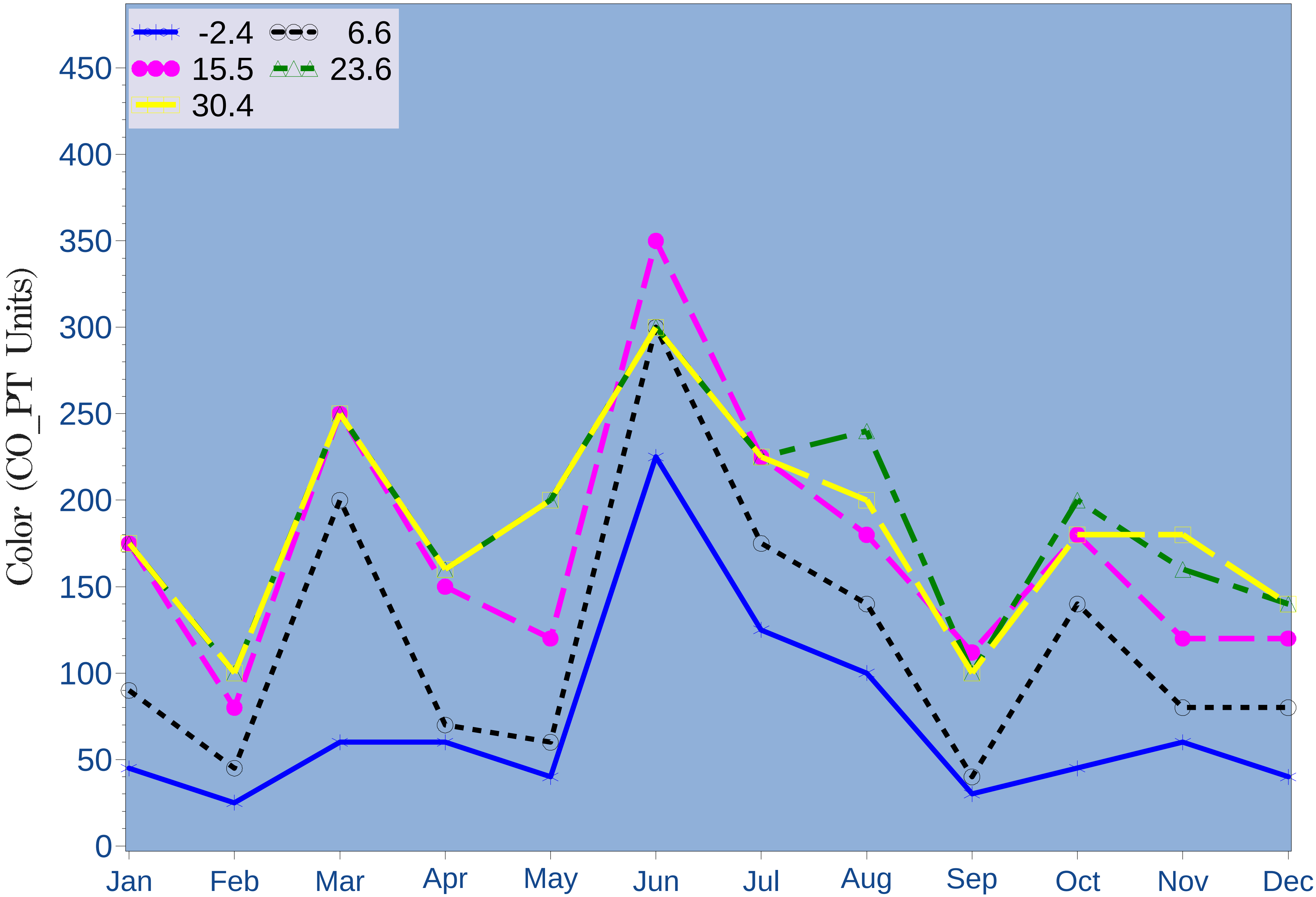


Figure 4.7b Bottom color at fixed sampling stations (2005)

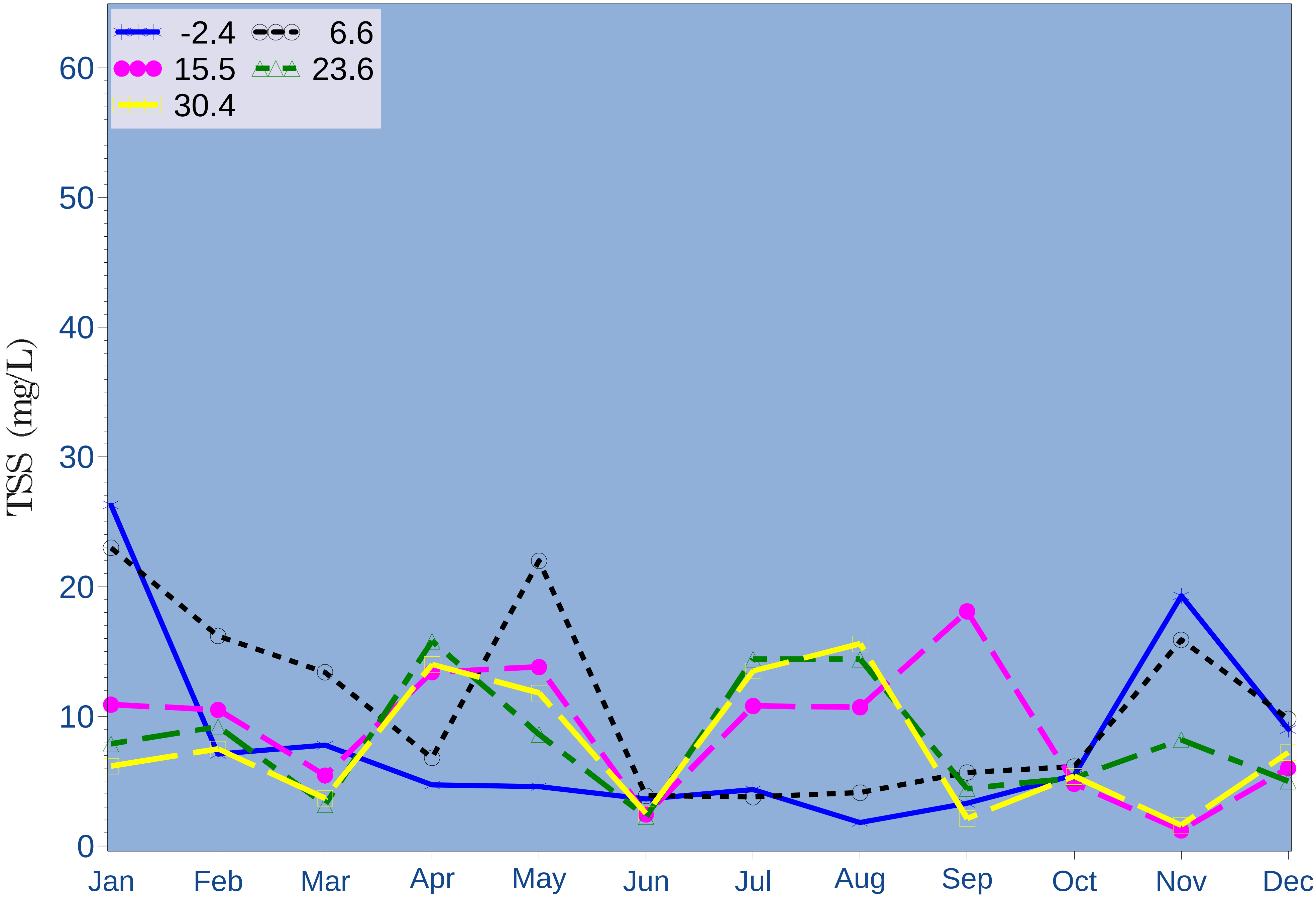


Figure 4.8a Surface total suspended solids at fixed sampling stations (2005)

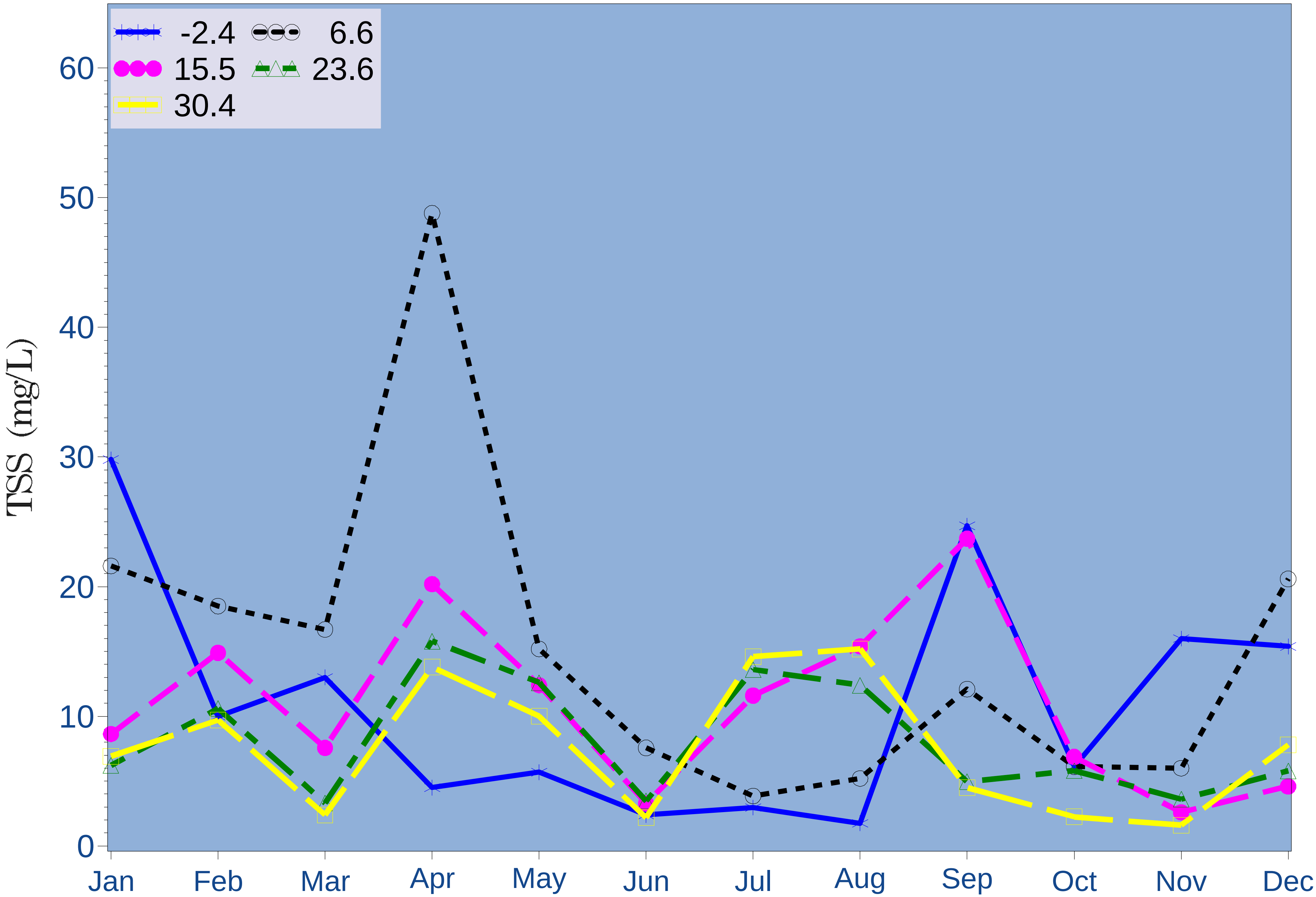


Figure 4.8b Monthly bottom total suspended solids at fixed sampling stations (2005)

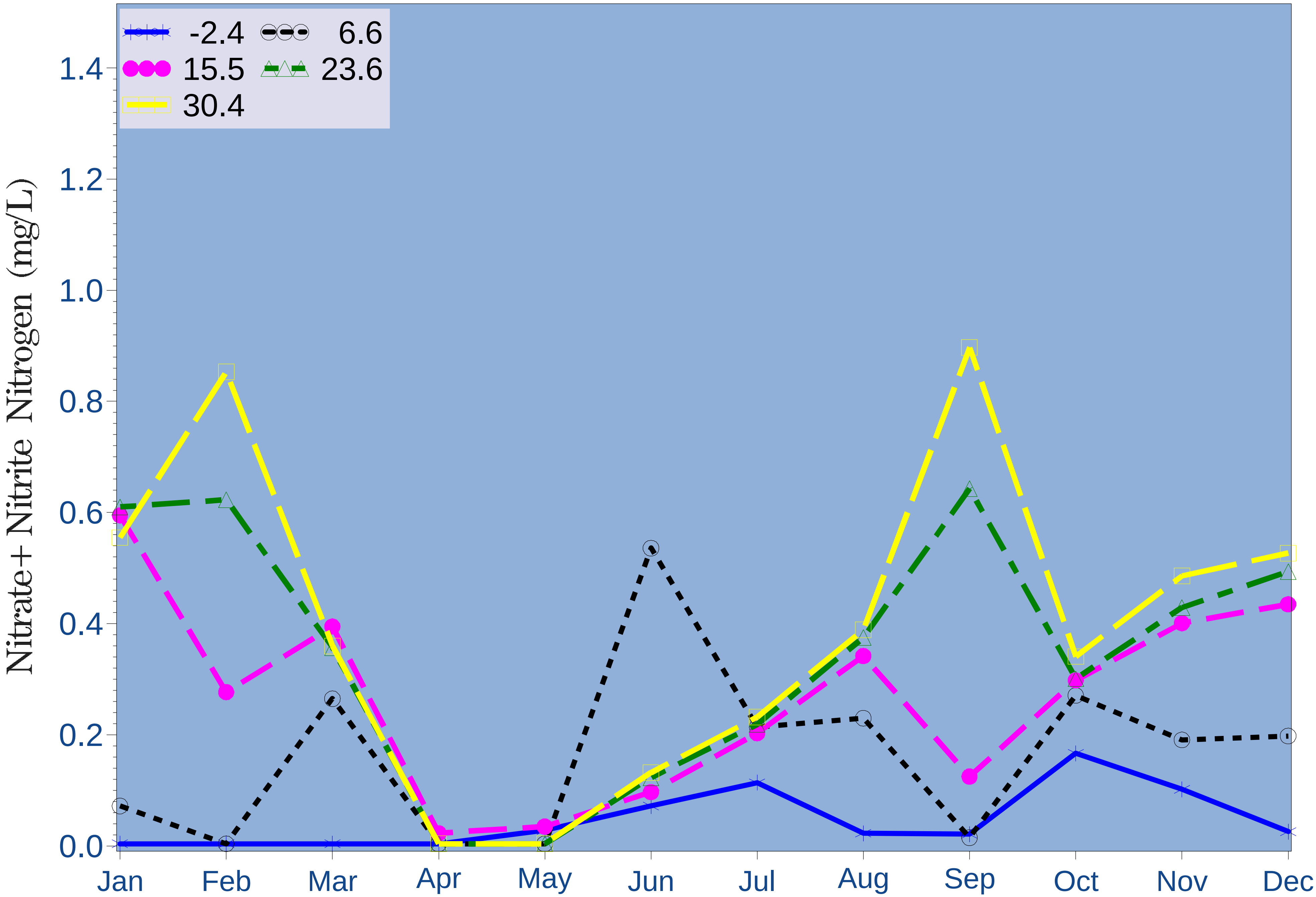


Figure 4.9a Monthly surface nitrate/nitrite nitrogen at fixed sampling stations (2005)

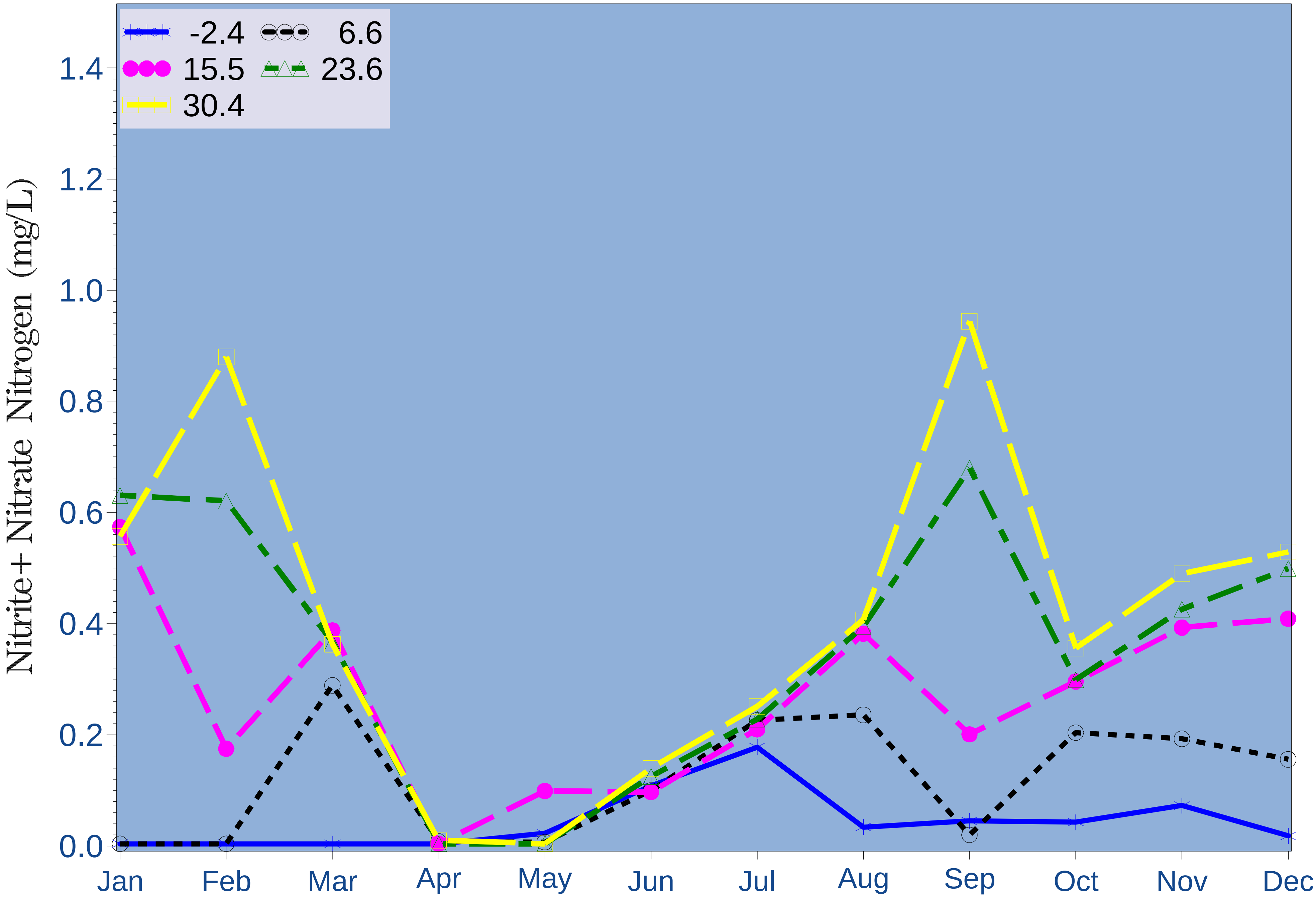


Figure 4.9b Monthly bottom nitrite/nitrate nitrogen at fixed sampling stations (2005)

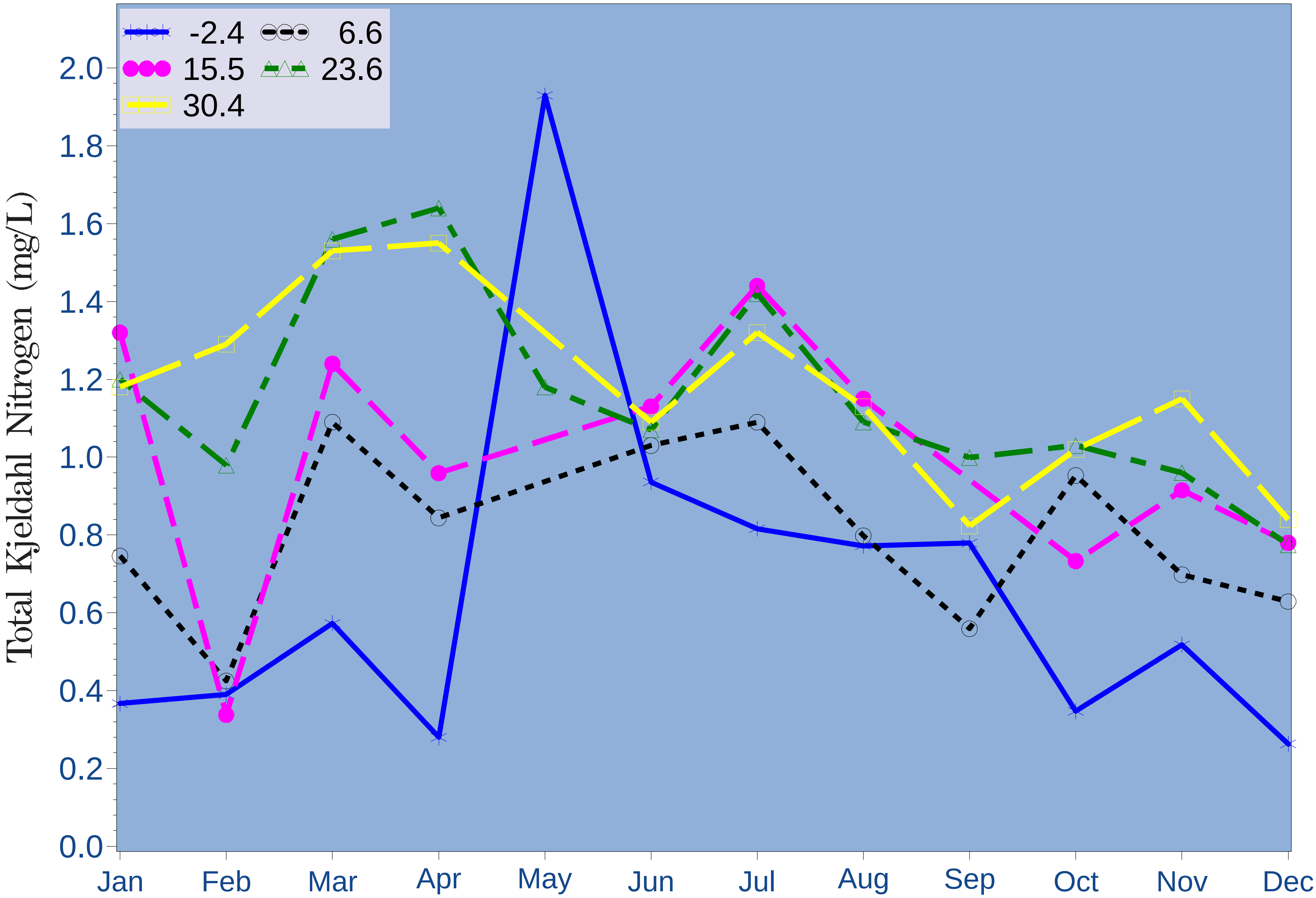


Figure 4.10a Monthly surface total Kjeldahl nitrogen at fixed sampling stations (2005)

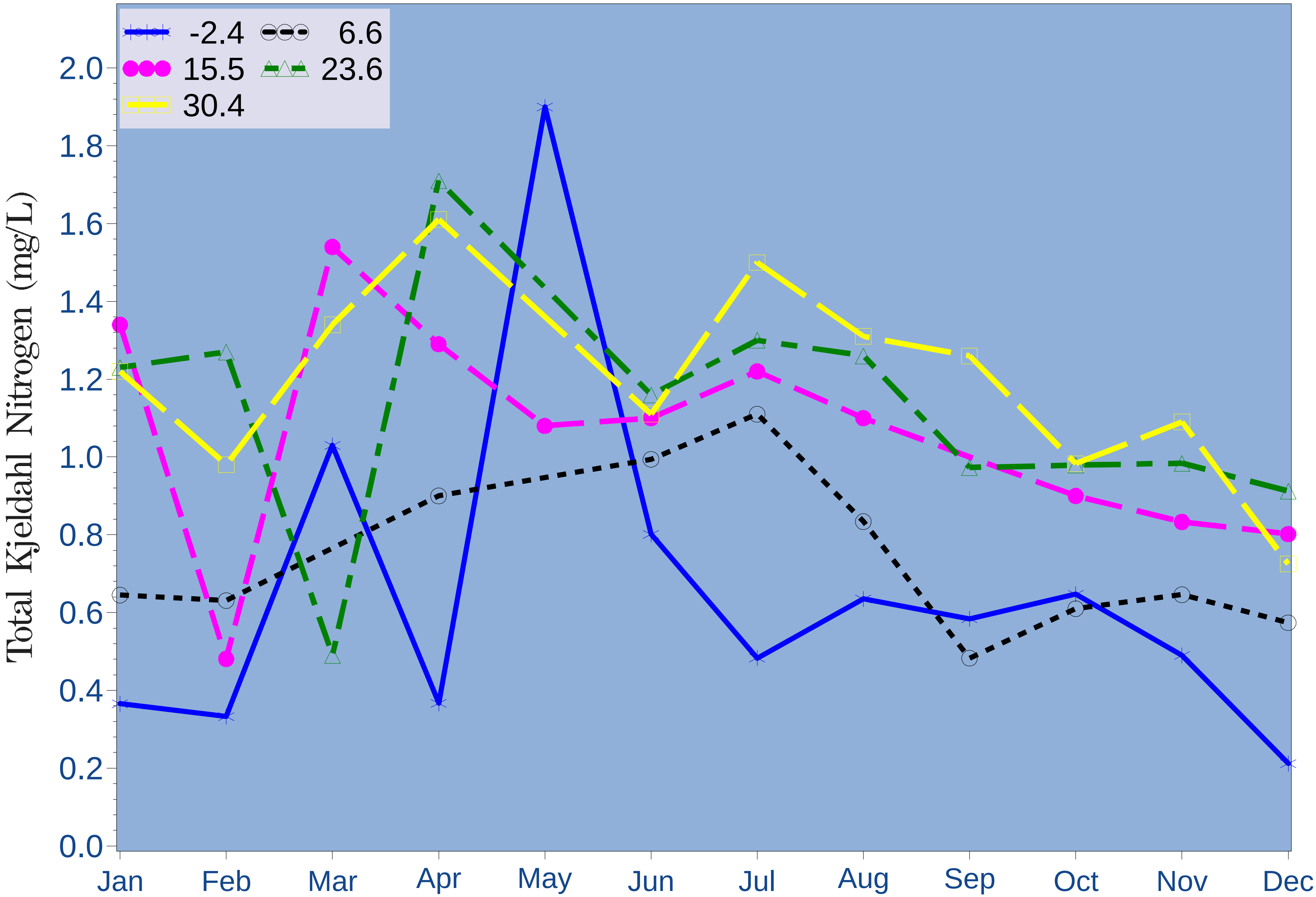


Figure 4.10b Monthly bottom total Kjeldahl nitrogen at fixed sampling stations (2005)

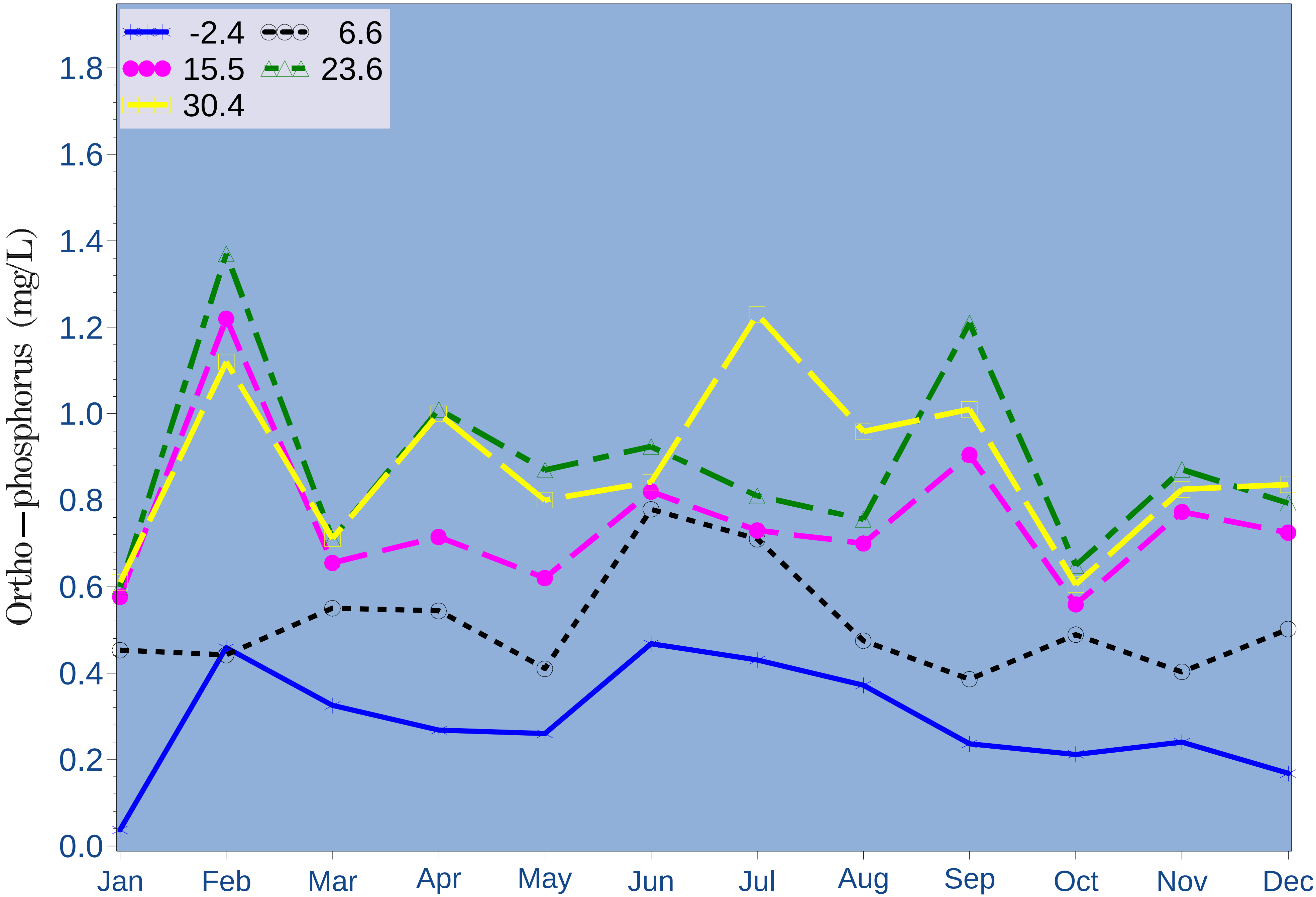


Figure 4.11a Monthly surface ortho-phosphorus at fixed sampling stations (2005)

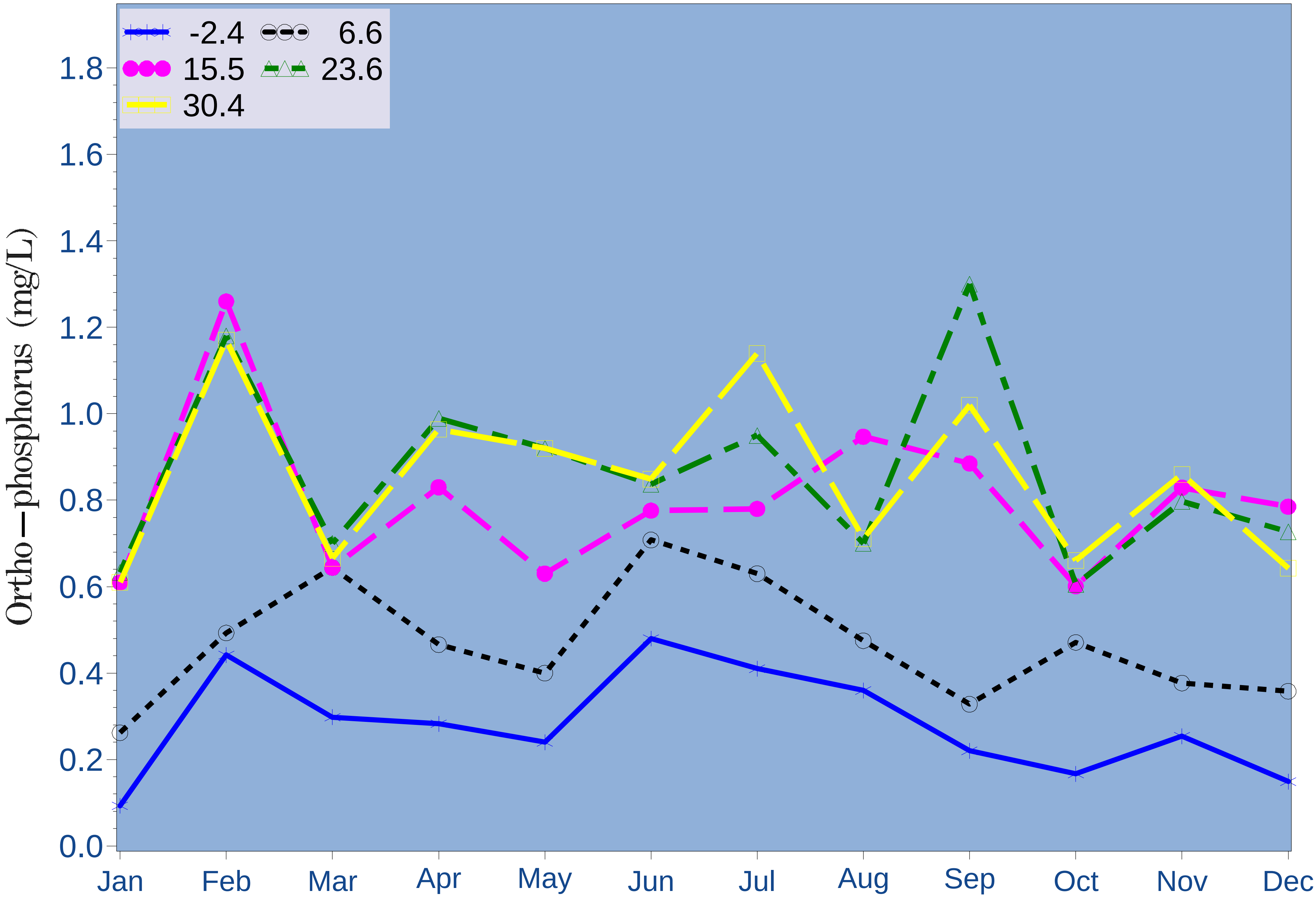


Figure 4.11b Monthly bottom orth-ophosphorus at fixed sampling stations (2005)

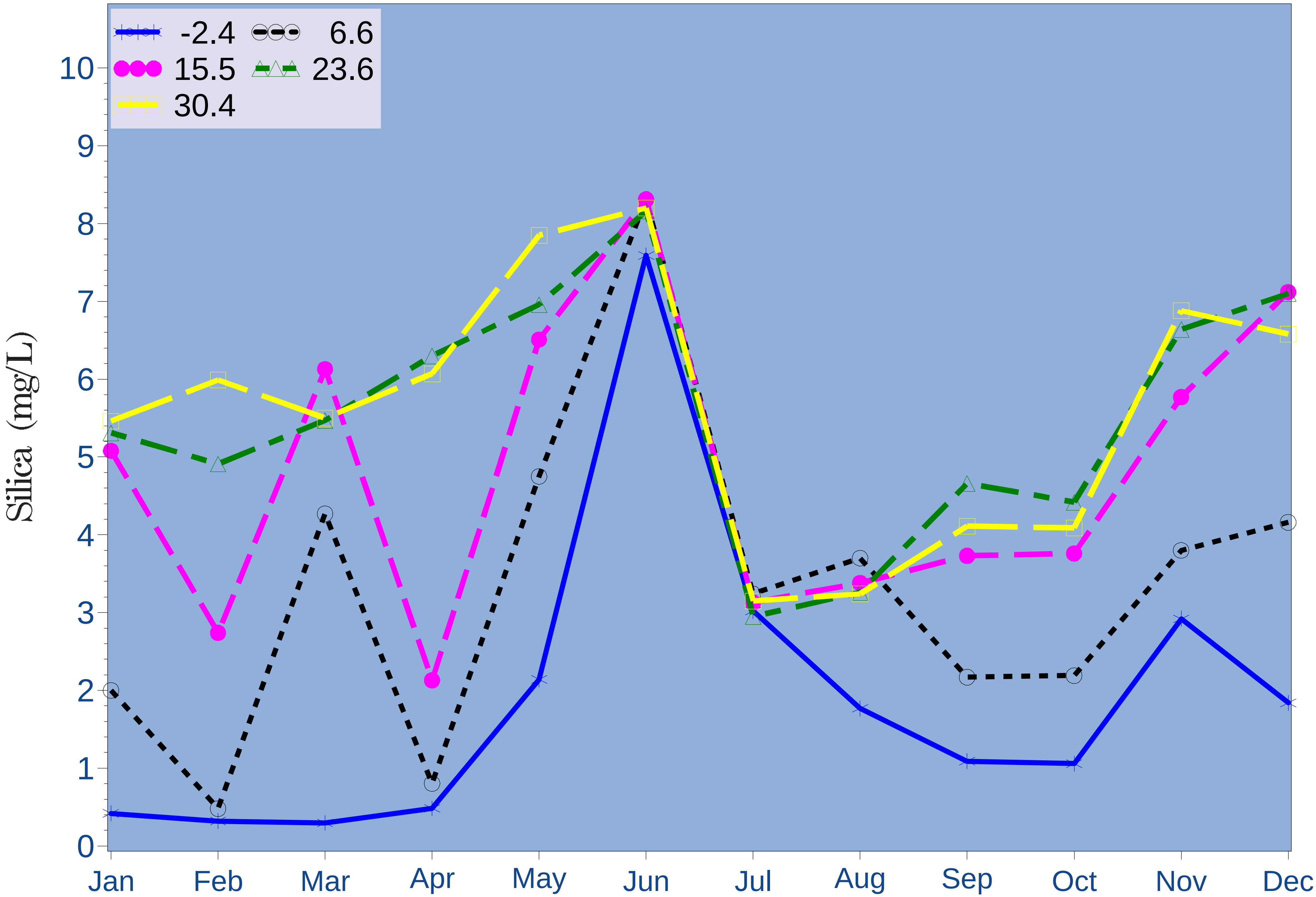


Figure 4.12a Monthly surface silica at fixed sampling stations (2005)

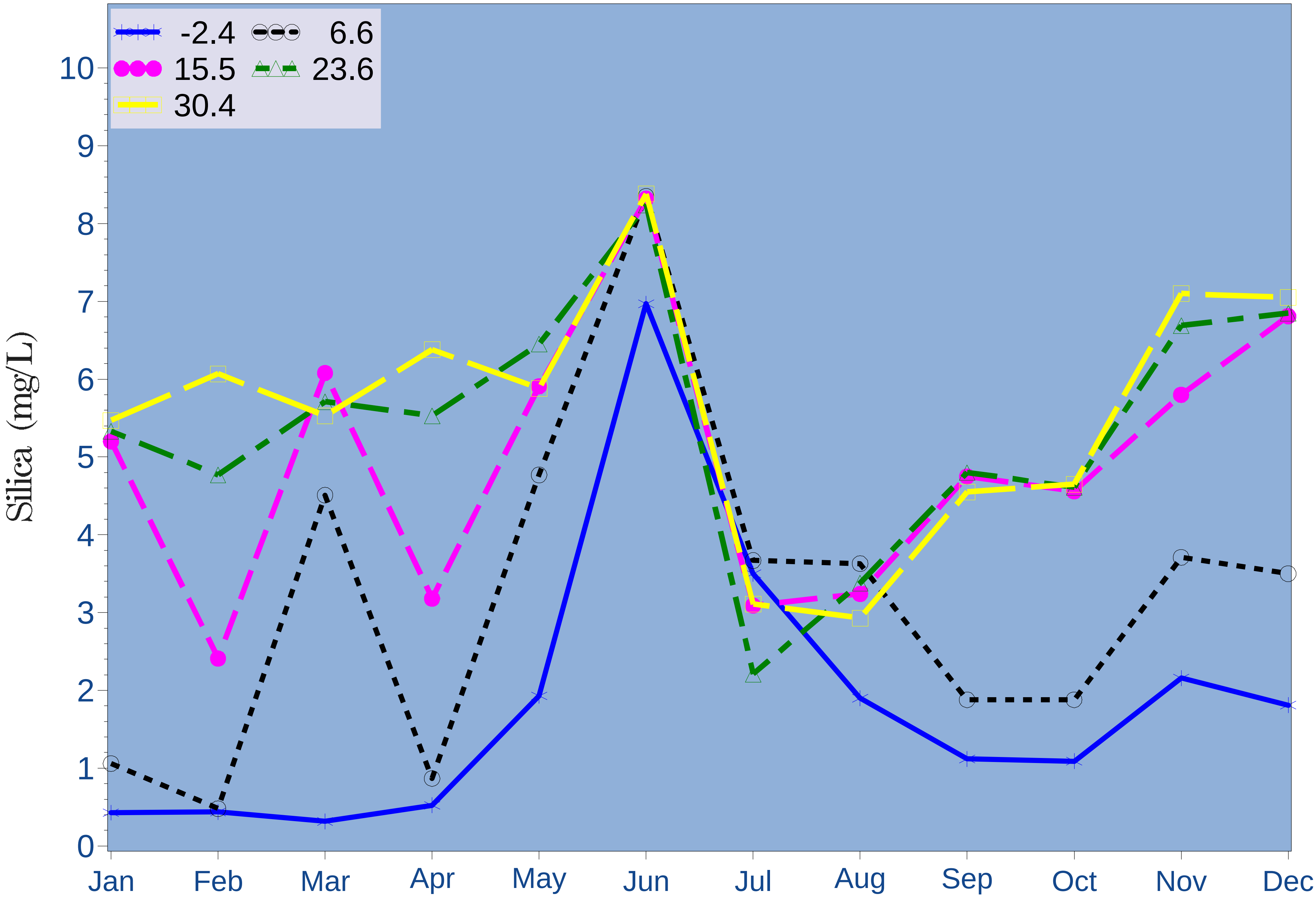


Figure 4.12b Monthly bottom silica at fixed sampling stations (2005)

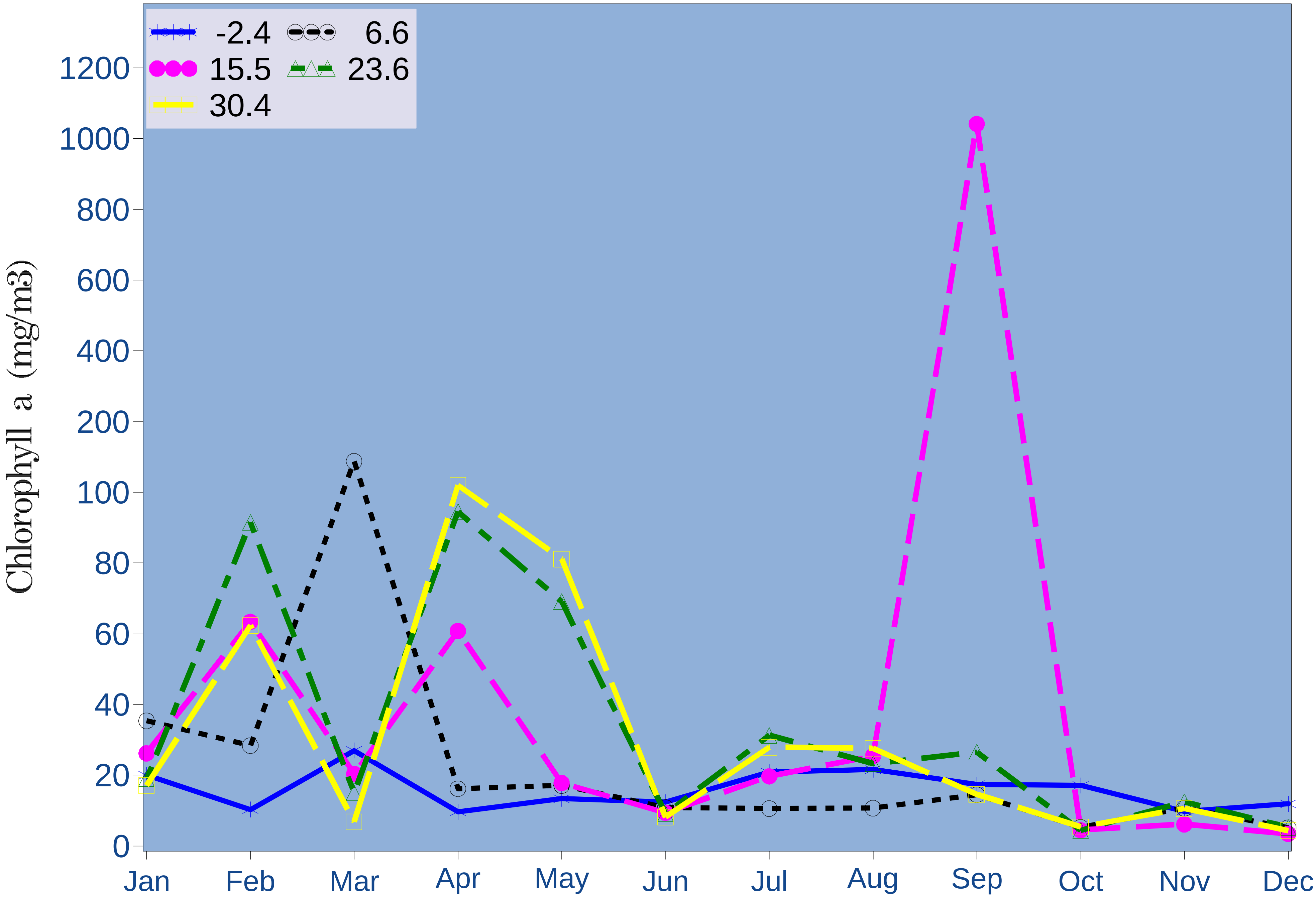


Figure 4.13a Monthly Surface chlorophyll a (mg/m3) at fixed stations (2005)

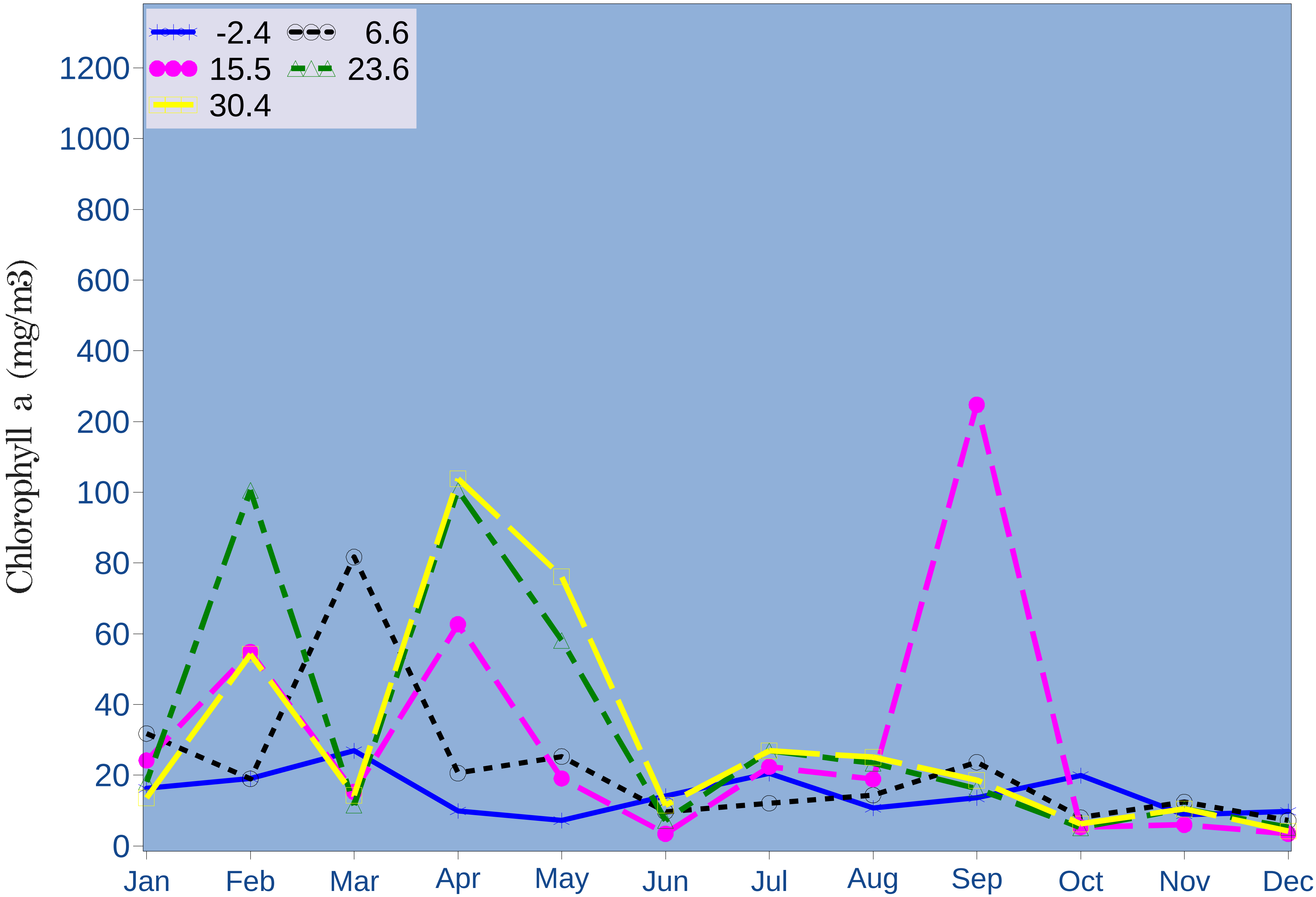


Figure 4.13b Monthyl bottom chlorophyll a (mg/m3) at fixed stations (2005)

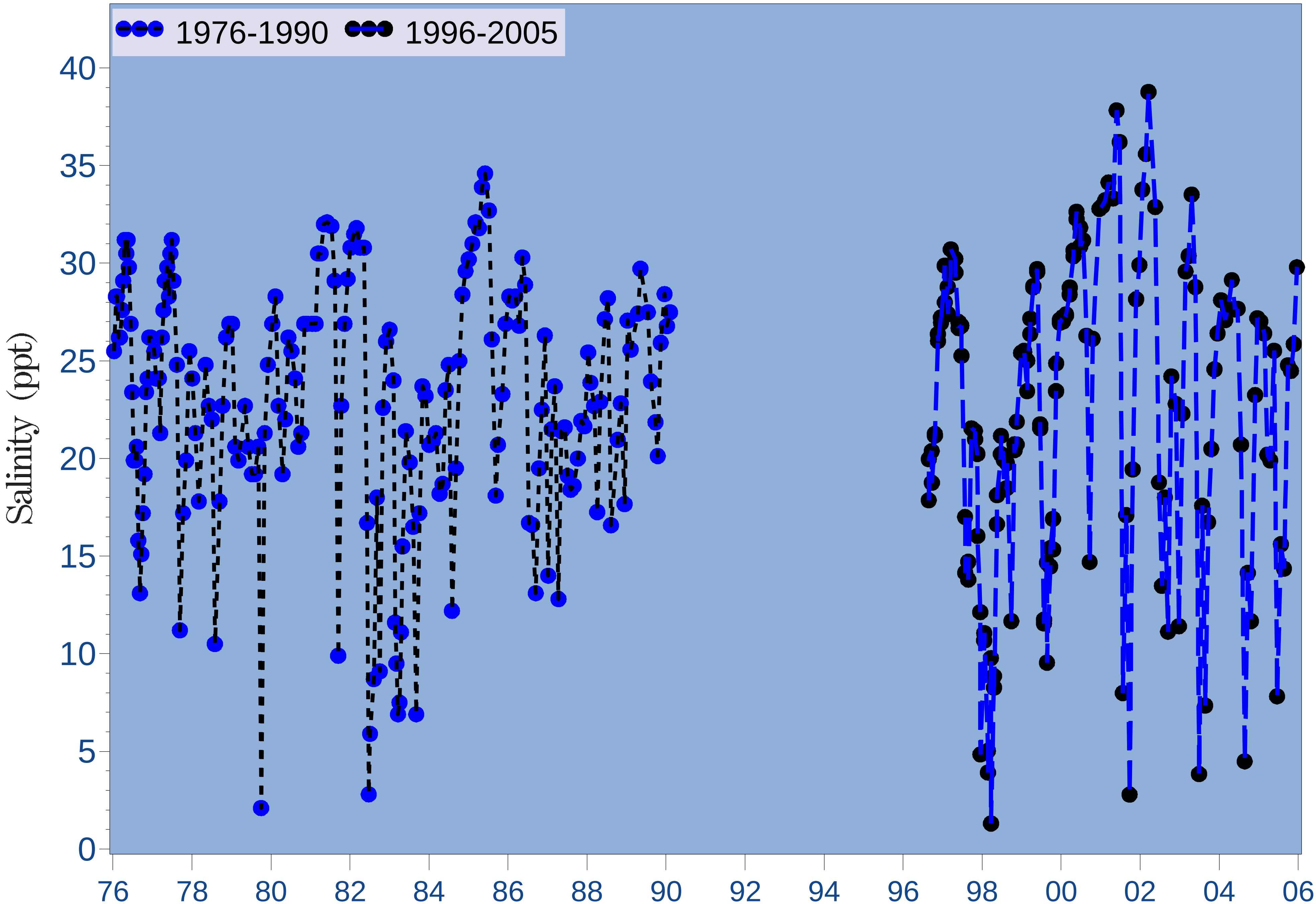


Figure 4.14a Monthly long-term surface salinity at river kilometer -2.4

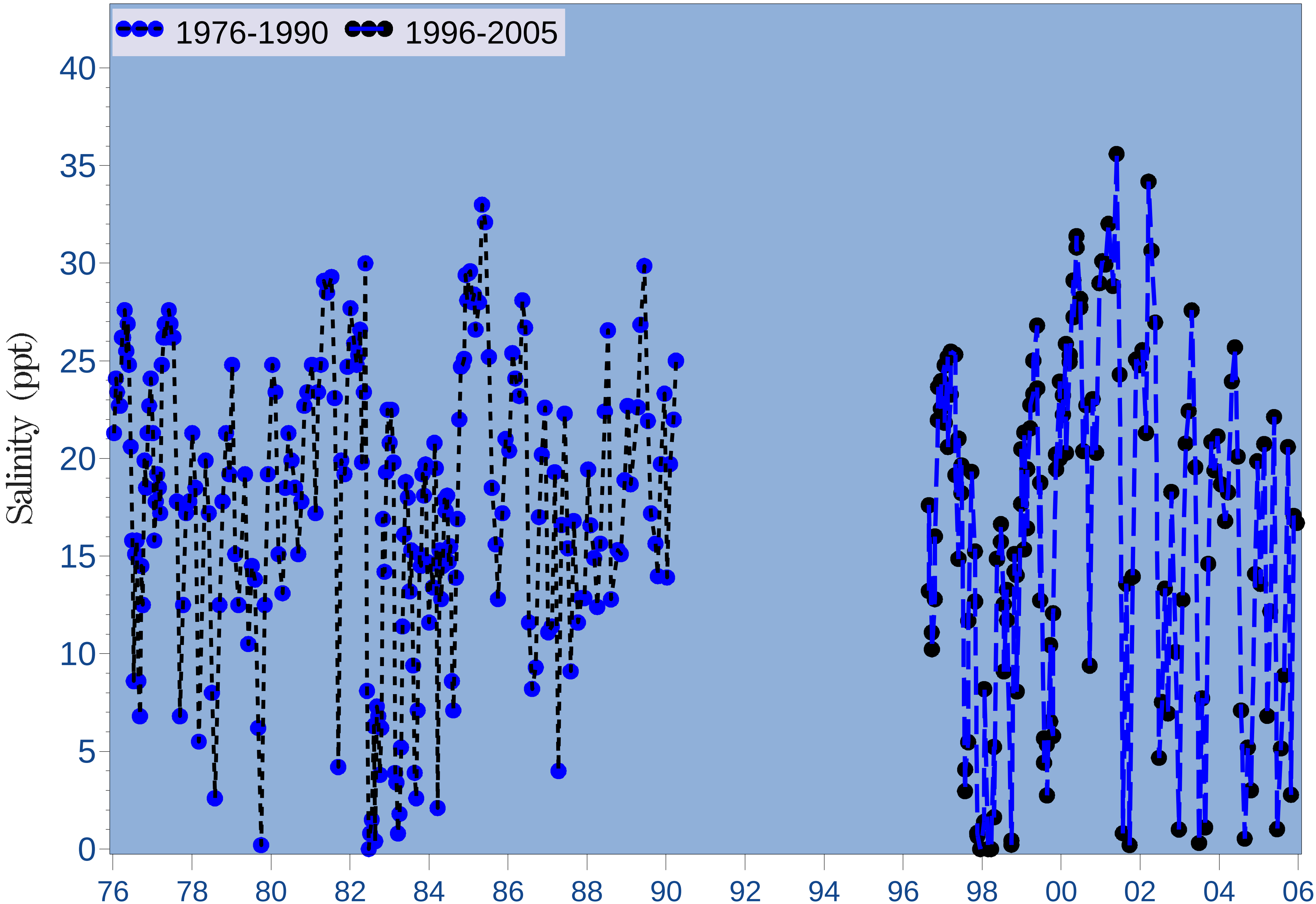


Figure 4.14b Monthly long-term surface salinity at river kilometer 6.6

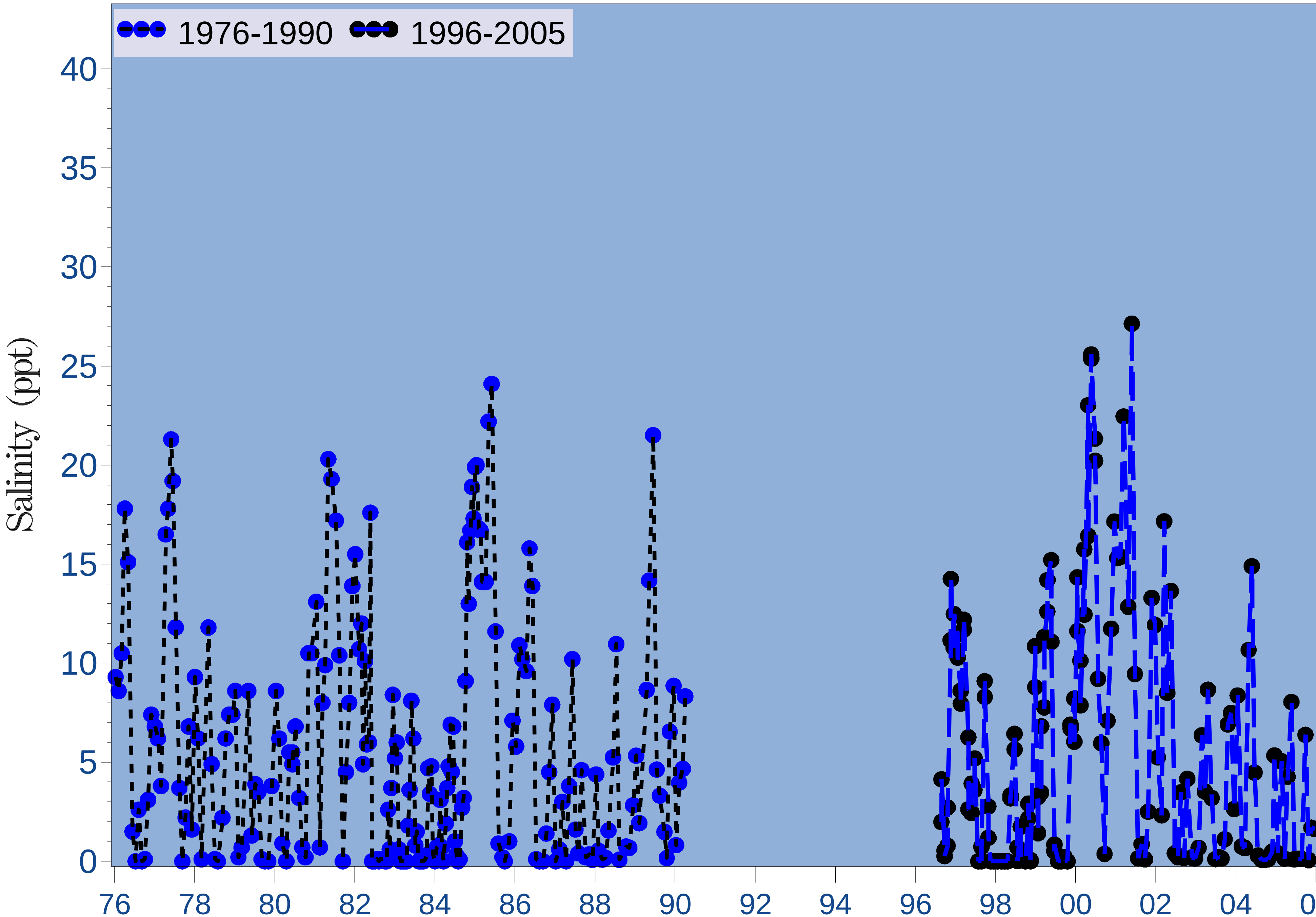


Figure 4.14c Monthly long-term surface salinity at river kilometer 15.5

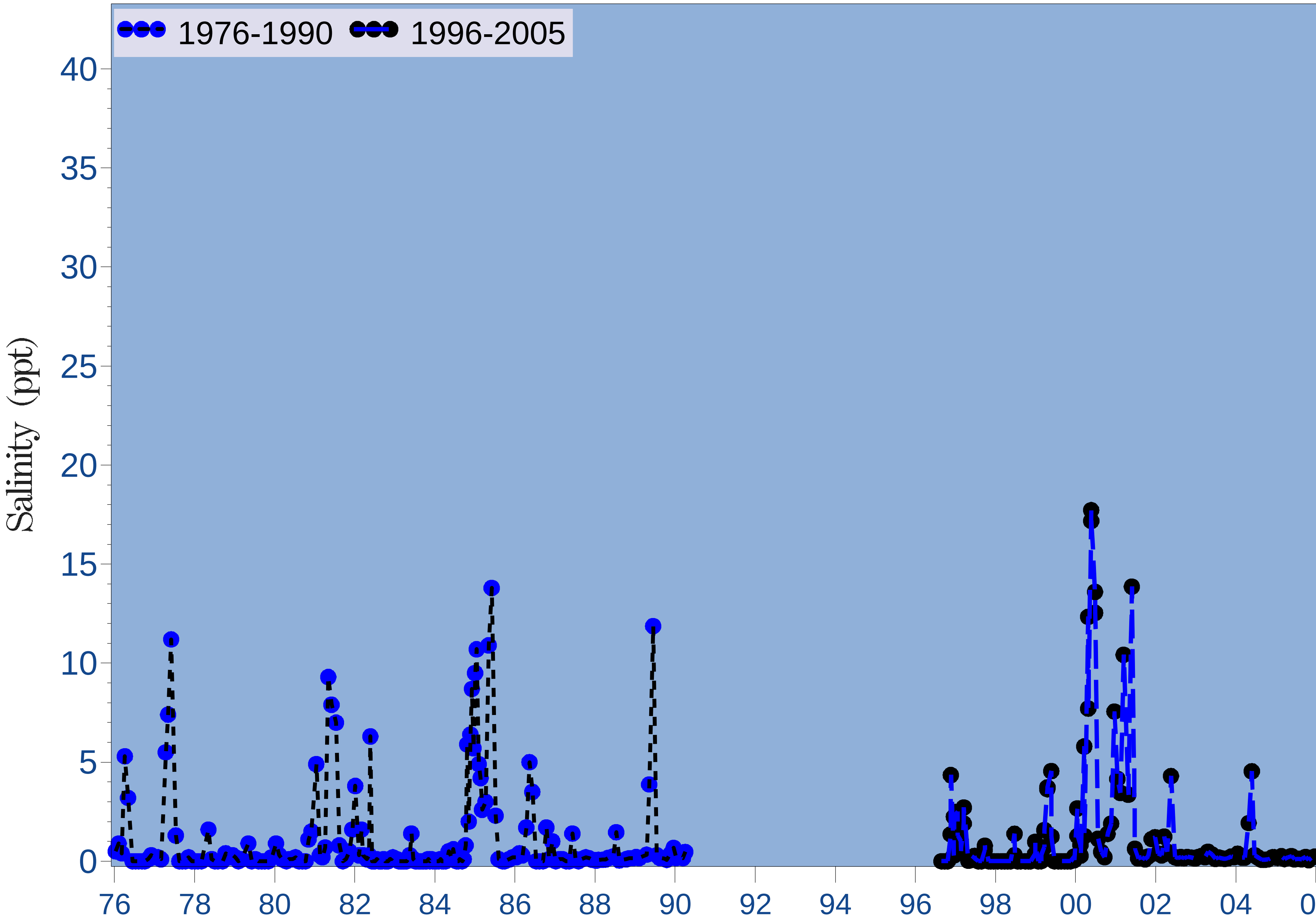


Figure 4.14d Monthly long-term surface salinity at river kilometer 23.6

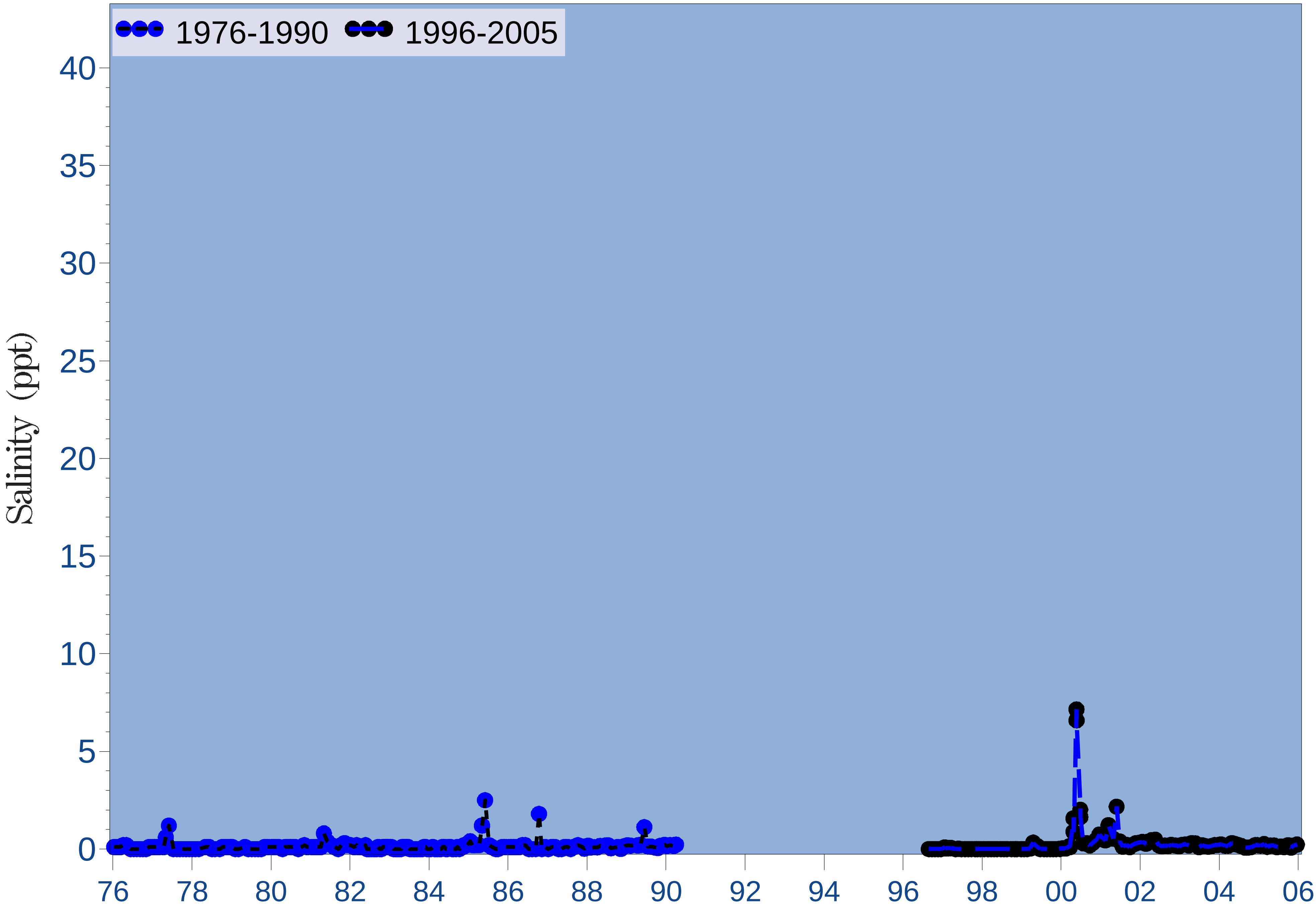


Figure 4.14e Monthly long-term surface salinity at river kilometer 30.4

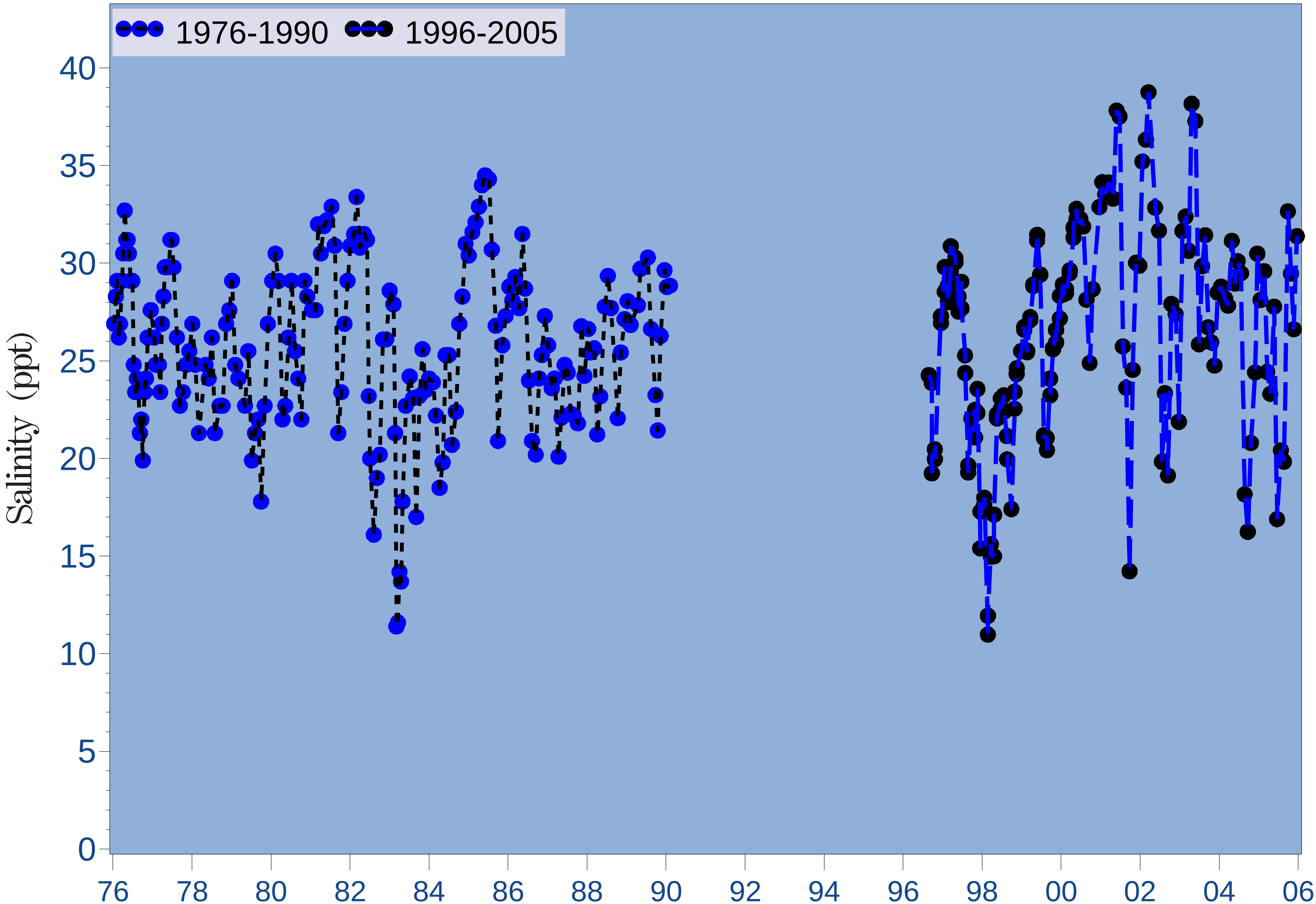


Figure 4.15a Monthly long-term bottom salinity at river kilometer -2.4

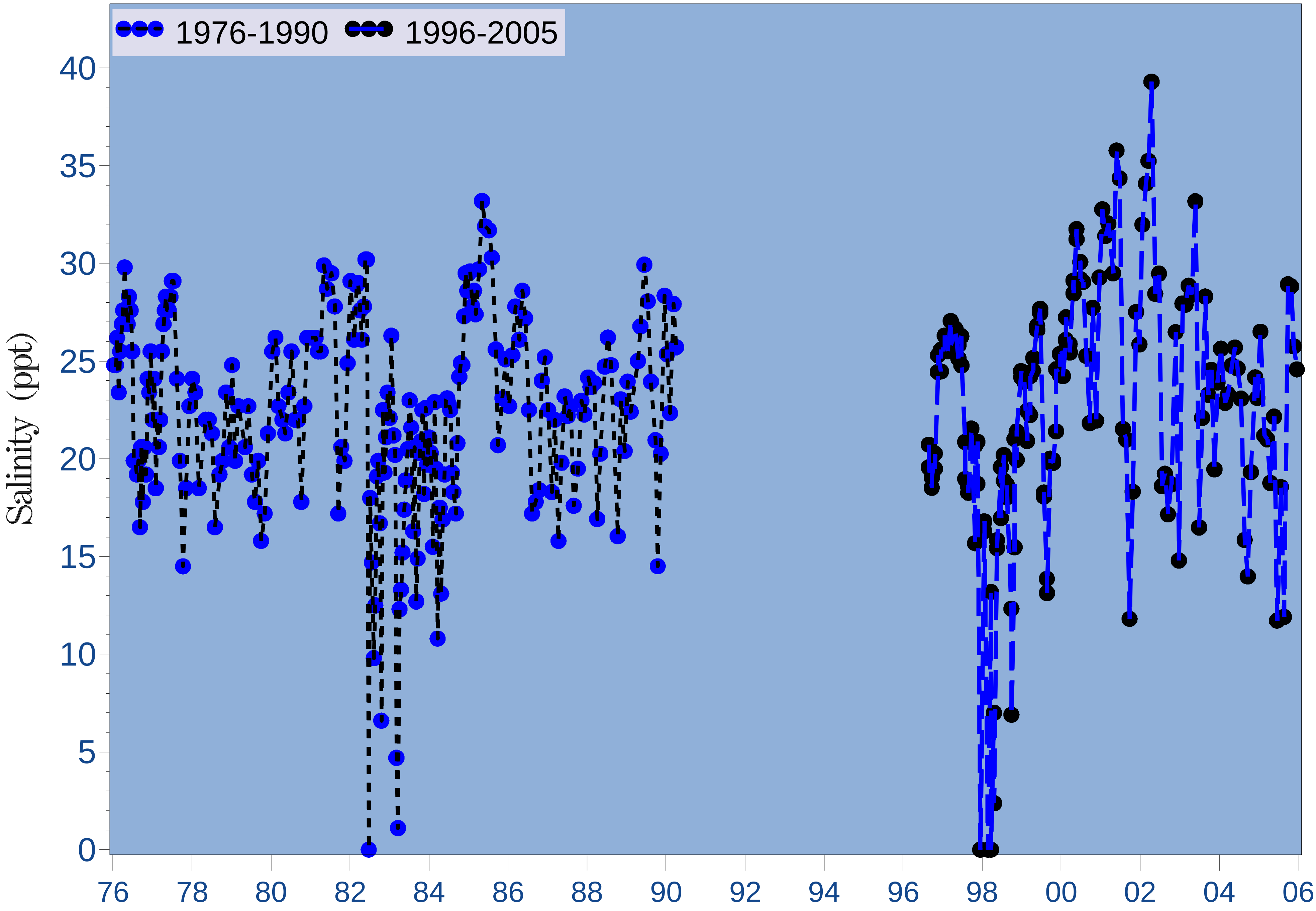


Figure 4.15b Monthly long-term bottom salinity at river kilometer 6.6

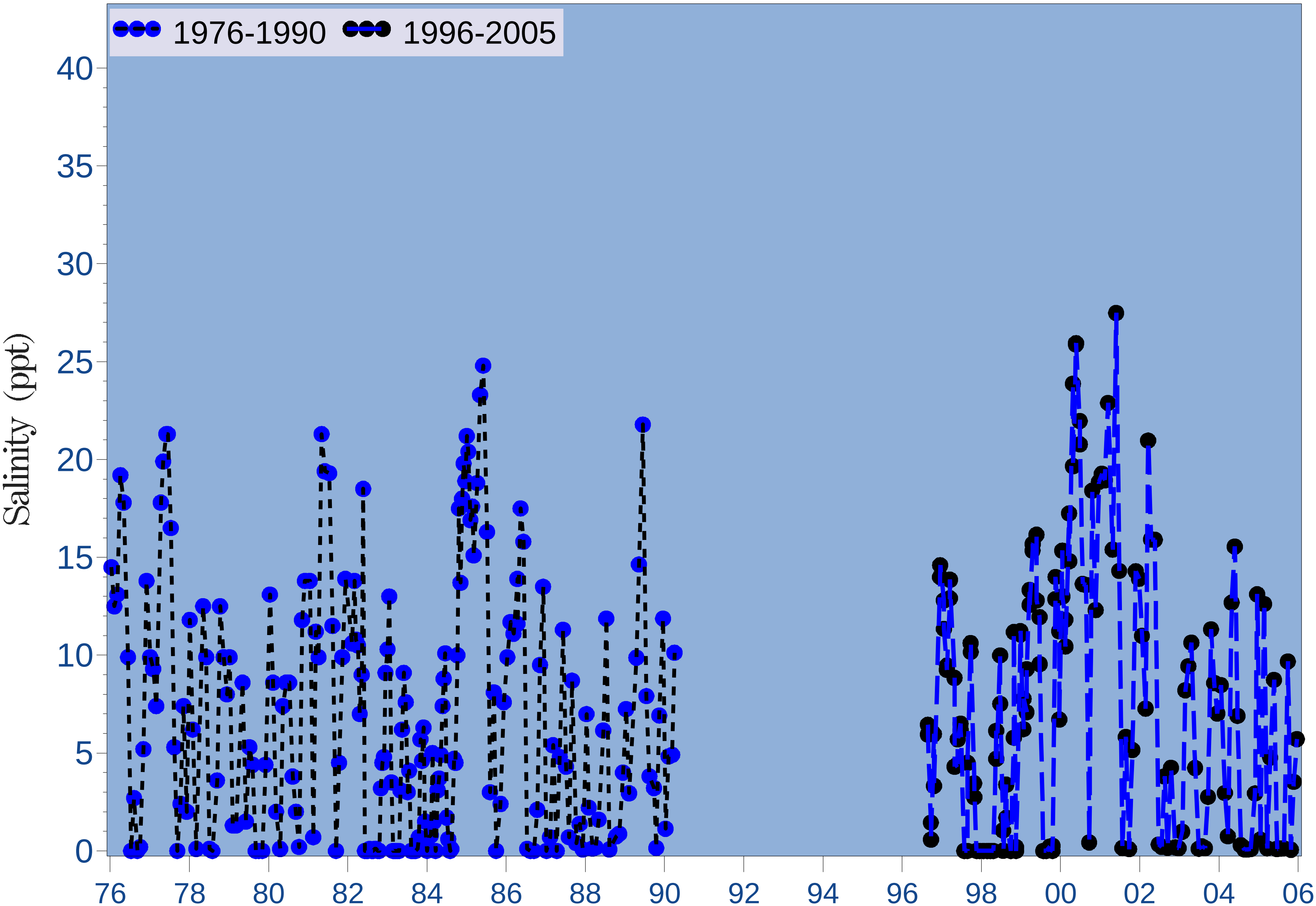


Figure 4.15c Monthly long-term bottom salinity at river kilometer 15.5

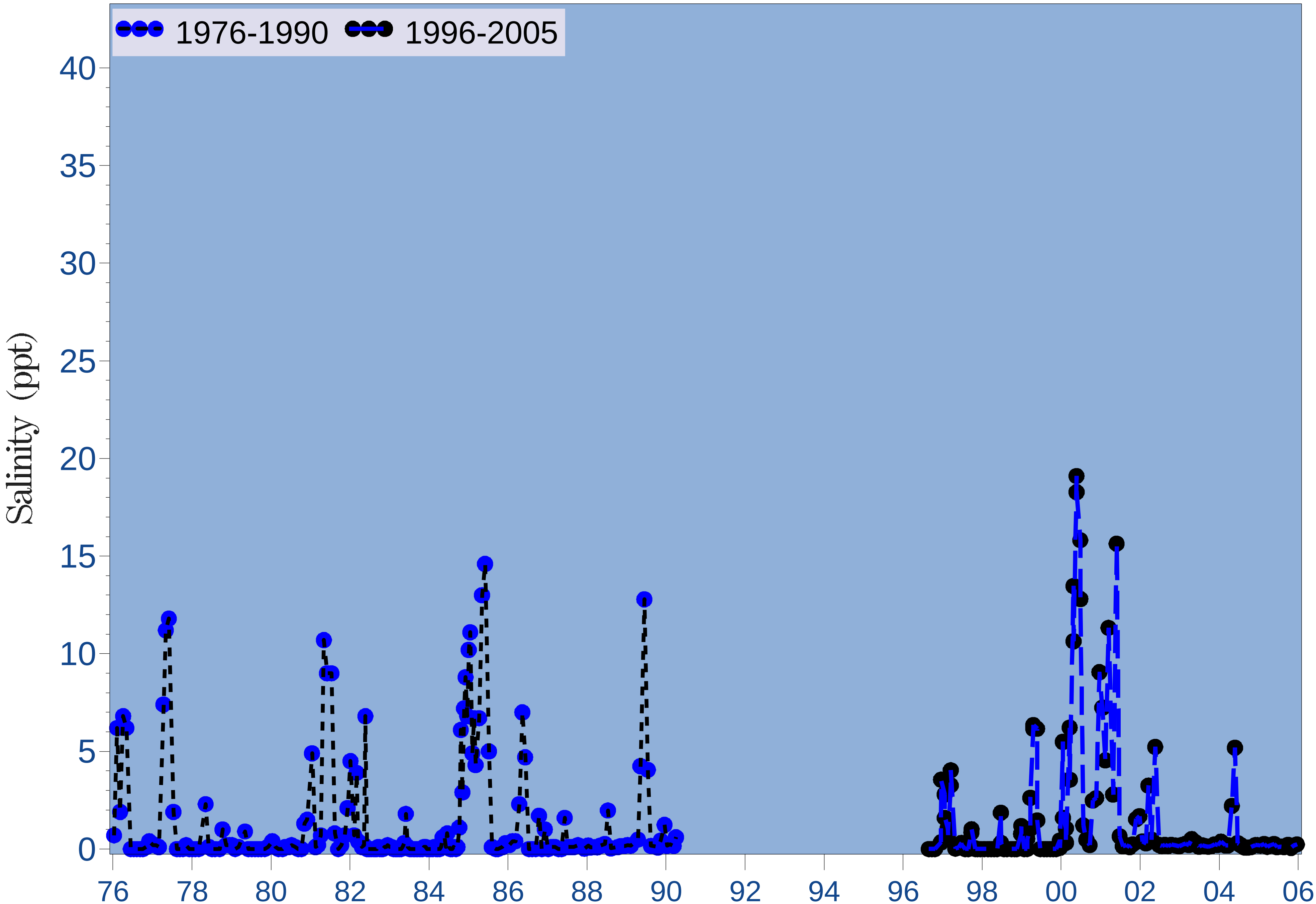


Figure 4.15d Monthly long-term bottom salinity at river kilometer 23.6

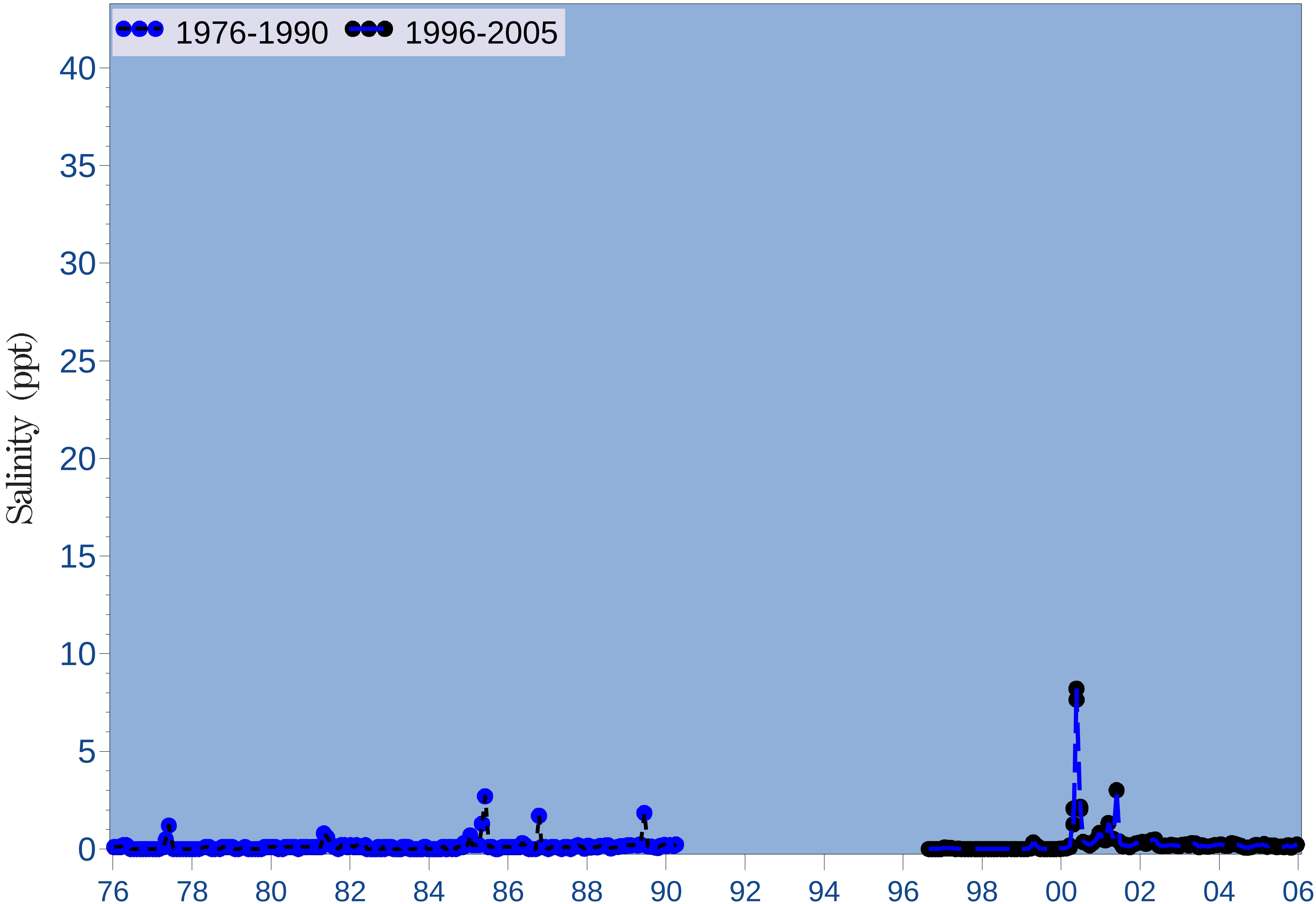


Figure 4.15e Monthly long-term bottom salinity at river kilometer 30.4

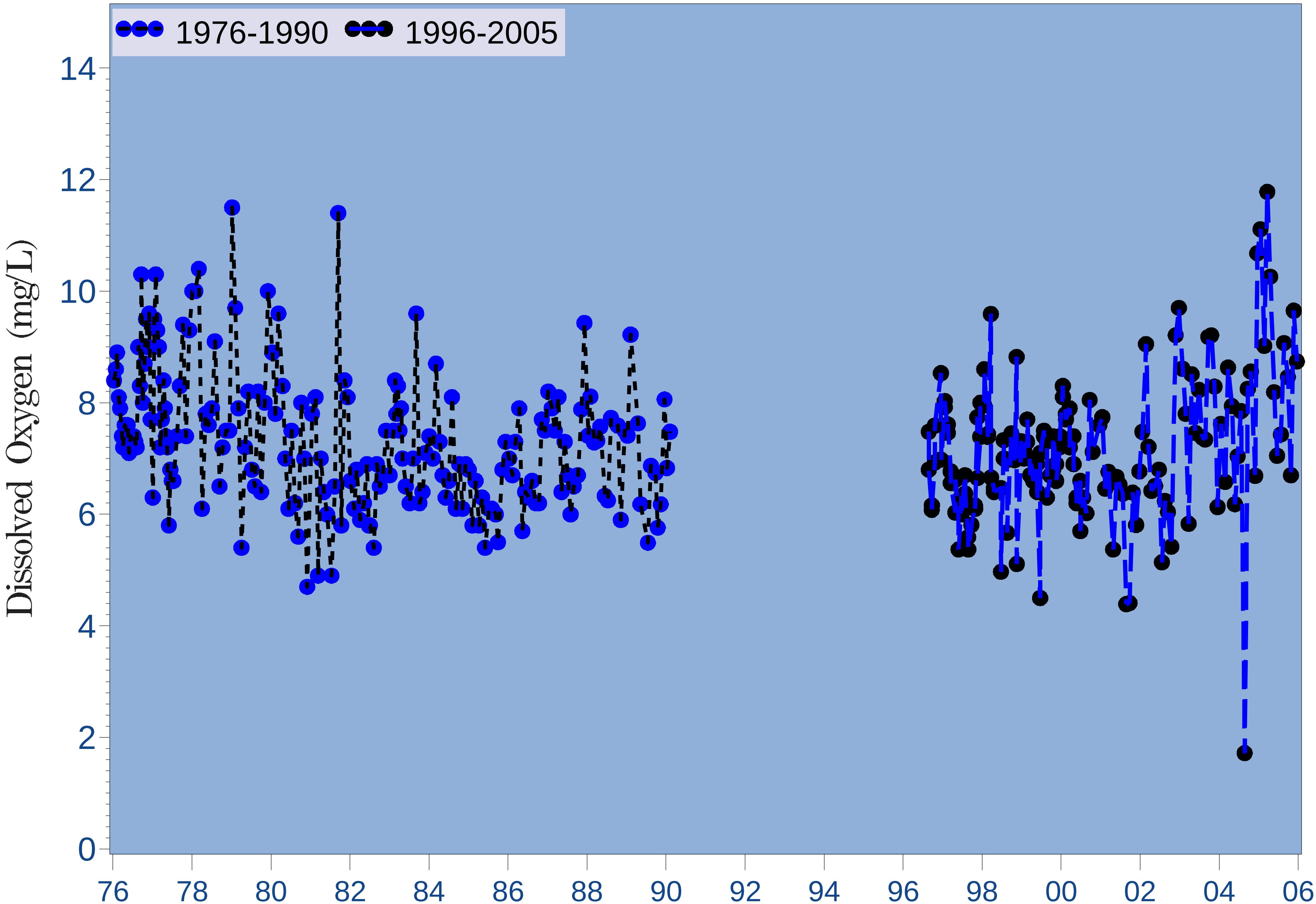


Figure 4.16a Monthly long-term surface dissolved oxygen at river kilometer -2.4

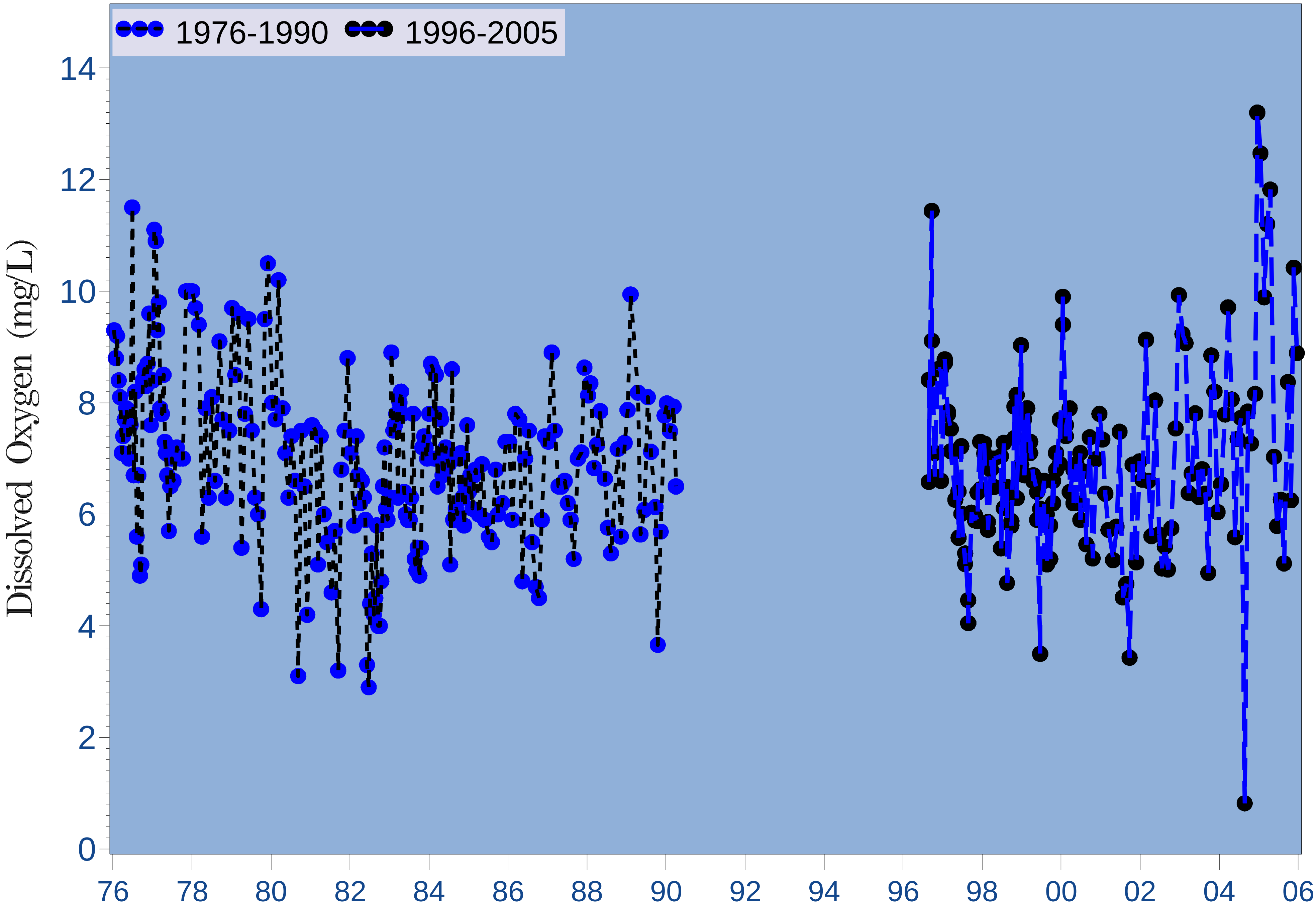


Figure 4.16b Monthly long-term surface dissolved oxygen at river kilometer 6.6

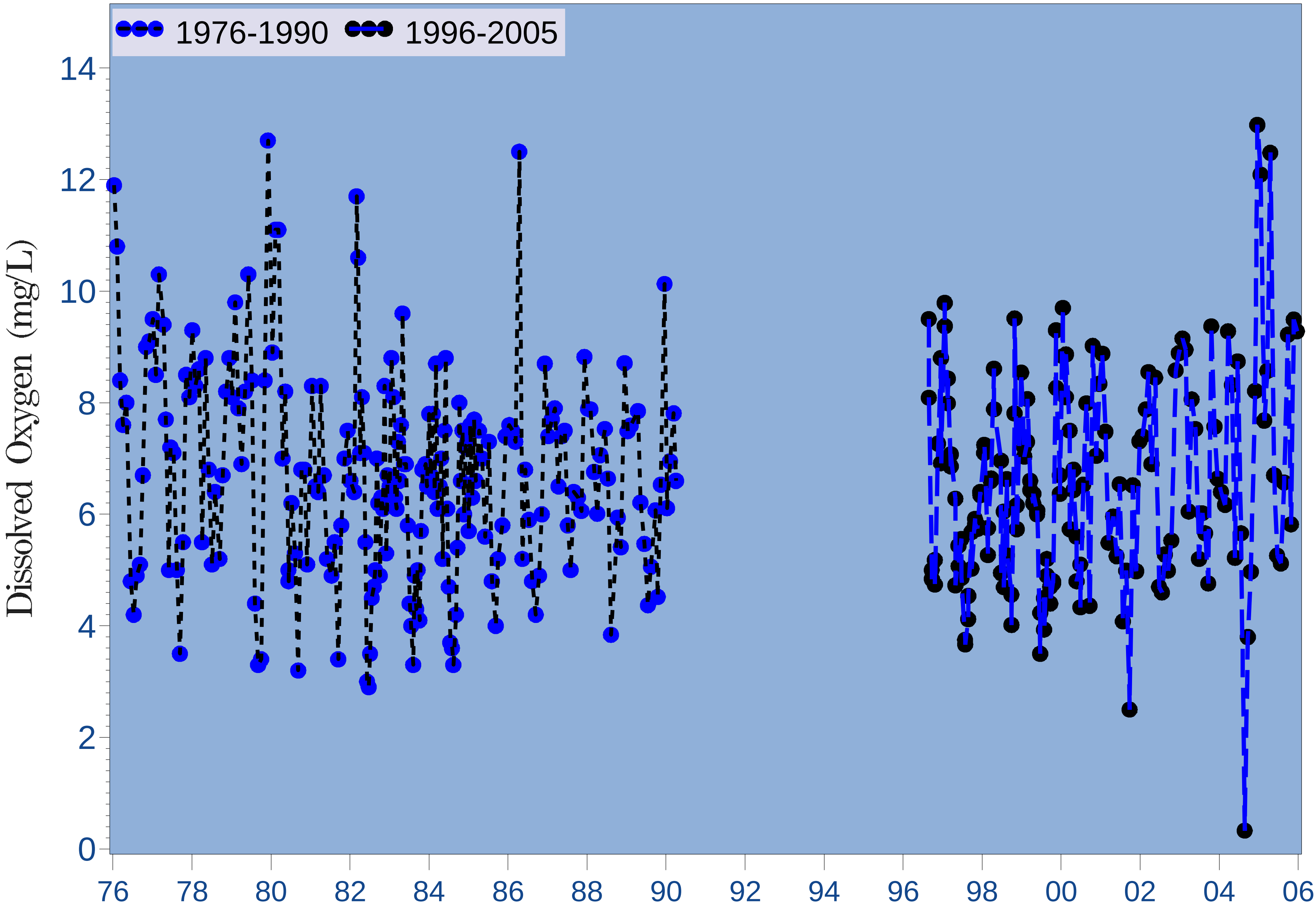


Figure 4.16c Monthly long-term surface dissolved oxygen at river kilometer 15.5

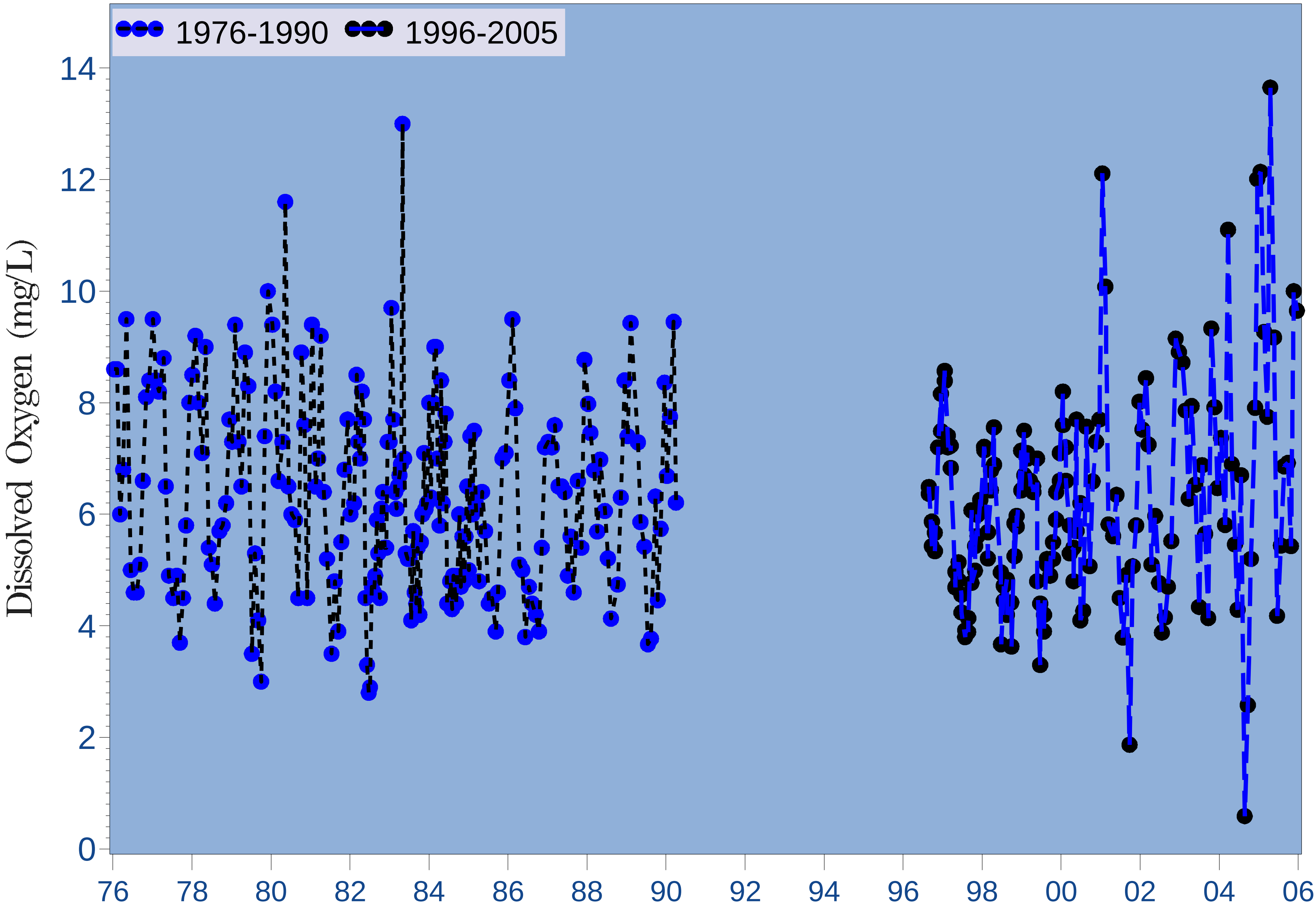


Figure 4.16d Monthly long-term surface dissolved oxygen at river kilometer 23.6

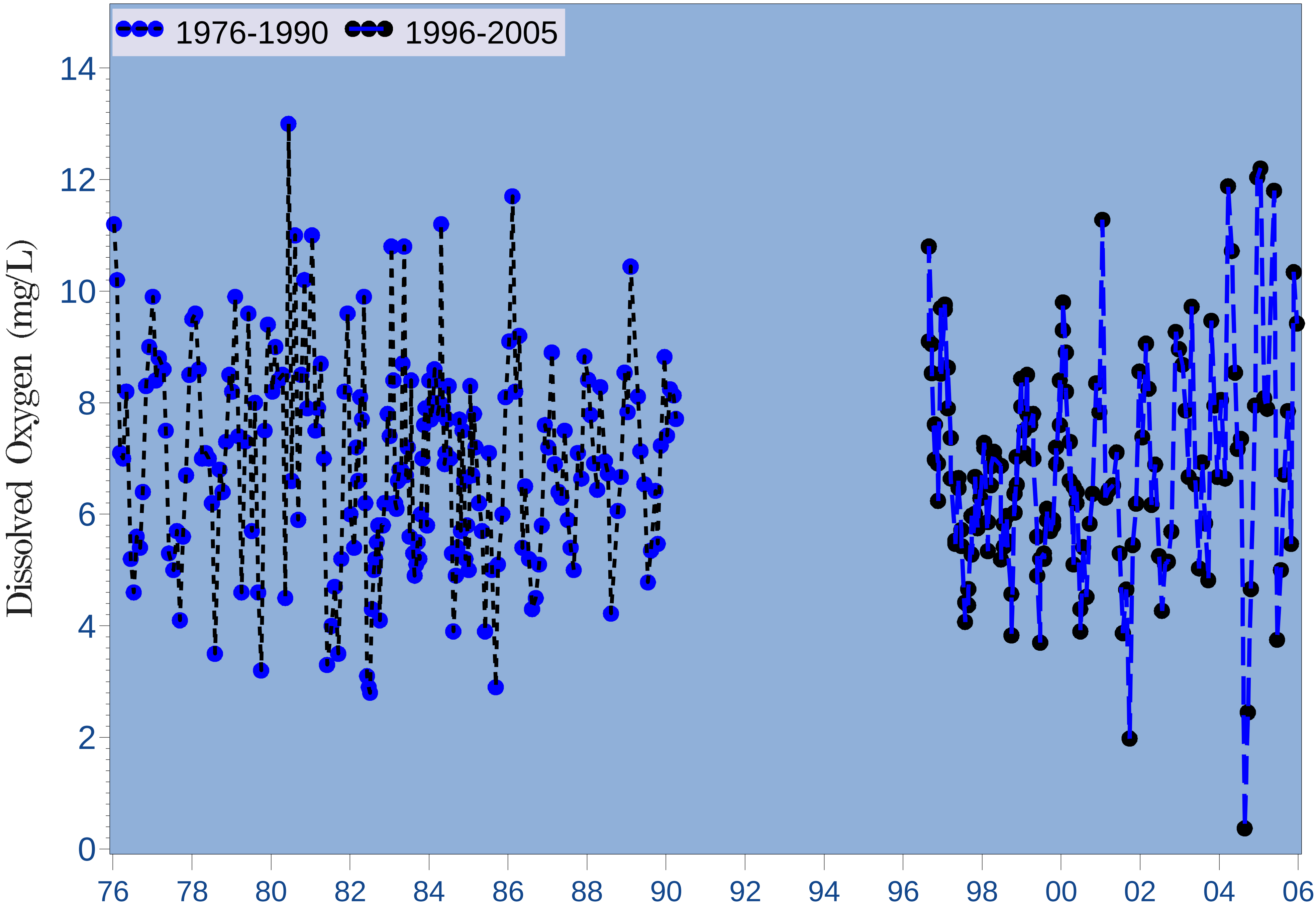


Figure 4.16e Monthly long-term surface dissolved oxygen at river kilometer 30.4

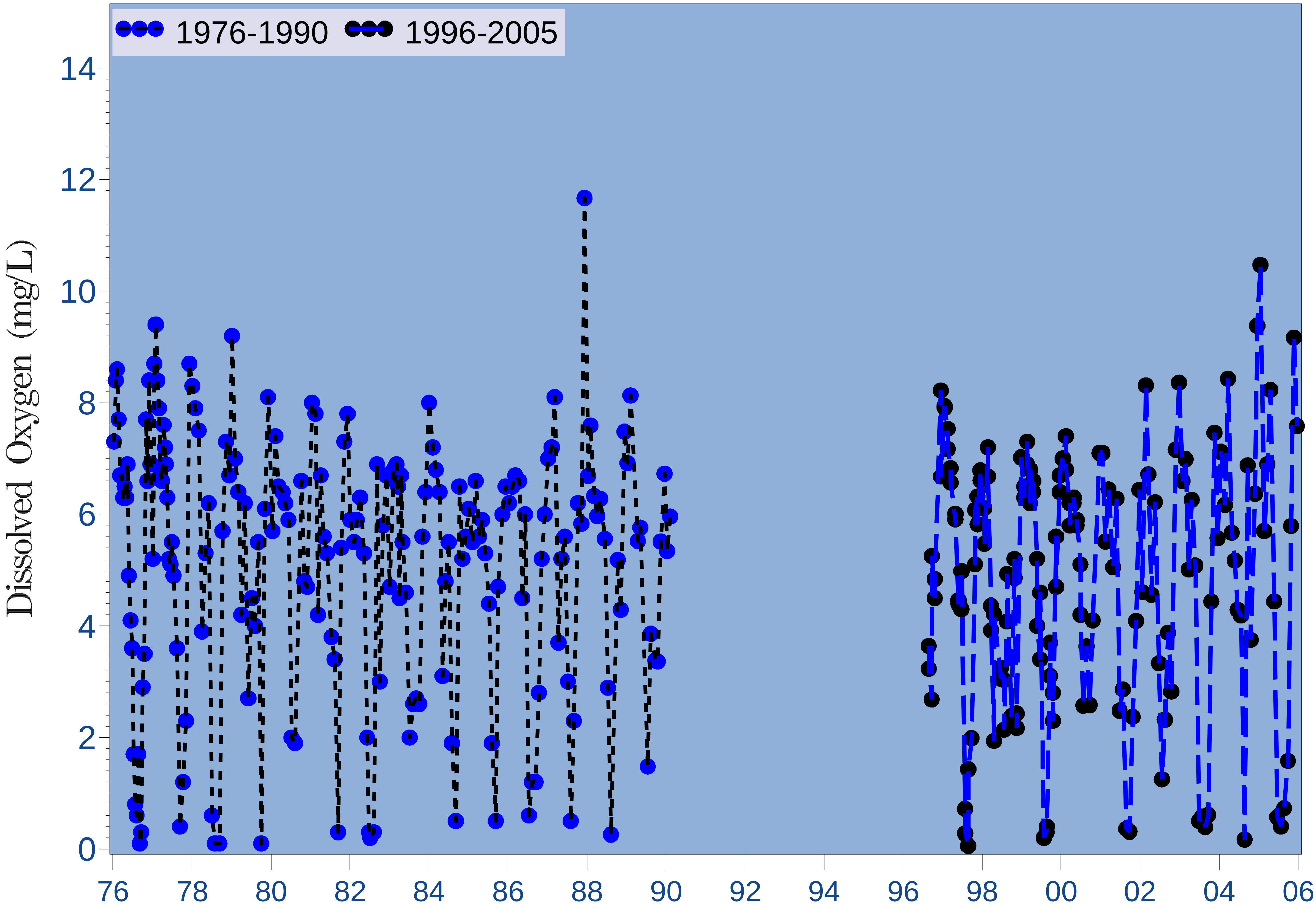


Figure 4.17a Monthly long-term bottom dissolved oxygen at river kilometer -2.4

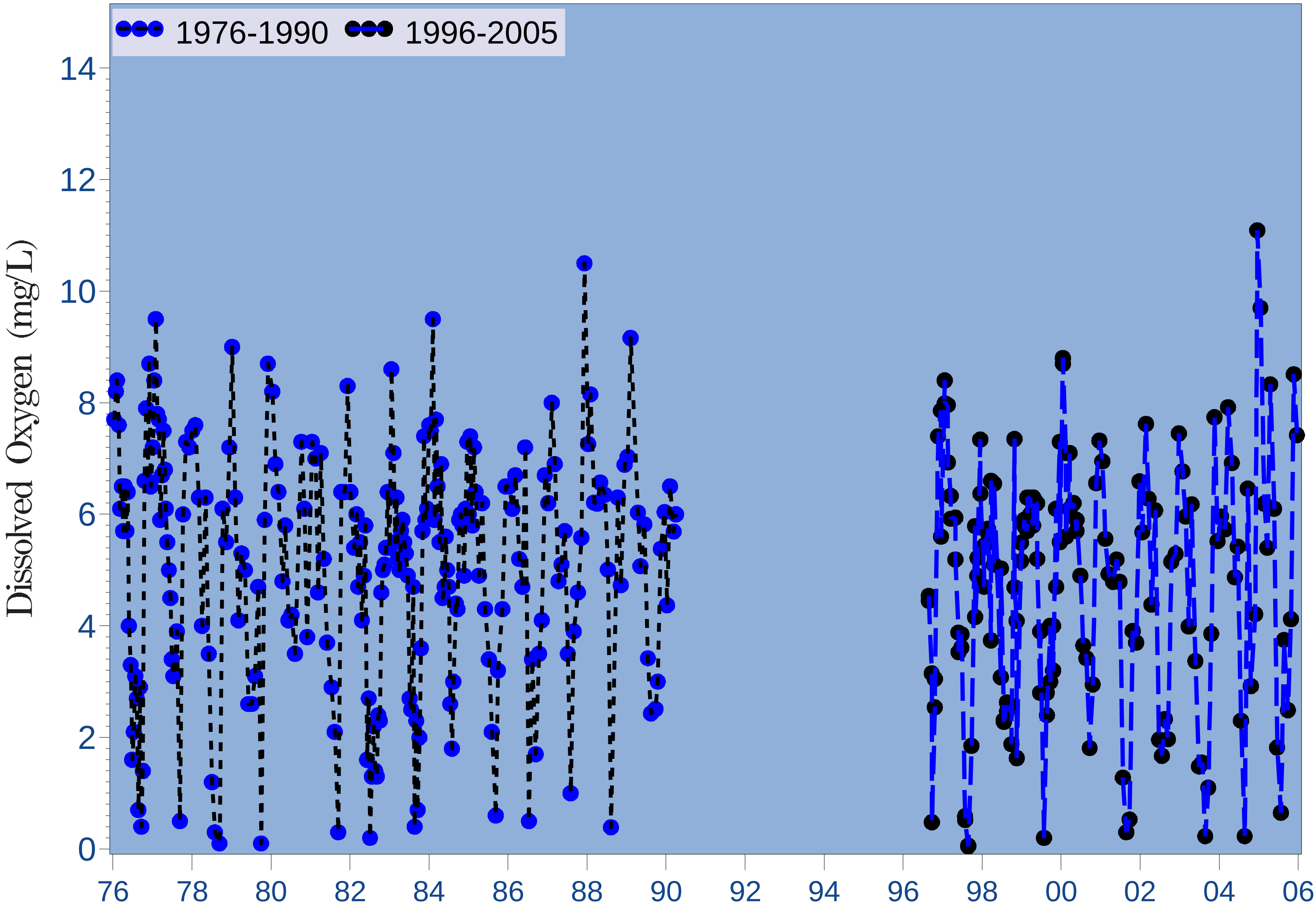


Figure 4.17b Monthly long-term bottom dissolved oxygen at river kilometer 6.6

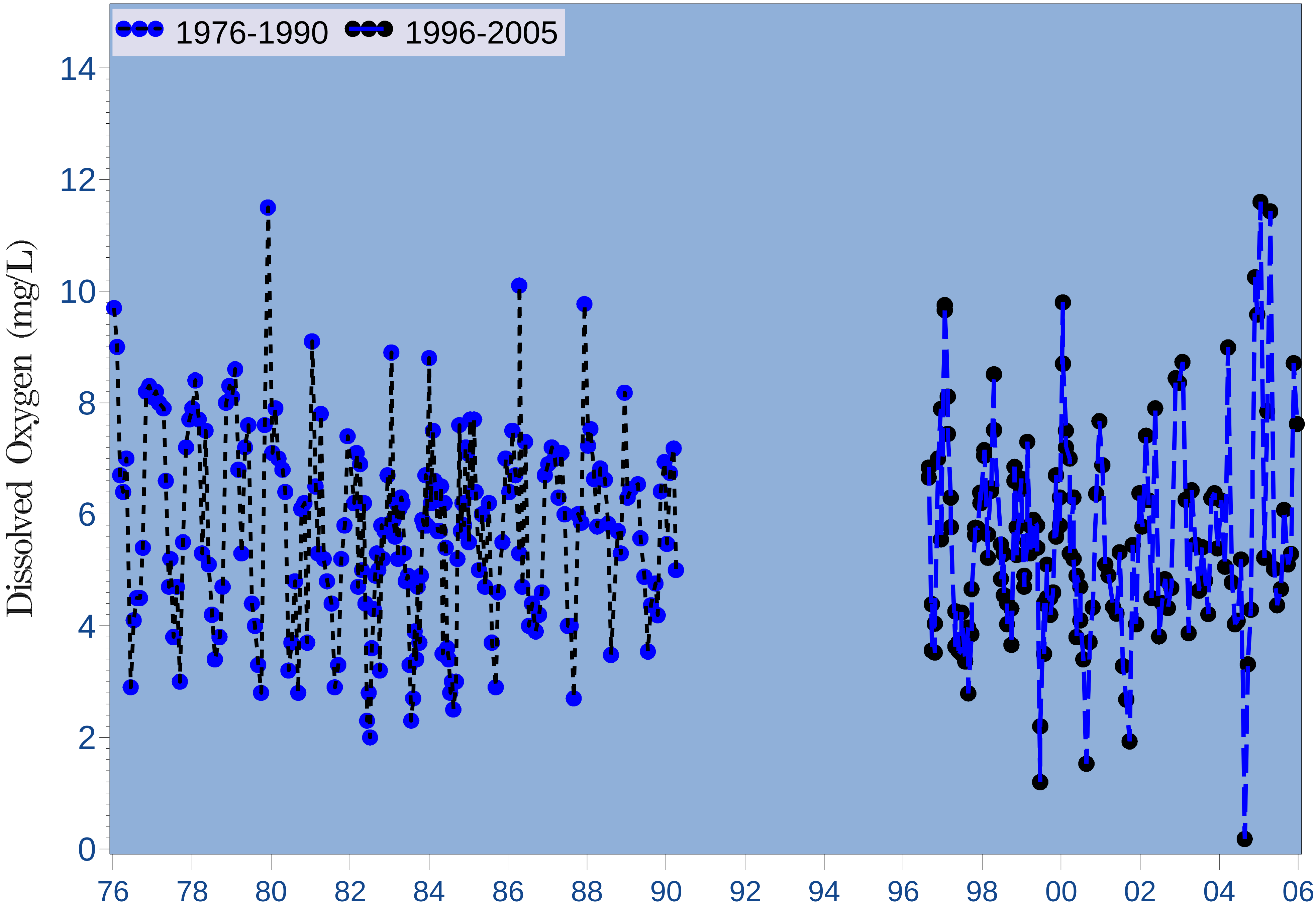


Figure 4.17c Monthly long-term bottom dissolved oxygen at river kilometer 15.5

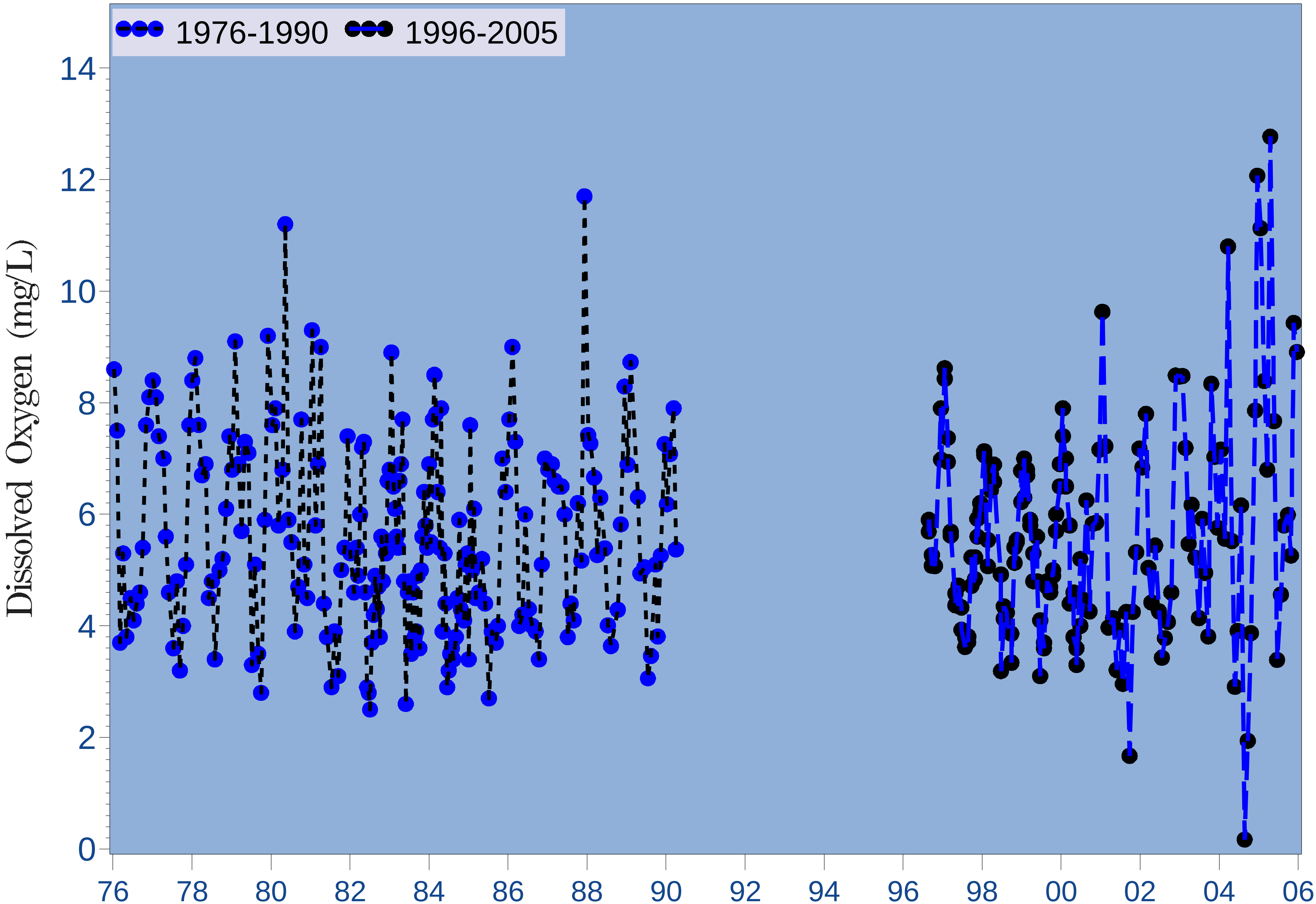


Figure 4.17d Monthly long-term bottom dissolved oxygen at river kilometer 23.6

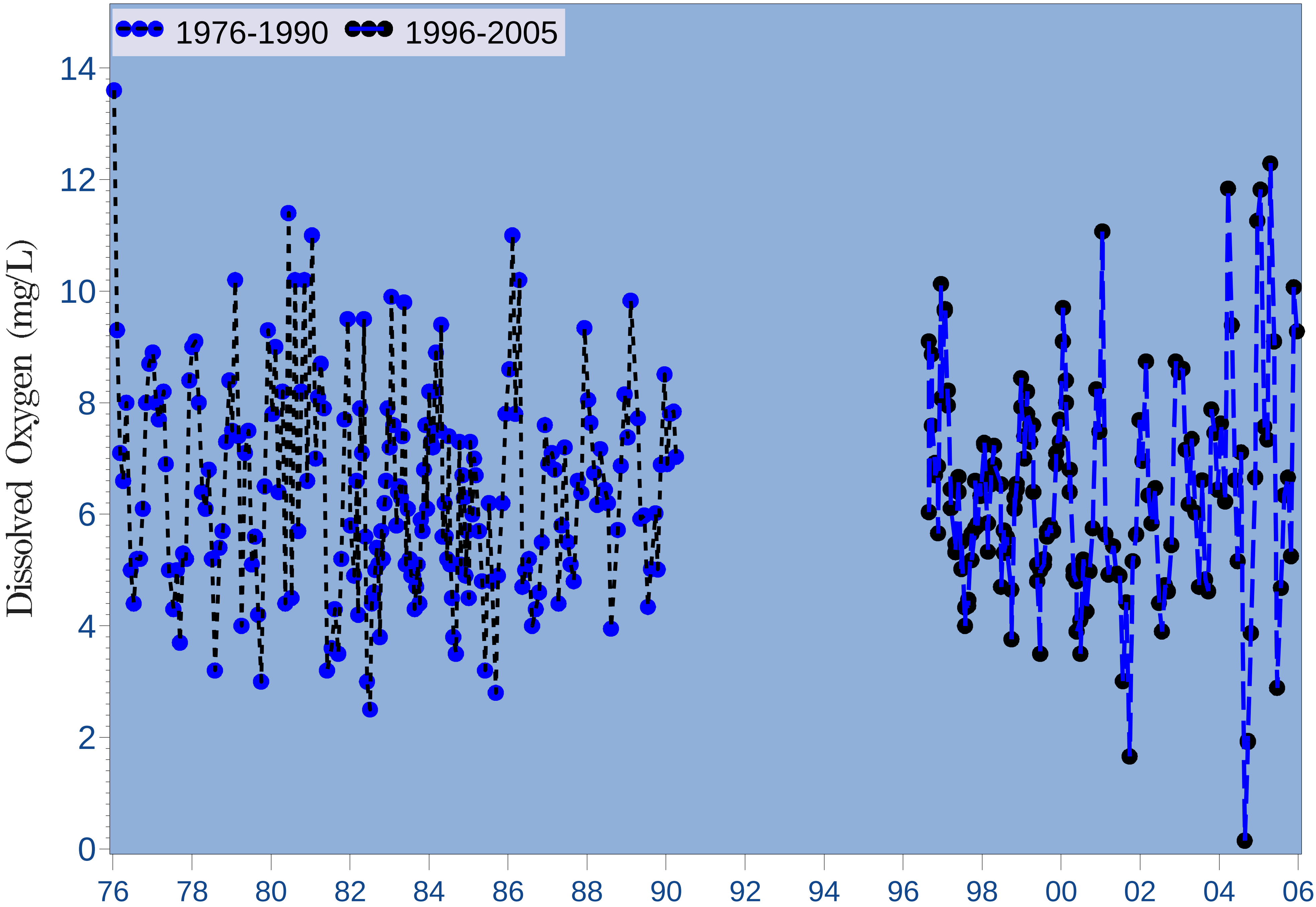


Figure 4.17e Monthly long-term bottom dissolved oxygen at river kilometer 30.4

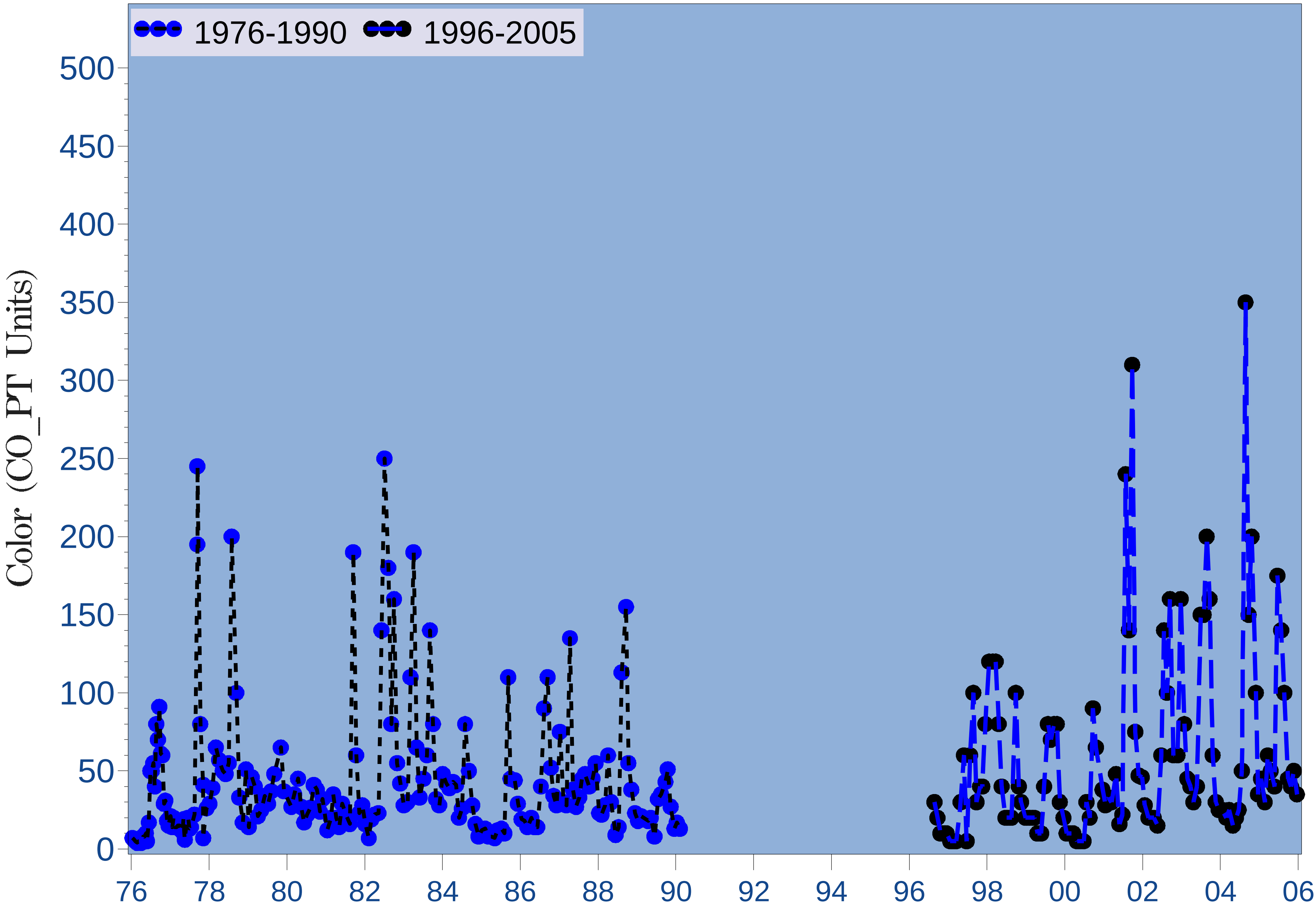


Figure 4.18a Monthly long-term surface color at river kilometer -2.4

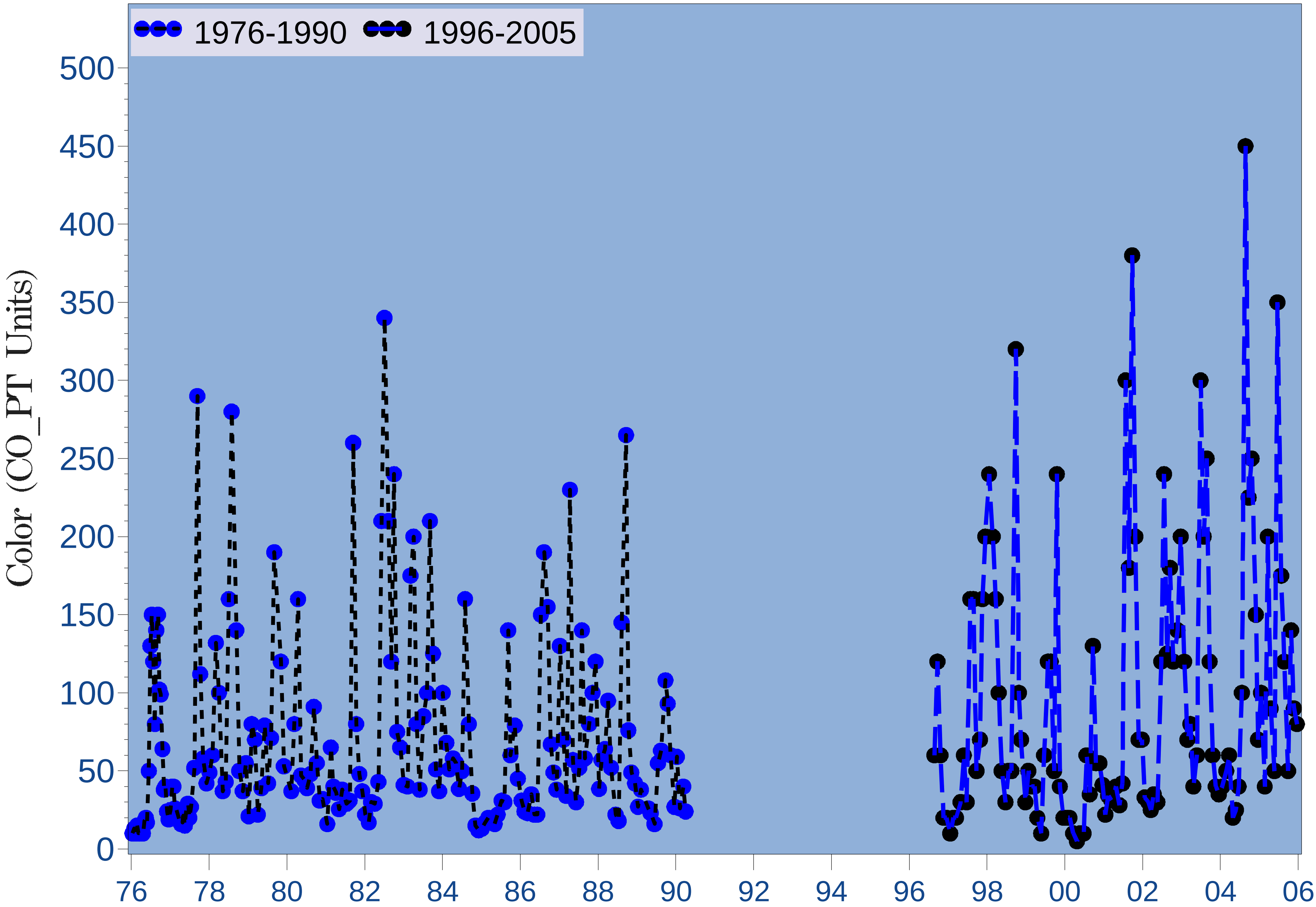


Figure 4.18b Monthly long-term surface color at river kilometer 6.6

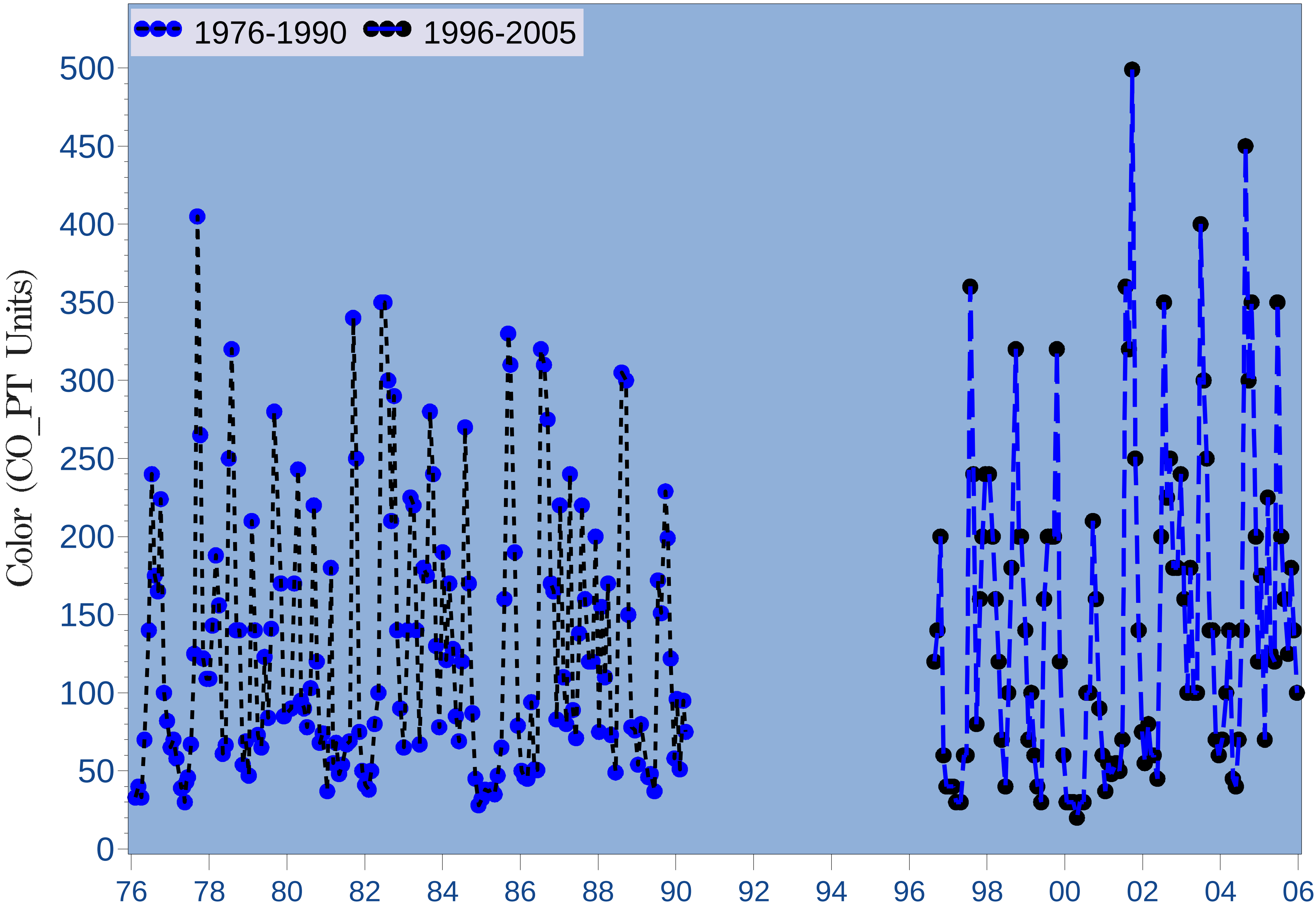


Figure 4.18c Monthly long-term surface color at river kilometer 15.5

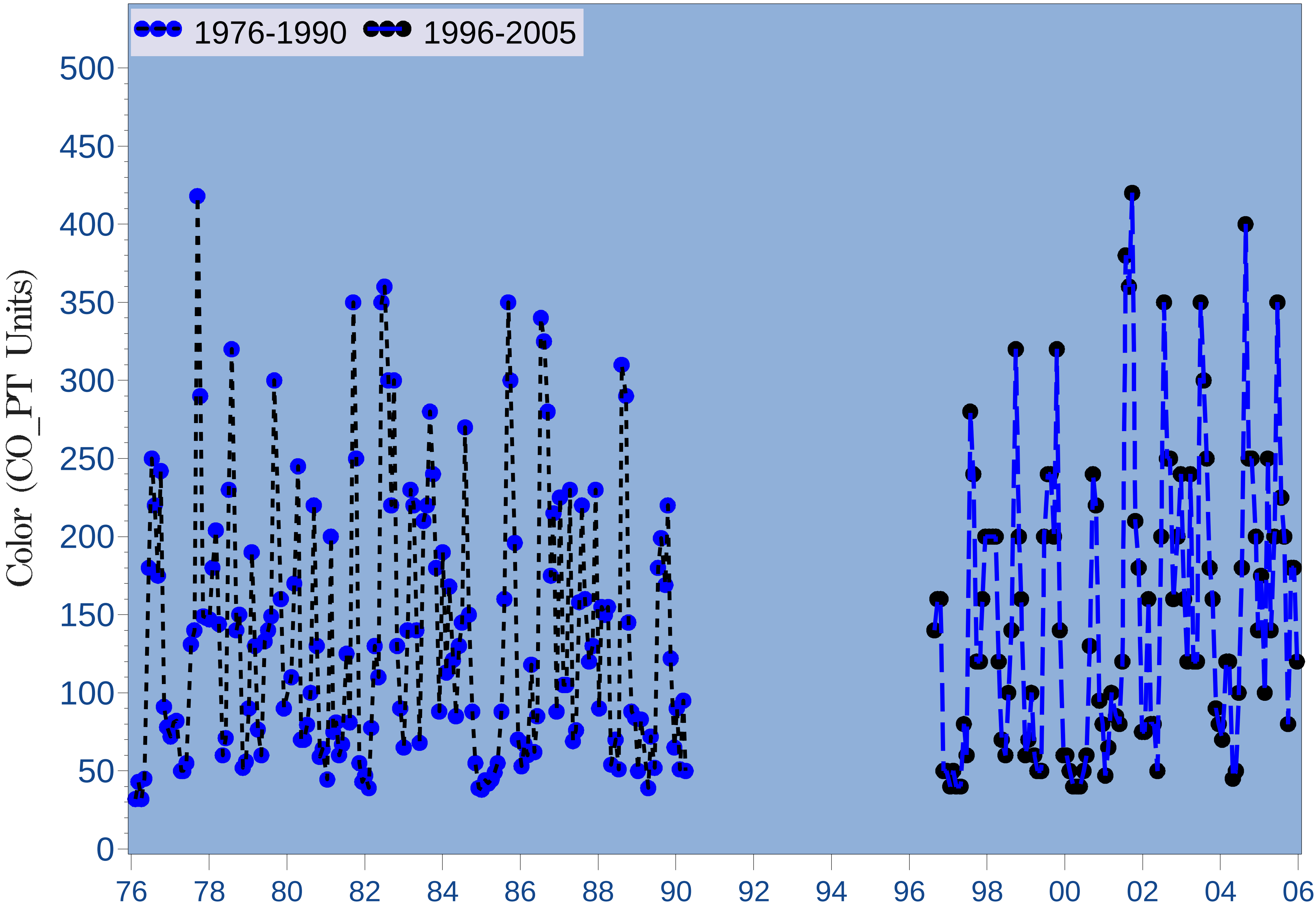


Figure 4.18d Monthly long-term surface color at river kilometer 23.6

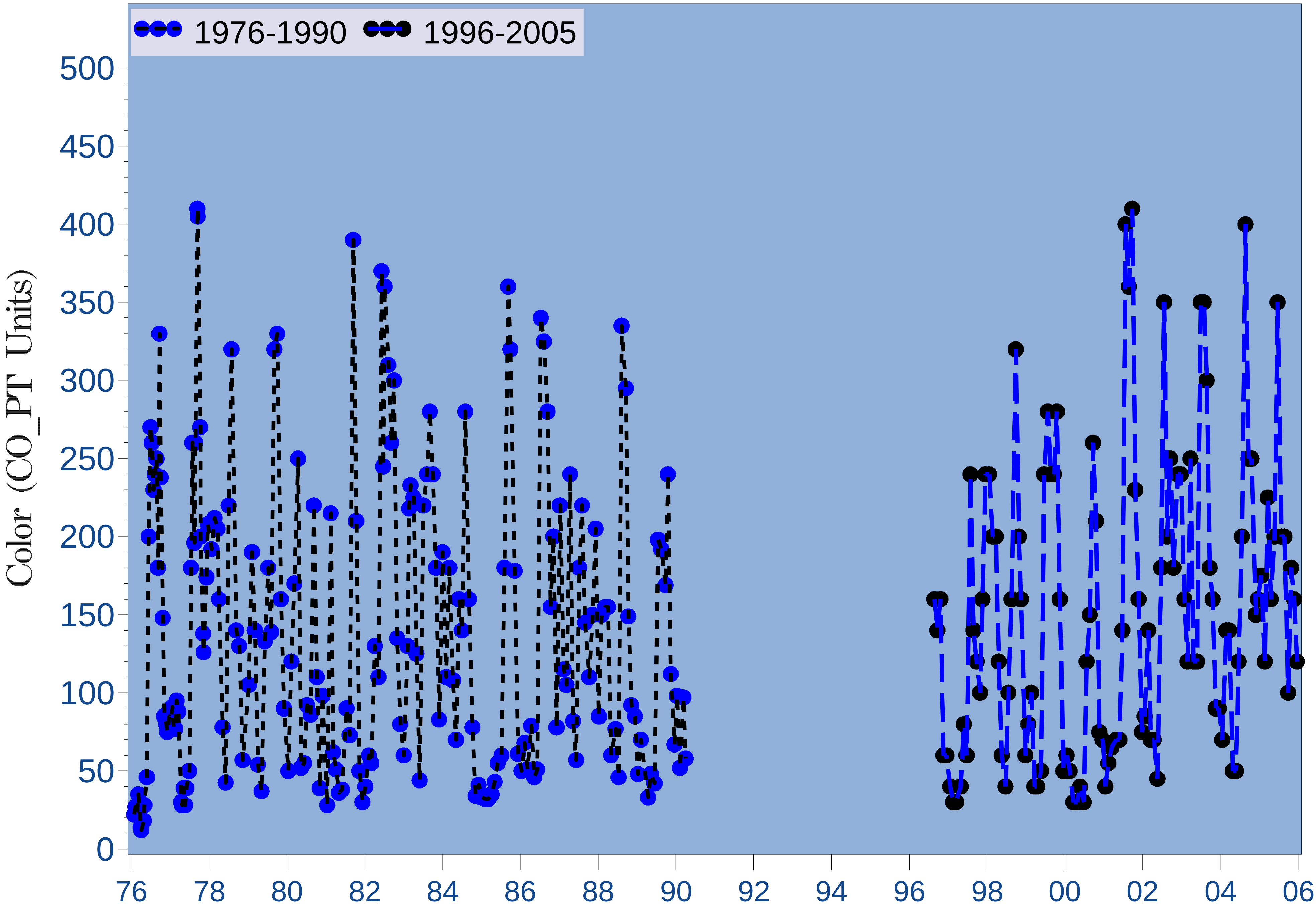


Figure 4.18e Monthly long-term surface color at river kilometer 30.4

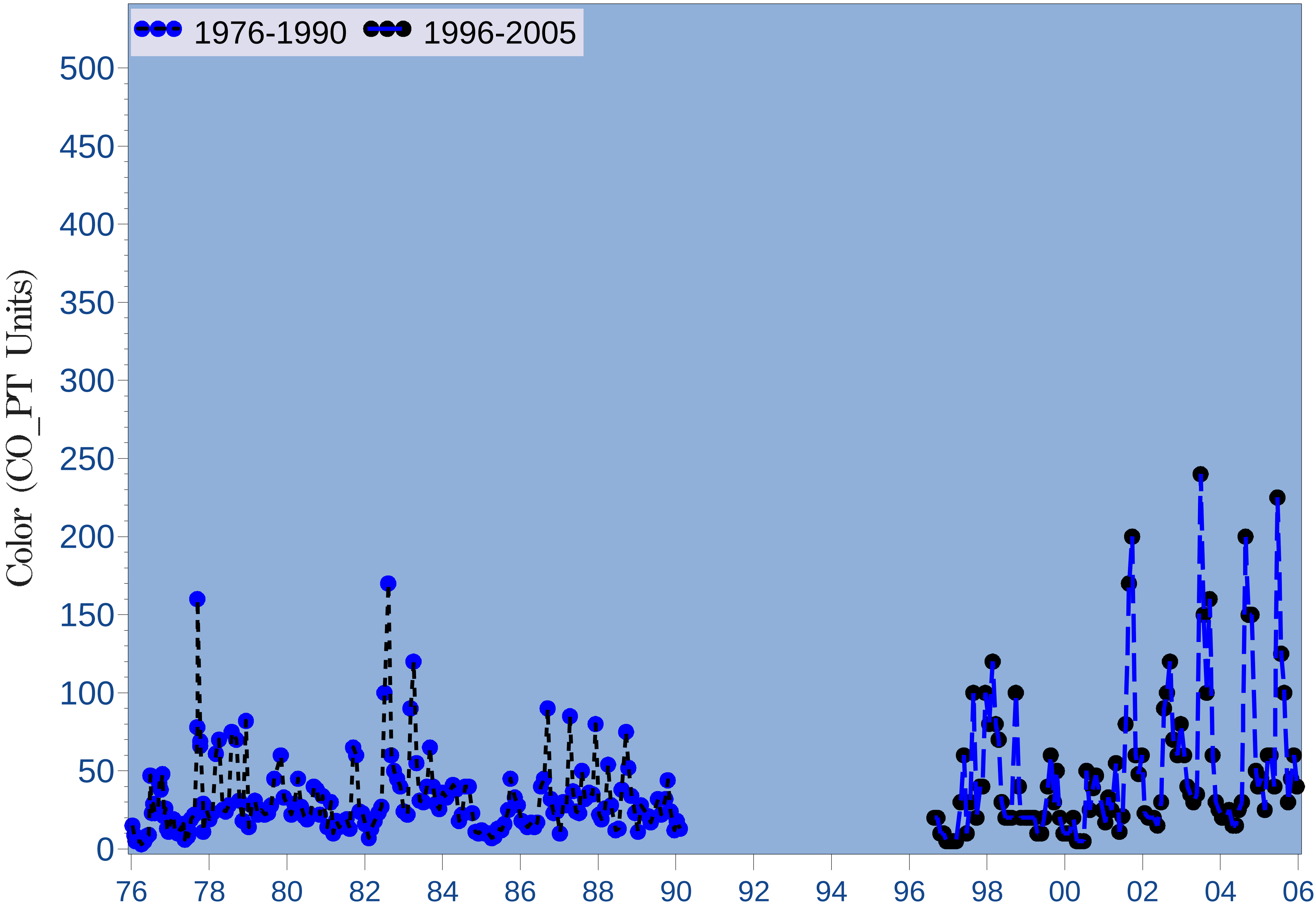


Figure 4.19a Monthly long-term bottom color at river kilometer -2.4

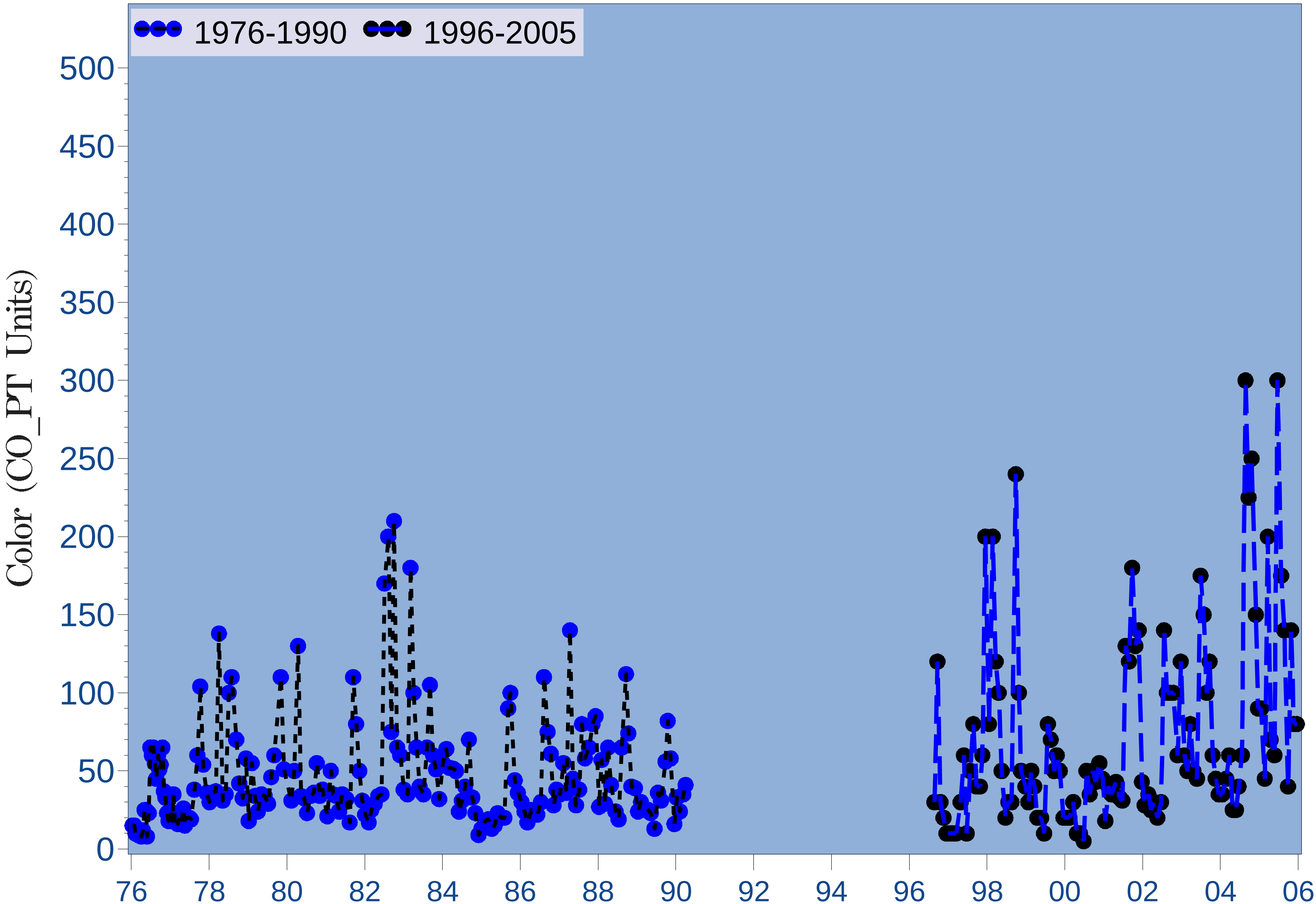


Figure 4.19b Monthly long-term bottom color at river kilometer 6.6

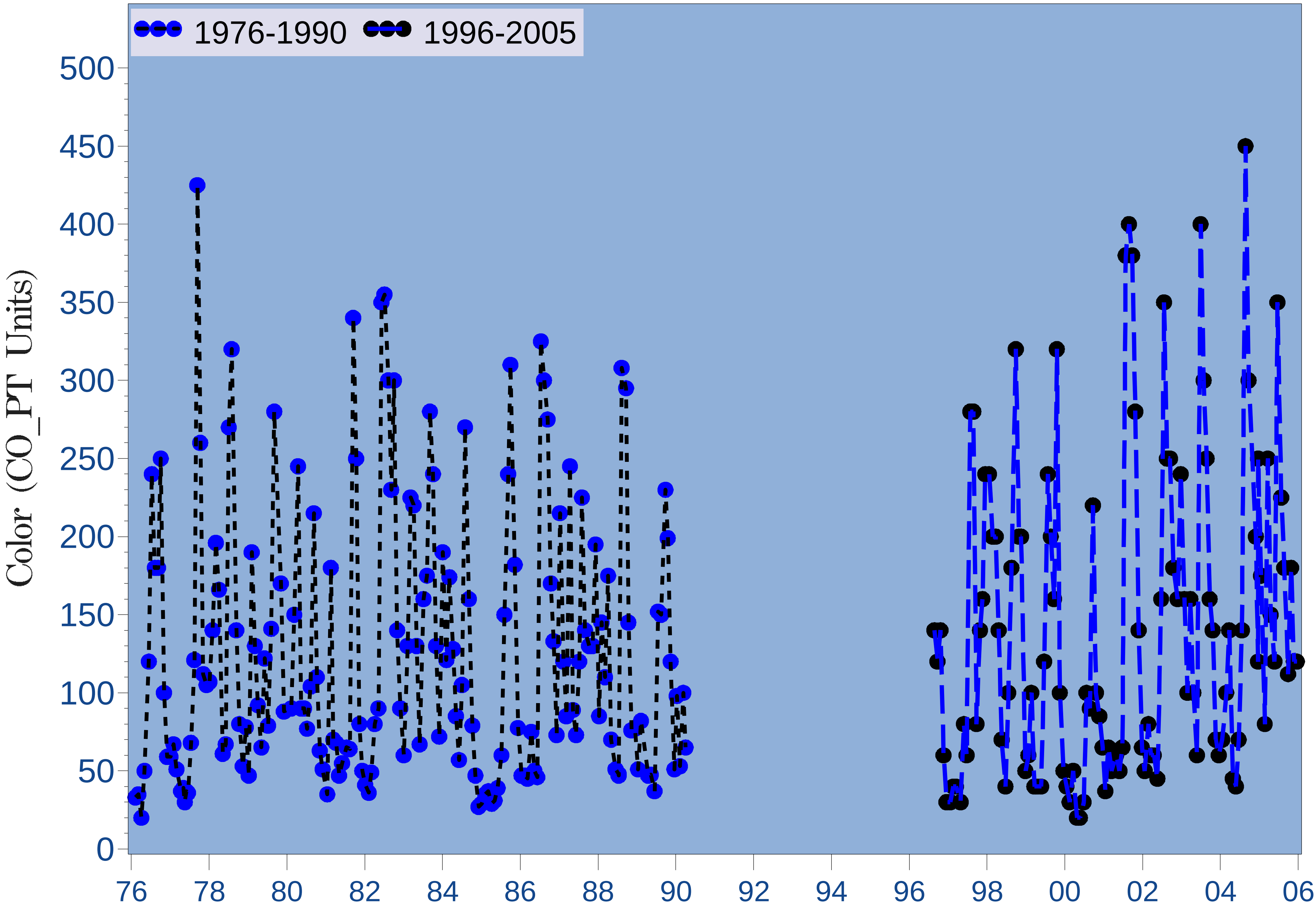


Figure 4.19c Monthly long-term bottom color at river kilometer 15.5

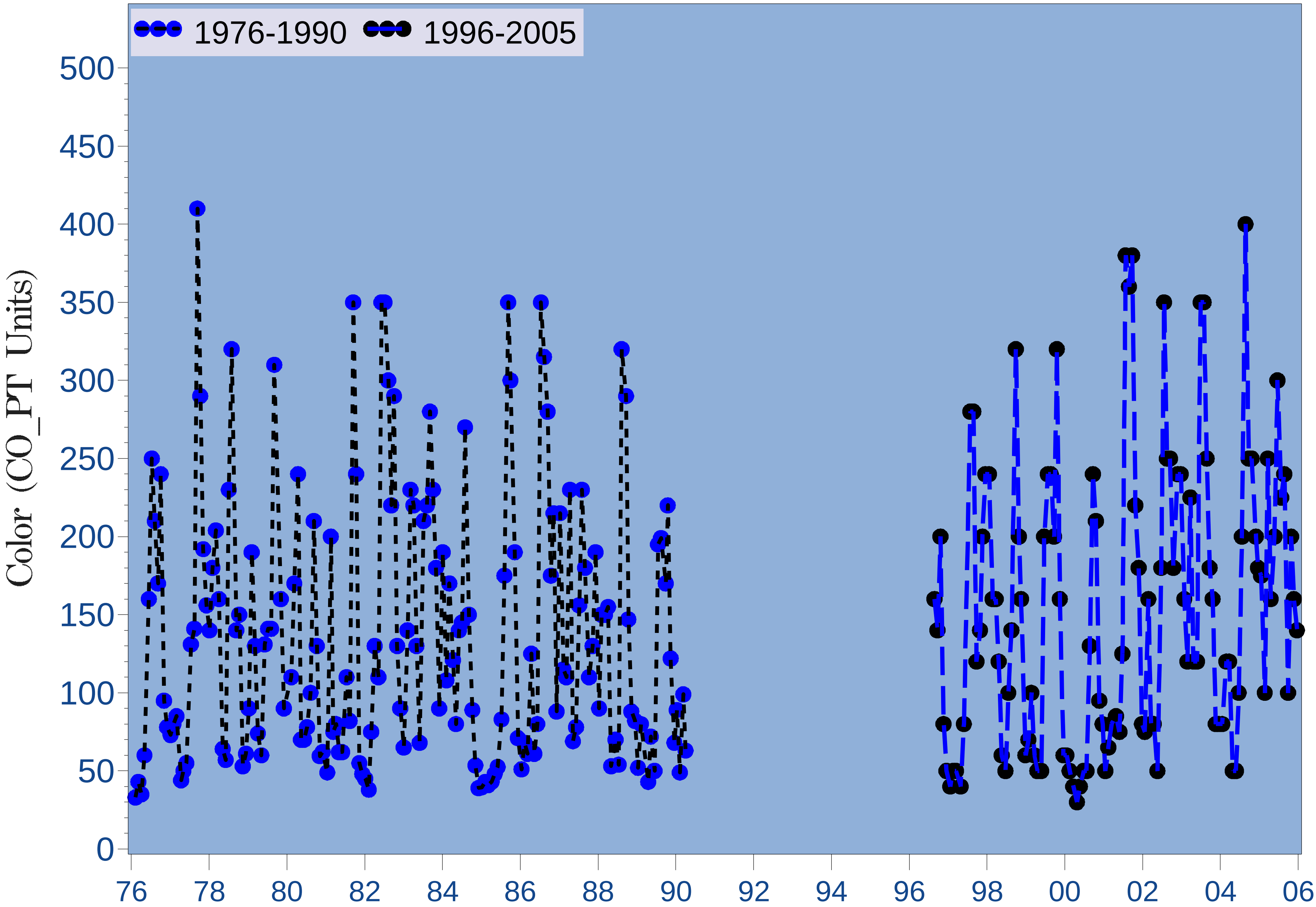


Figure 4.19d Monthly long-term bottom color at river kilometer 23.6

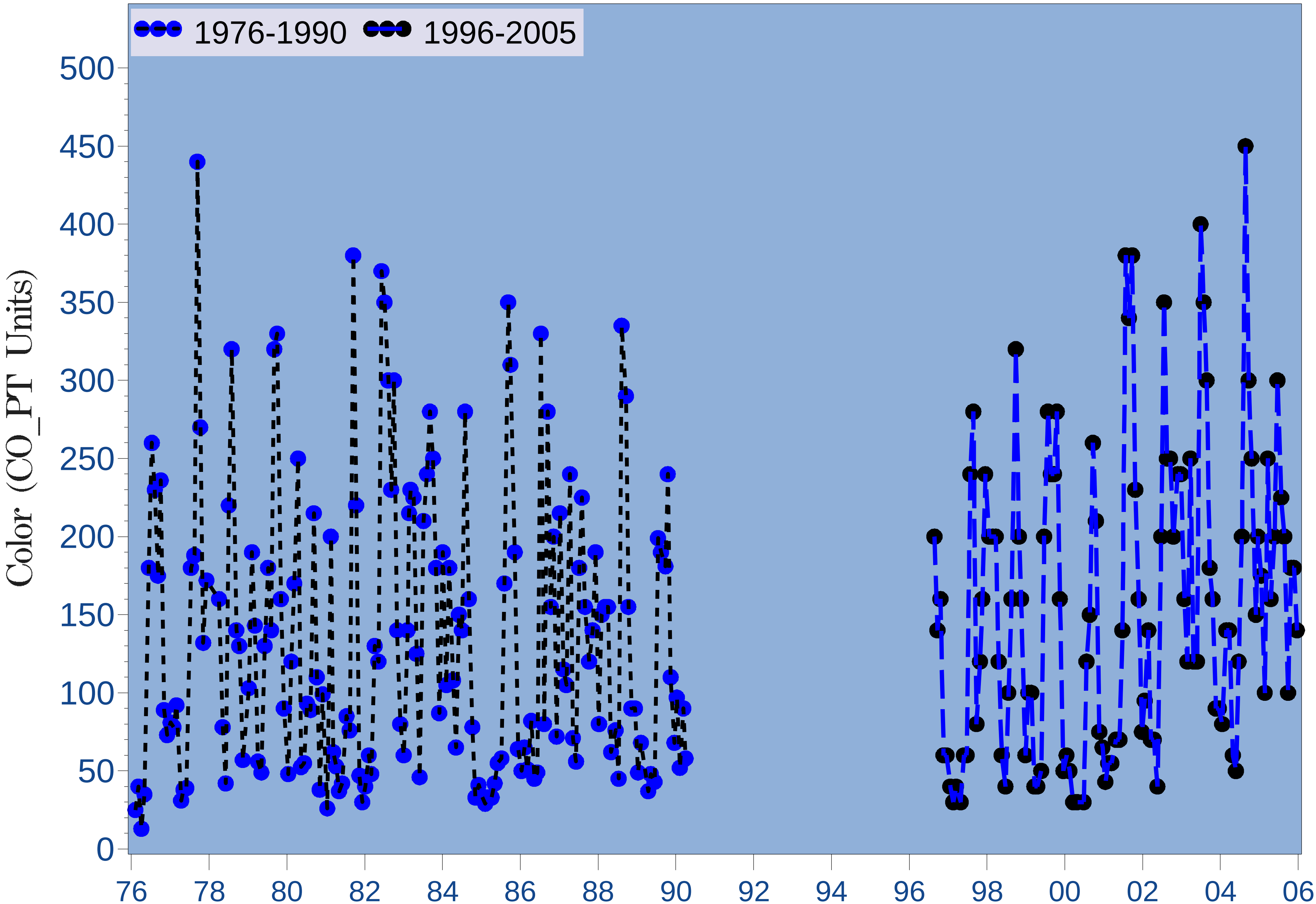


Figure 4.19e Monthly long-term bottom color at river kilometer 30.4

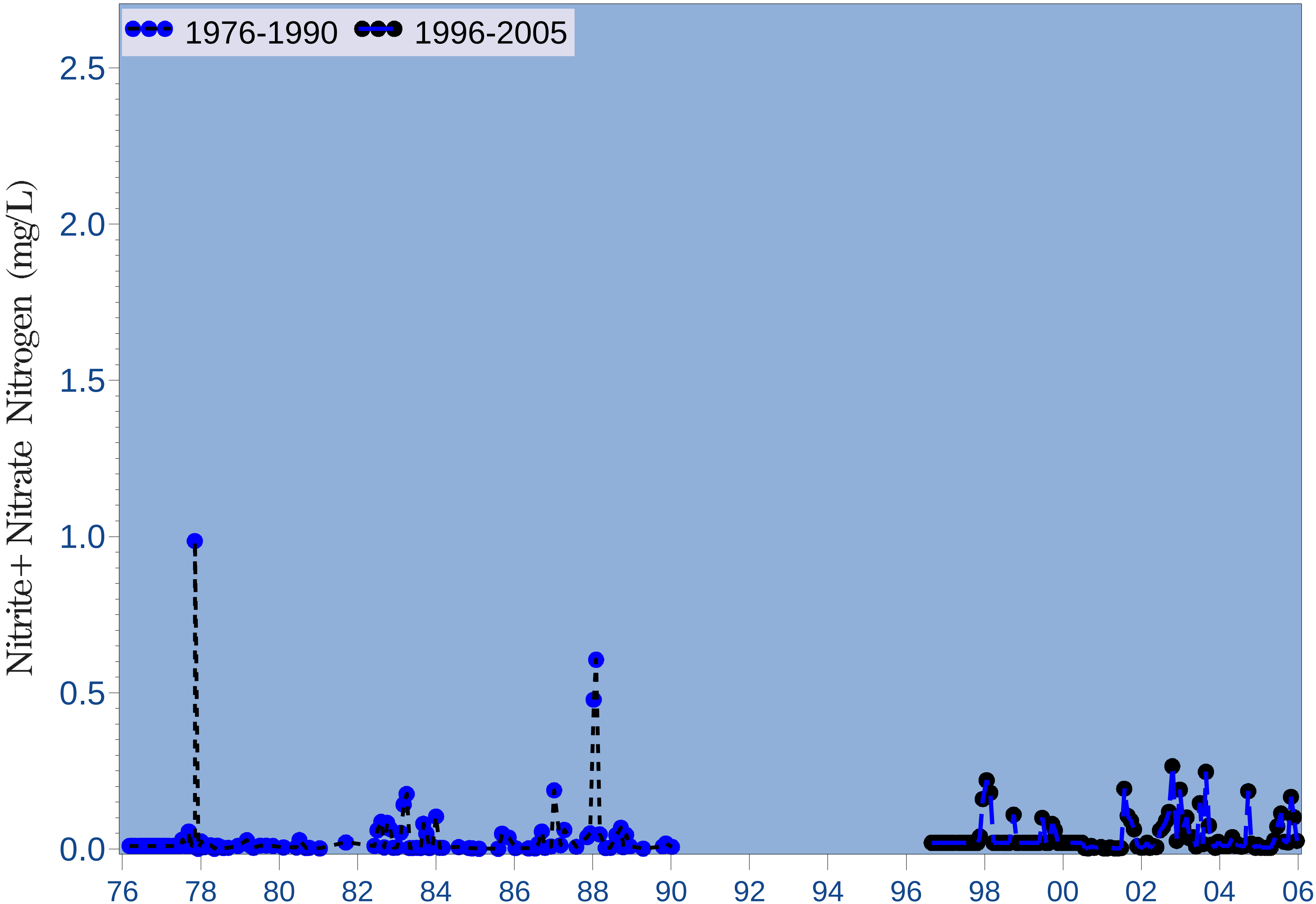


Figure 4.20a Monthly long-term surface nitrite/nitrate nitrogen at river kilometer -2.4

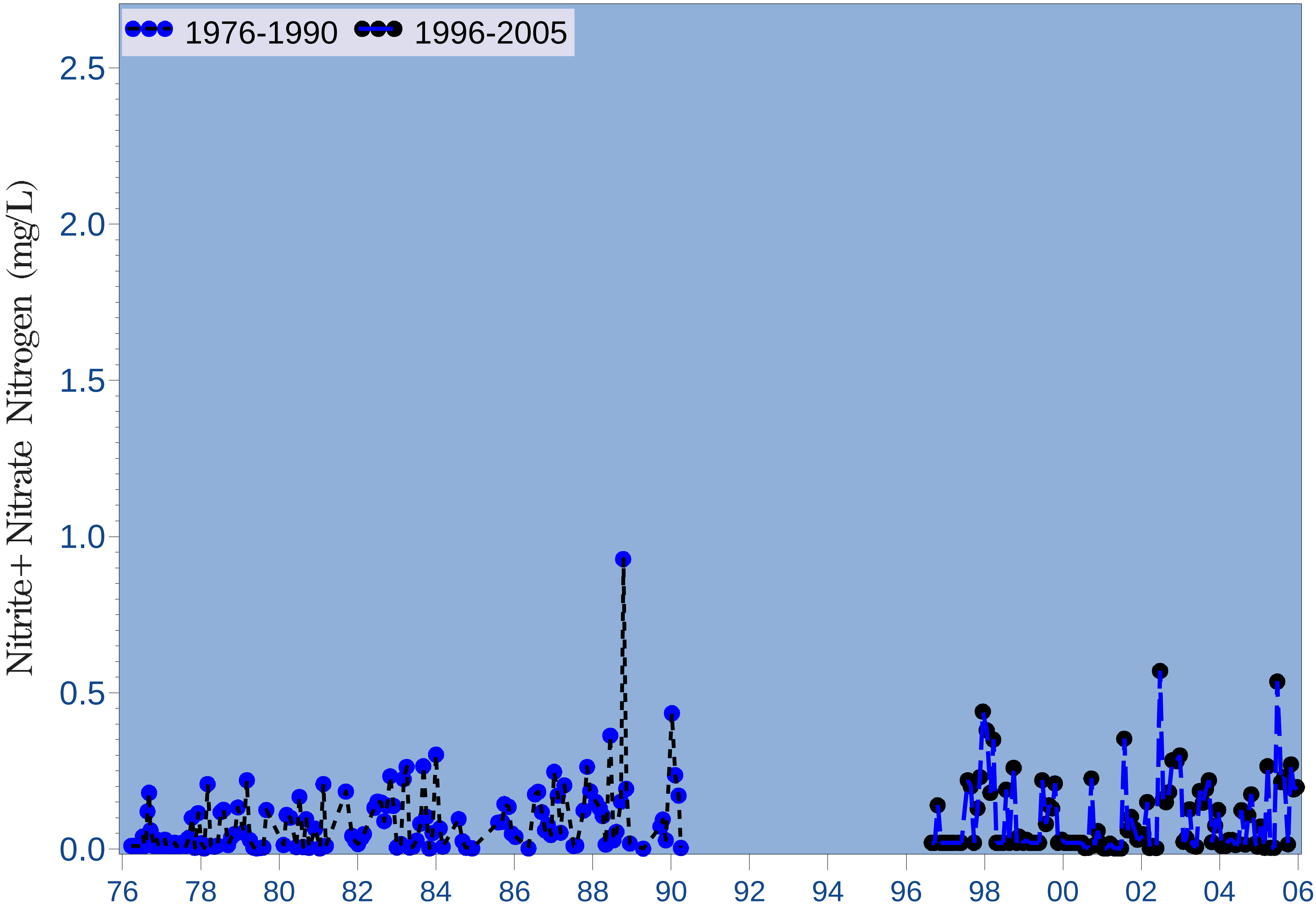


Figure 4.20b Monthly long-term surface nitrite/nitrate nitrogen at river kilometer 6.6

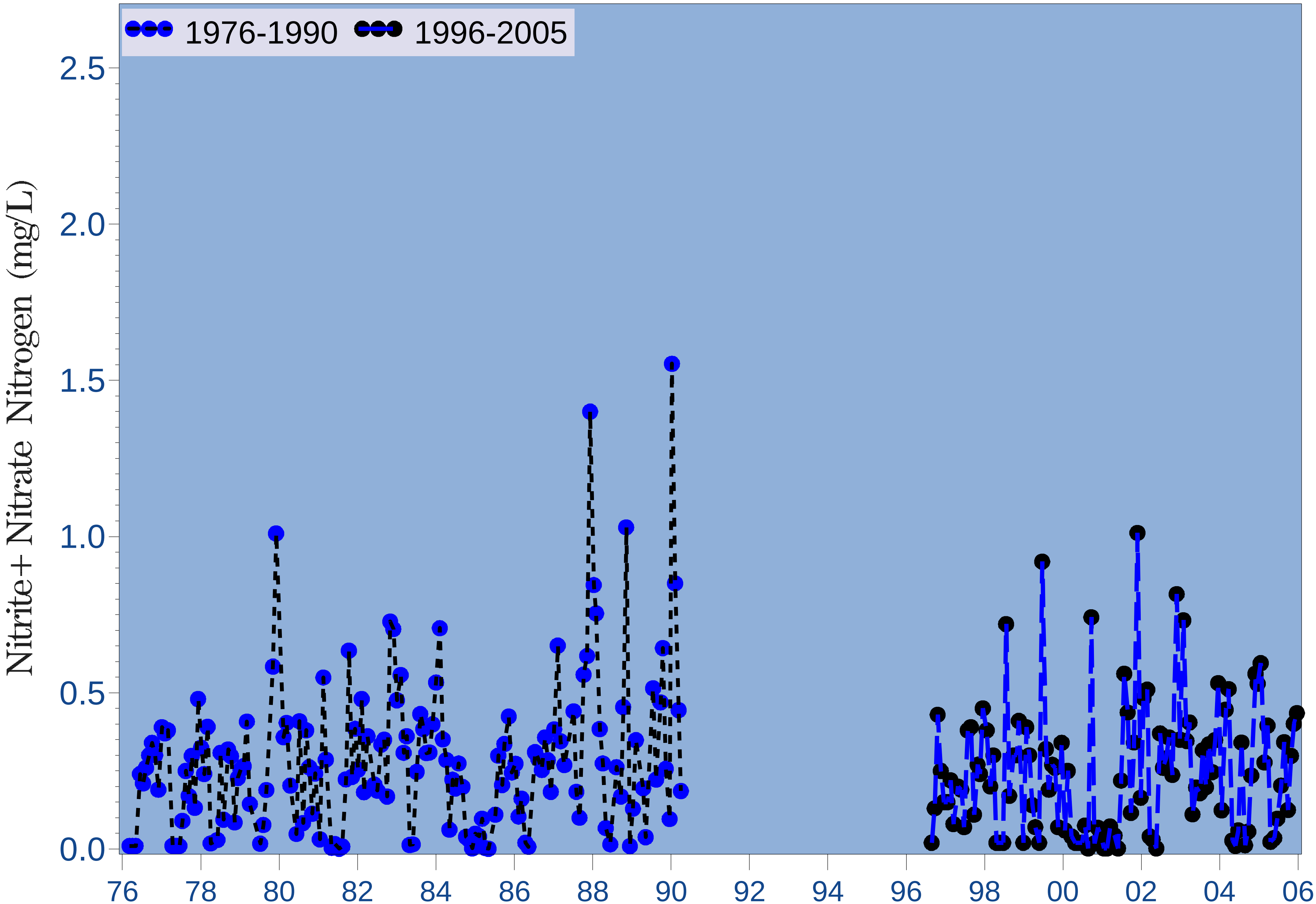


Figure 4.20c Monthly long-term surface nitrite/nitrate nitrogen at river kilometer 15.5

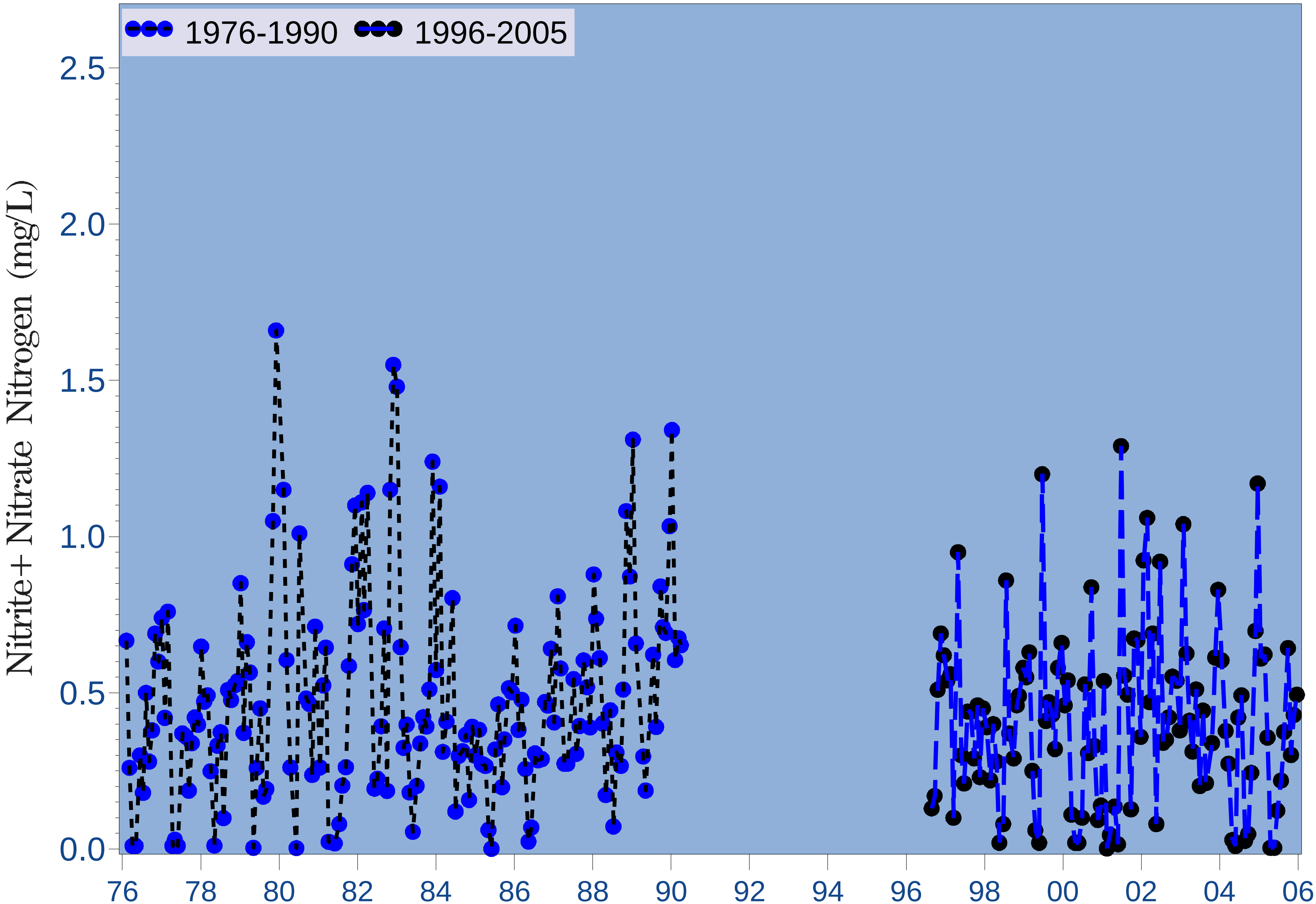


Figure 4.20d Monthly long-term surface nitrite/nitrate nitrogen at river kilometer 23.6

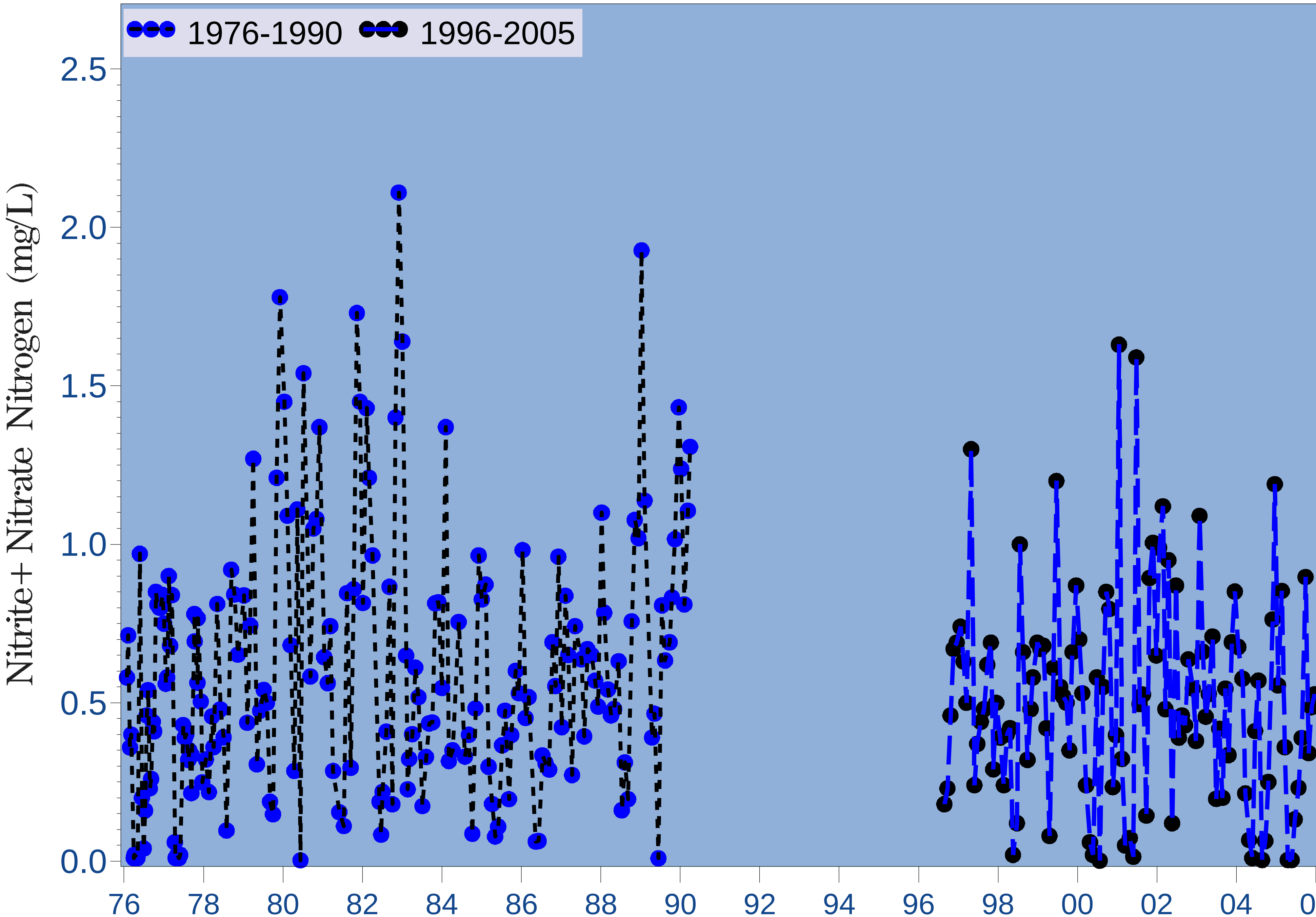


Figure 4.20e Monthly long-term surface nitrite/nitrate nitrogen at river kilometer 30.4

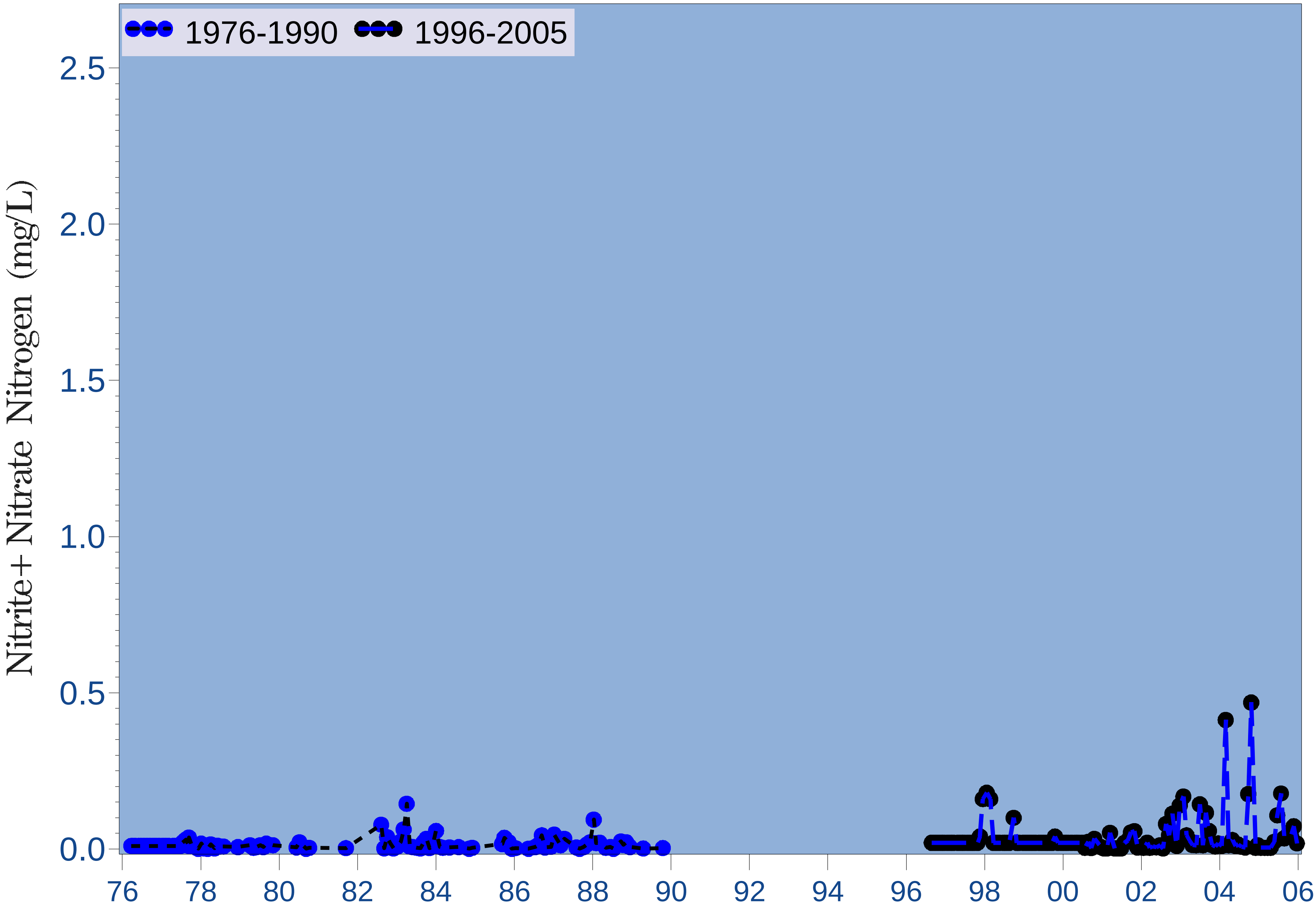


Figure 4.21a Monthly long-term bottom nitrate/nitrite nitrogen at river kilometer -2.4

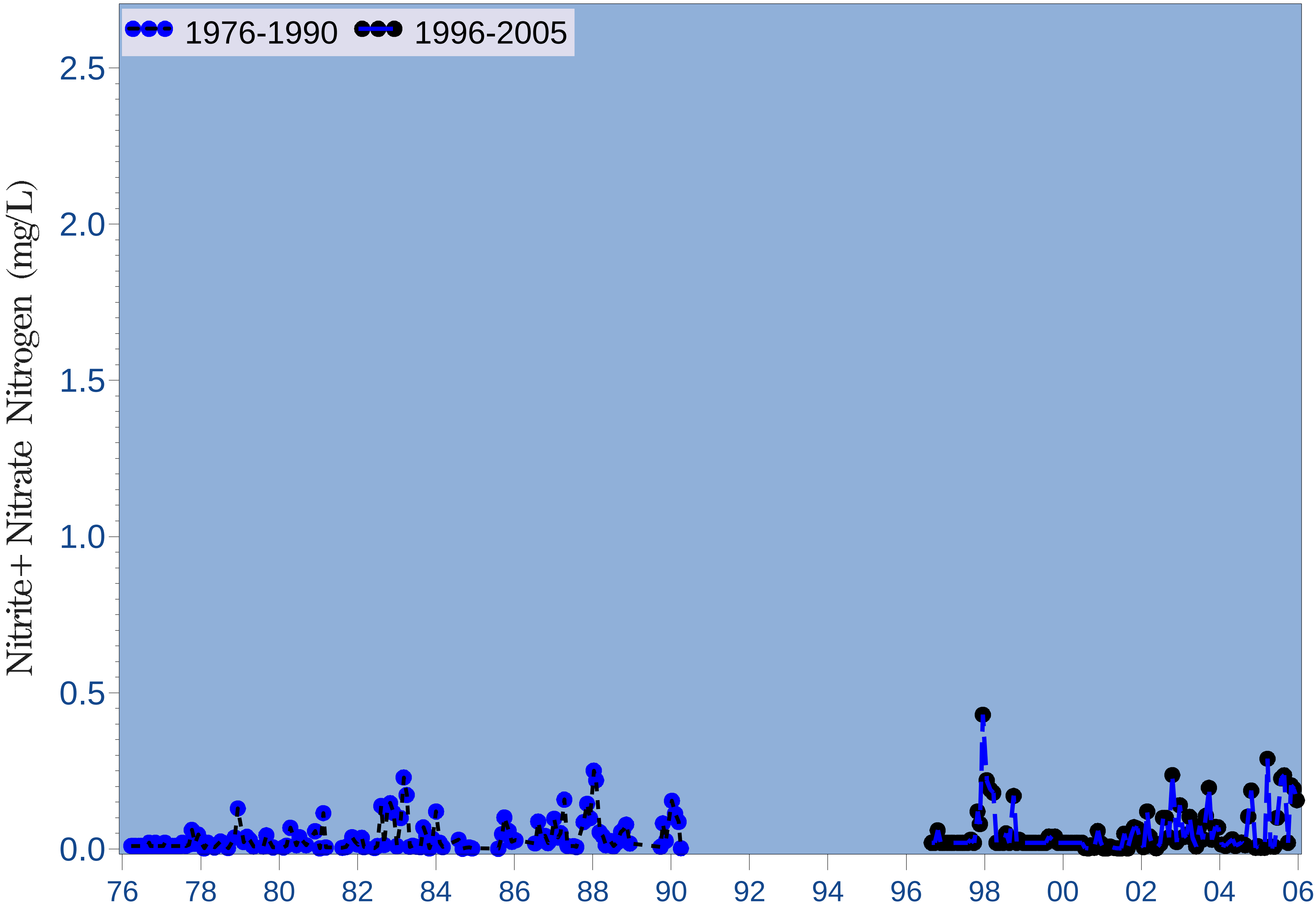


Figure 4.21b Monthly long-term bottom nitrate/nitrite nitrogen at river kilometer 6.6

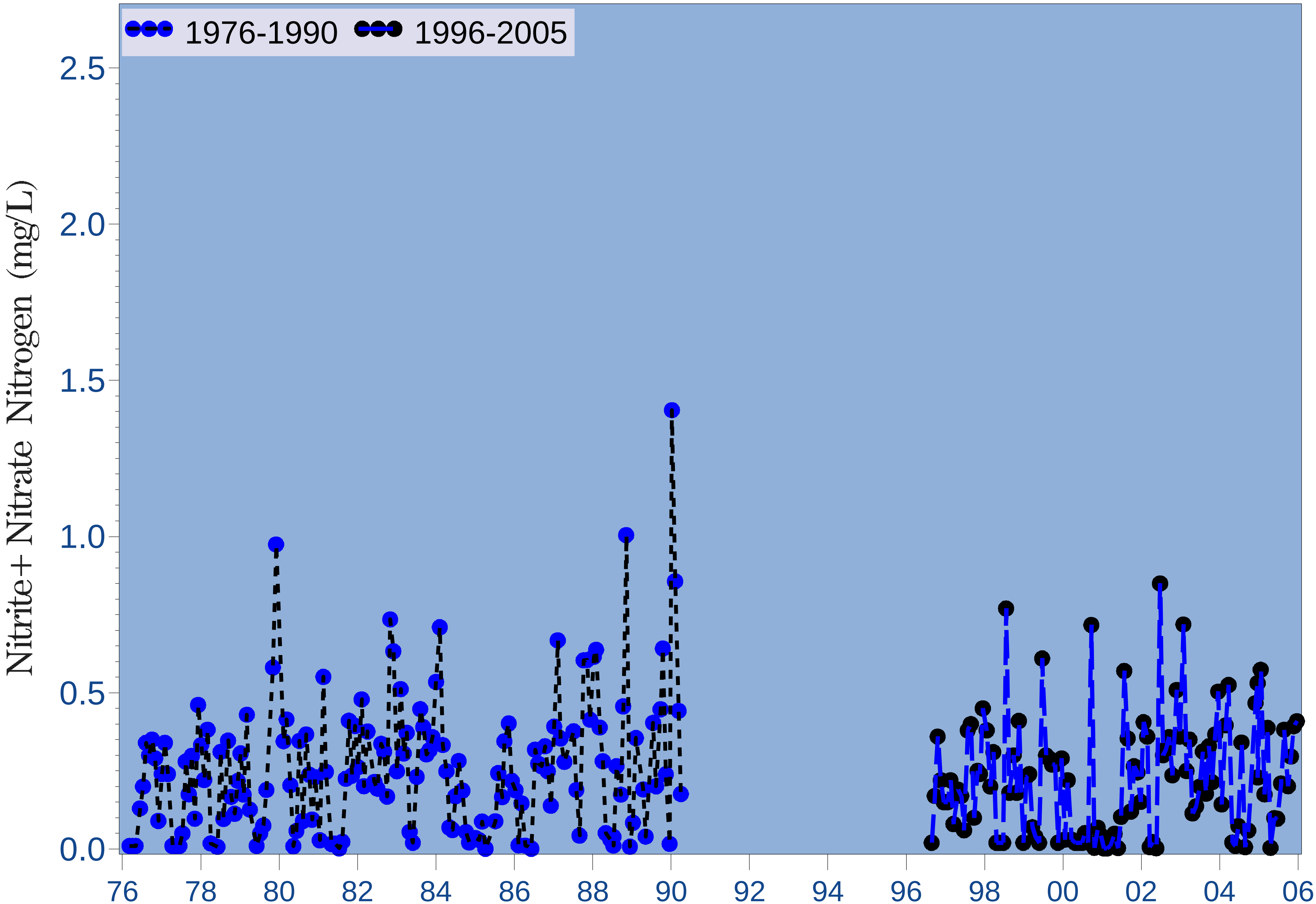


Figure 4.21c Monthly long-term bottom nitrate/nitrite nitrogen at river kilometer 15.5

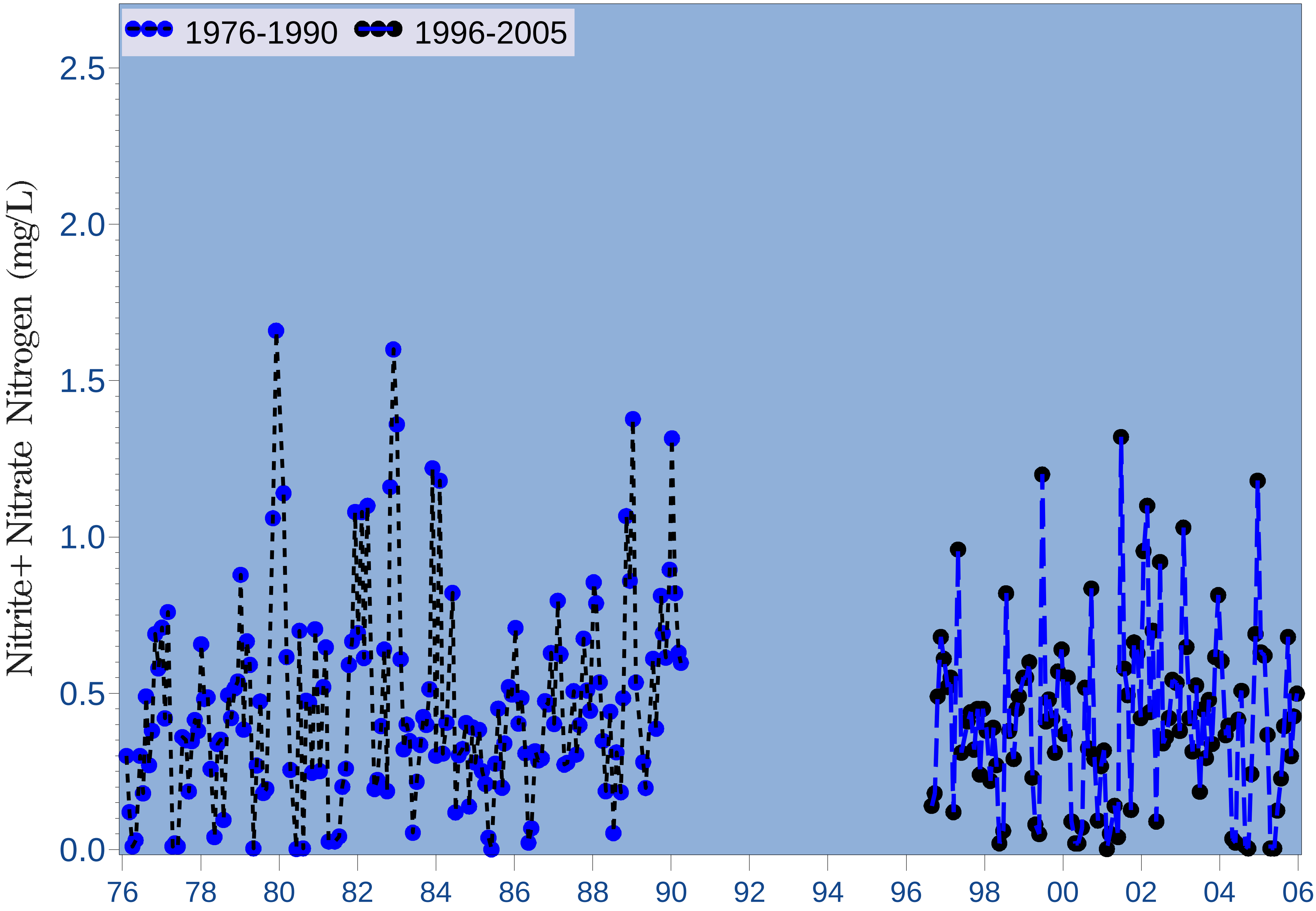


Figure 4.21d Monthly long-term bottom nitrate/nitrite nitrogen at river kilometer 23.6

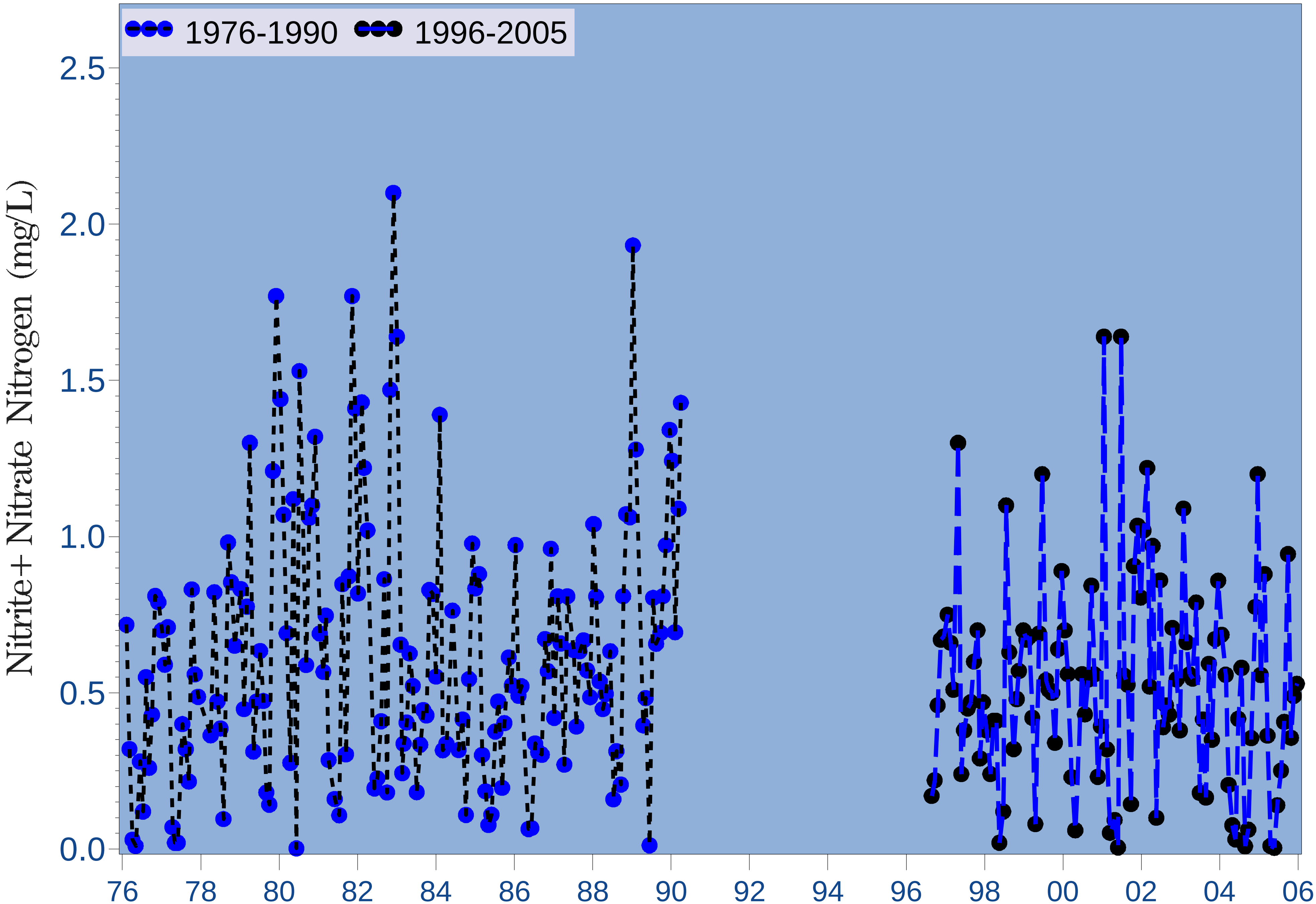


Figure 4.21e Monthly long-term bottom nitrate/nitrite nitrogen at river kilometer 30.4

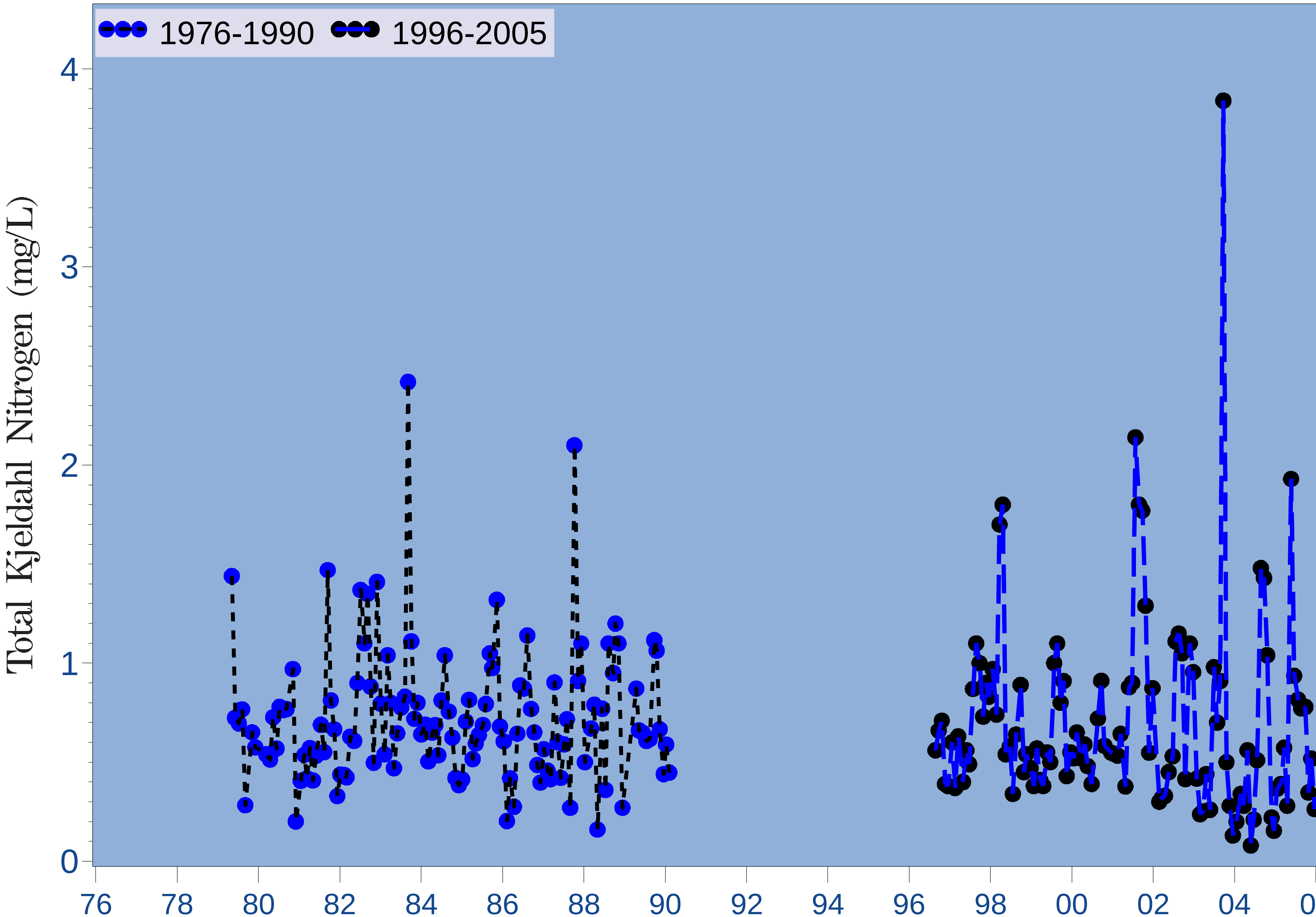


Figure 4.22a Monthly long-term surface total Kjeldahl nitrogen at river kilometer -2.4

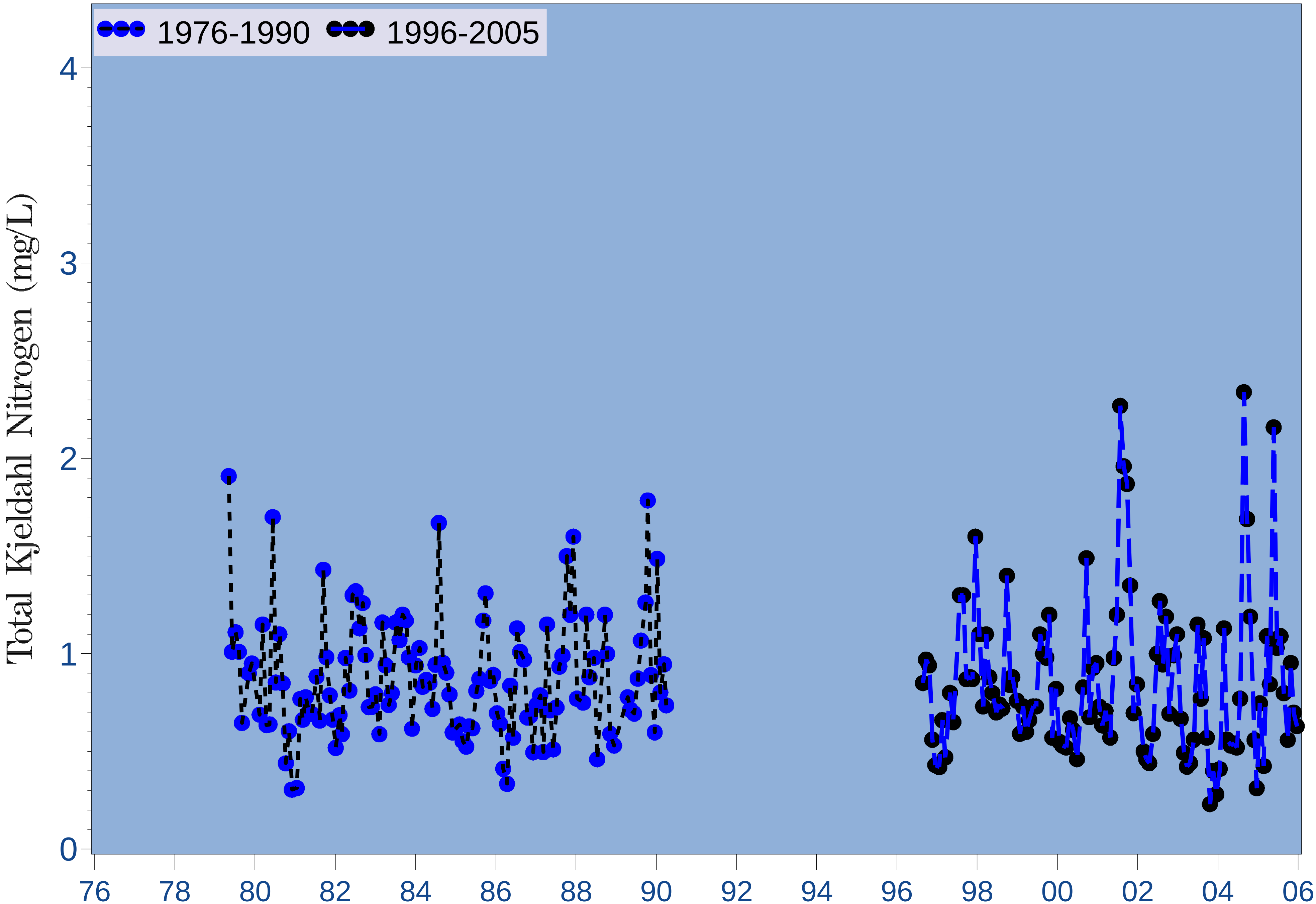


Figure 4.22b Monthly long-term surface total Kjeldahl nitrogen at river kilometer 6.6

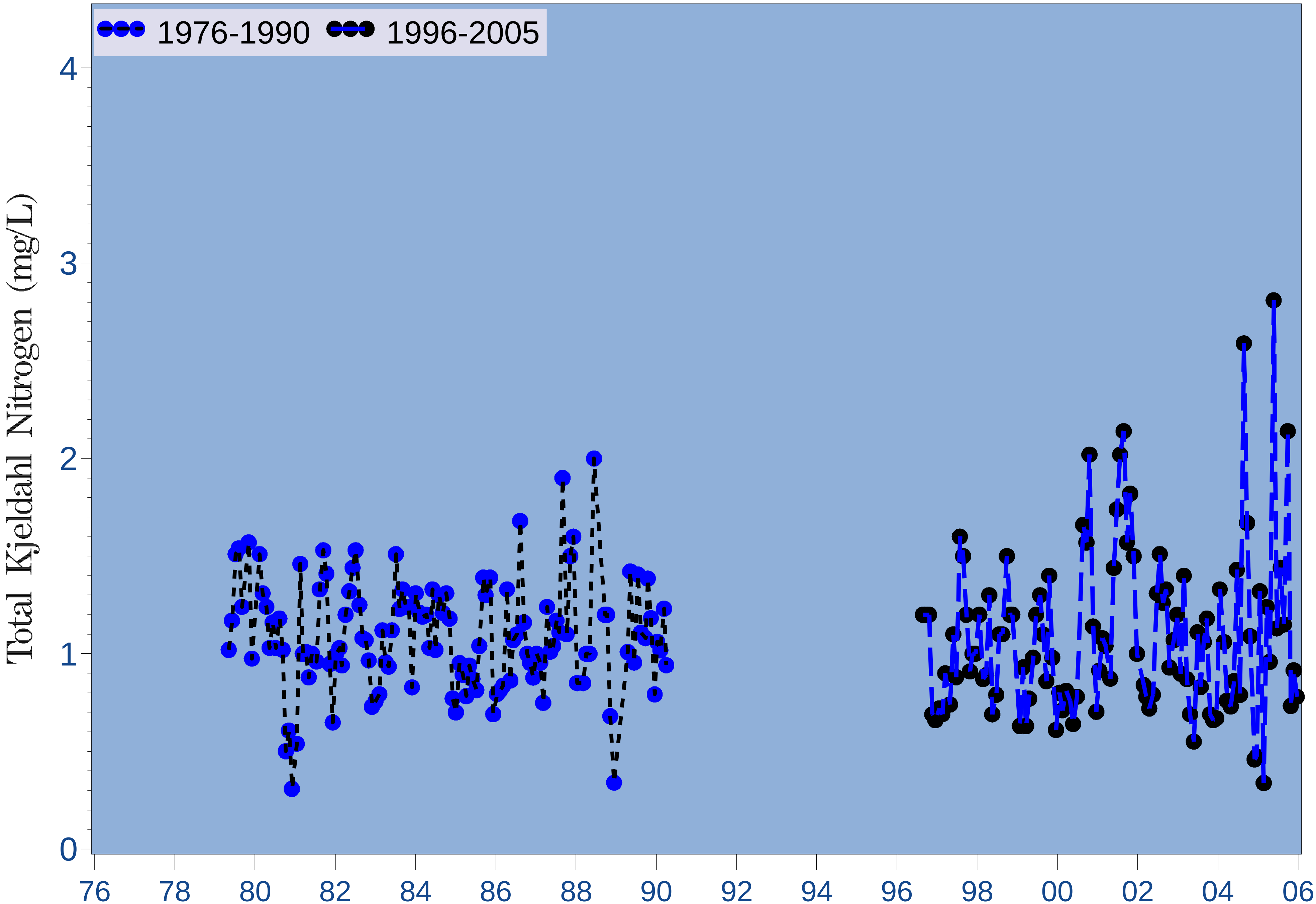


Figure 4.22c Monthly long-term surface total Kjeldahl nitrogen at river kilometer 15.5

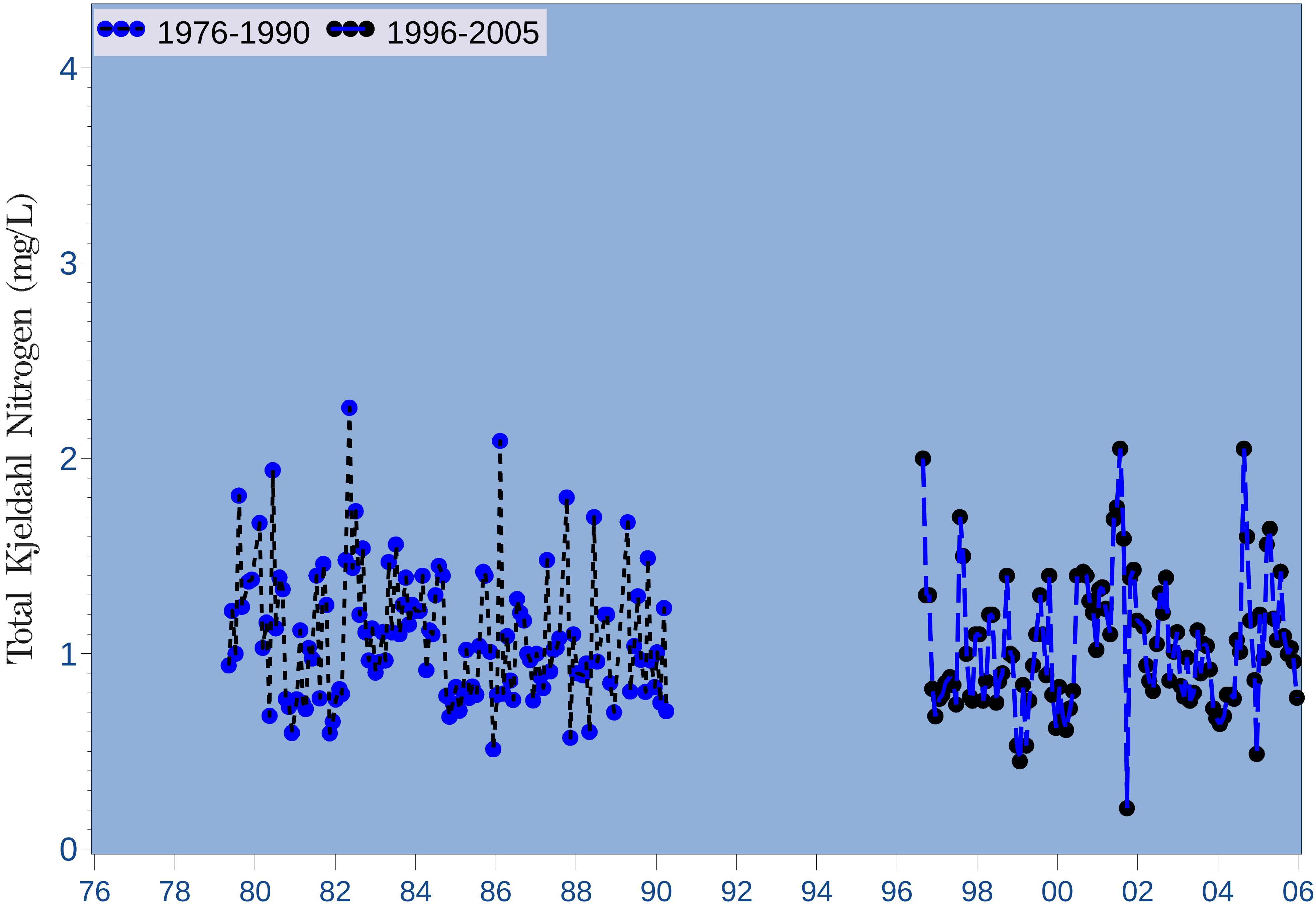


Figure 4.22d Monthly long-term surface total Kjeldahl nitrogen at river kilometer 23.6

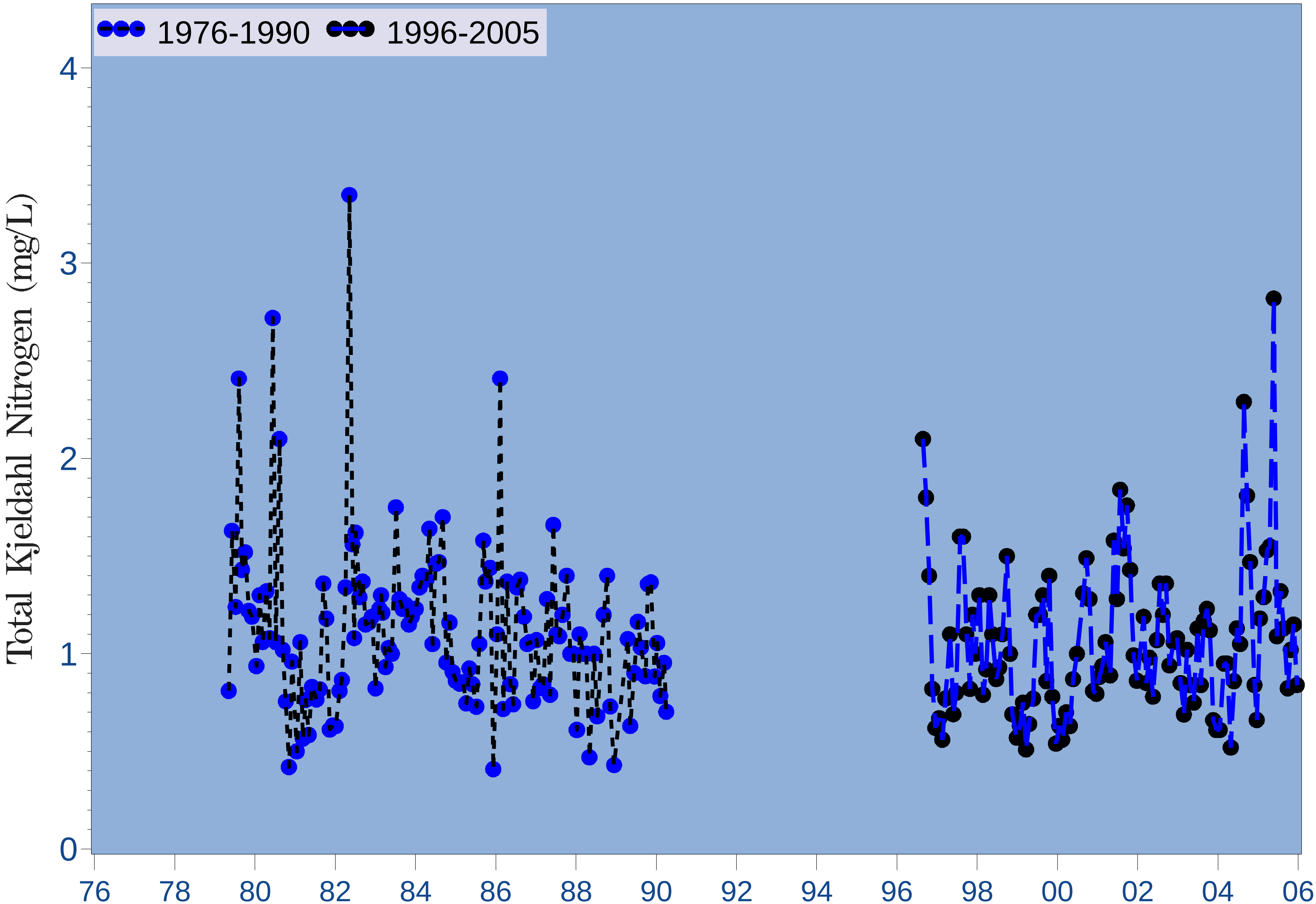


Figure 4.22e Monthly long-term surface total Kjeldahl nitrogen at river kilometer 30.4

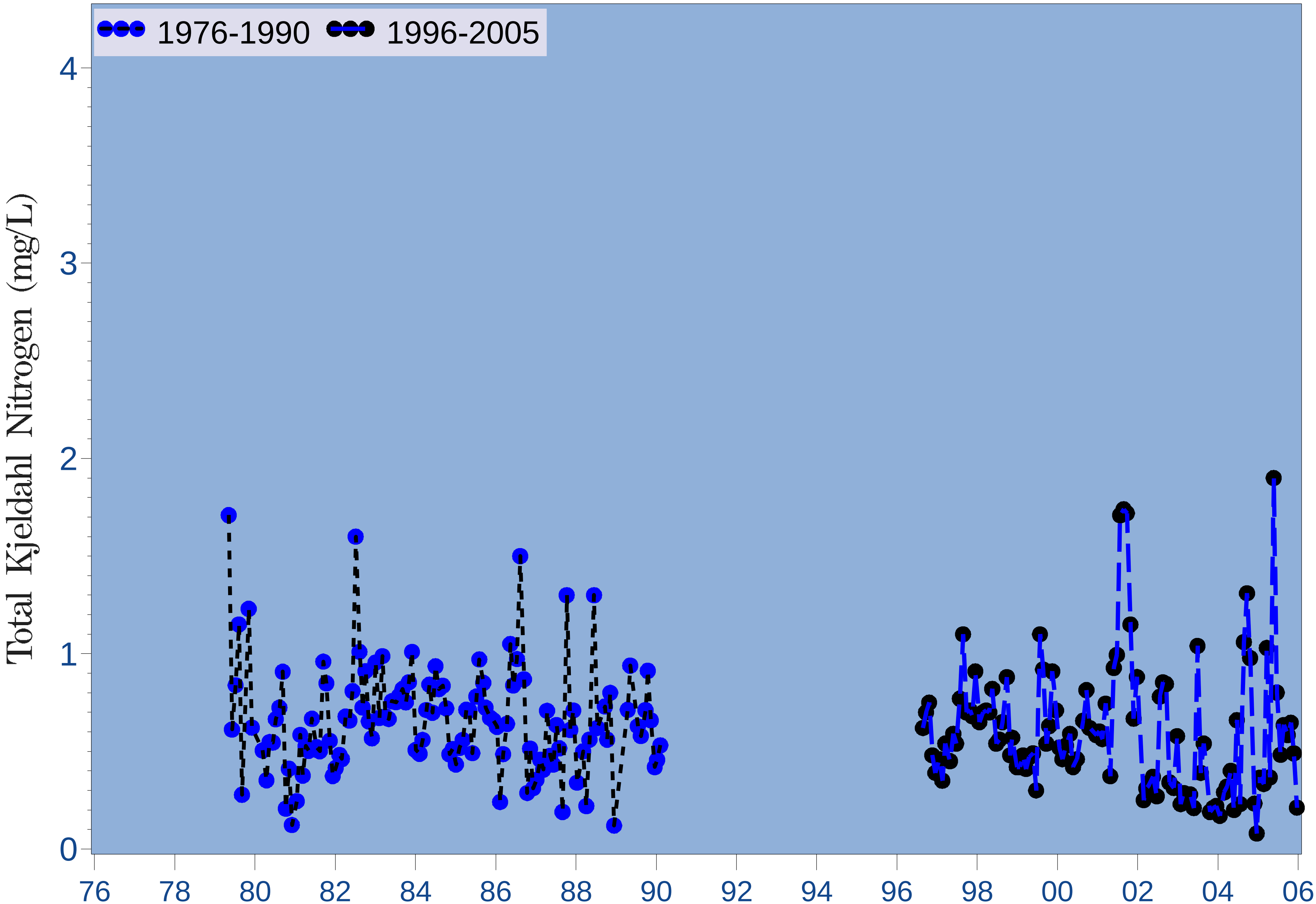


Figure 4.23a Monthly long-term bottom total Kjeldhal nitrogen at river kilometer -2.4

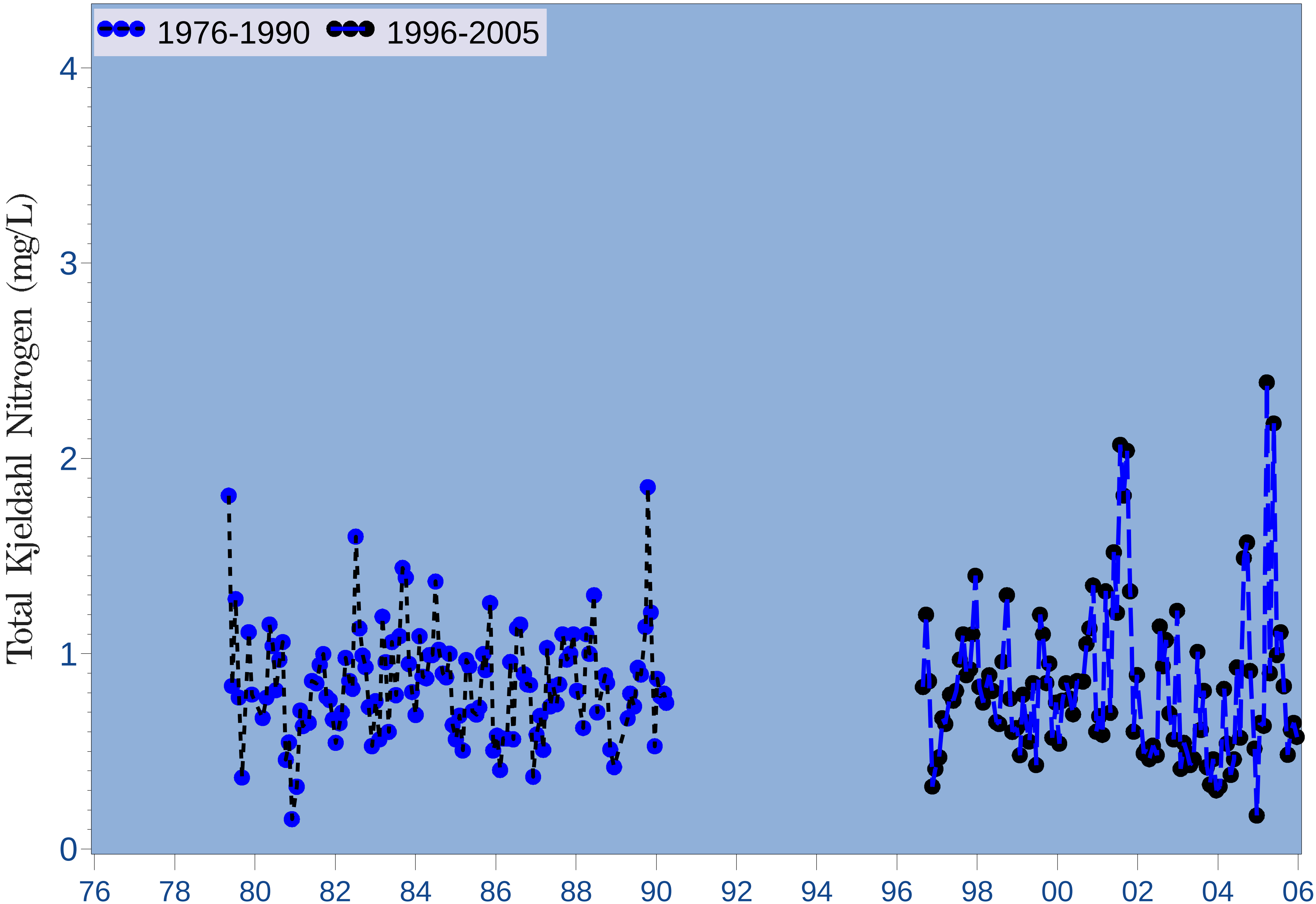


Figure 4.23b Monthly long-term bottom total Kjeldhal nitrogen at river kilometer 6.6

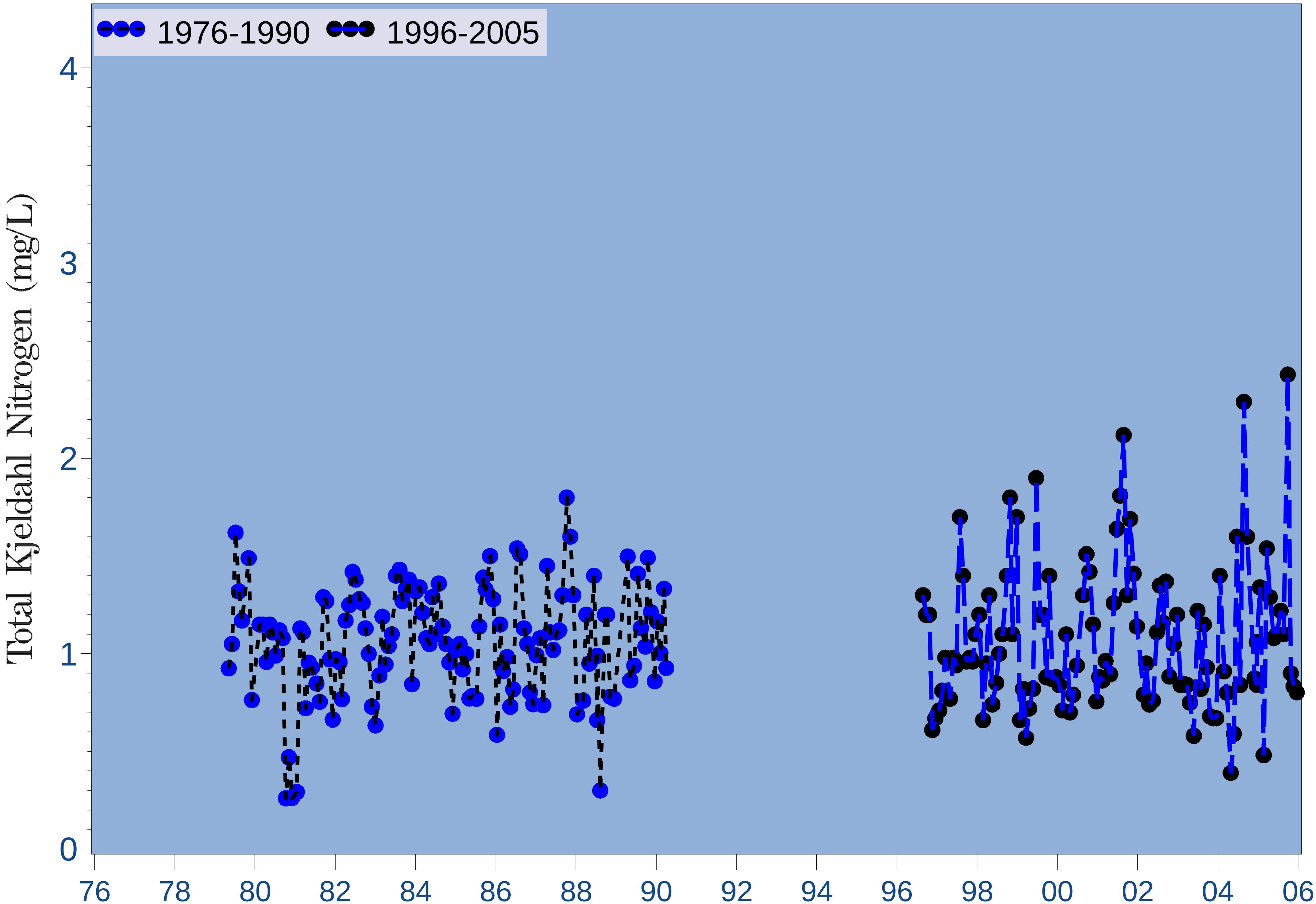


Figure 4.23c Monthly long-term bottom total Kjeldhal nitrogen at river kilometer 15.5

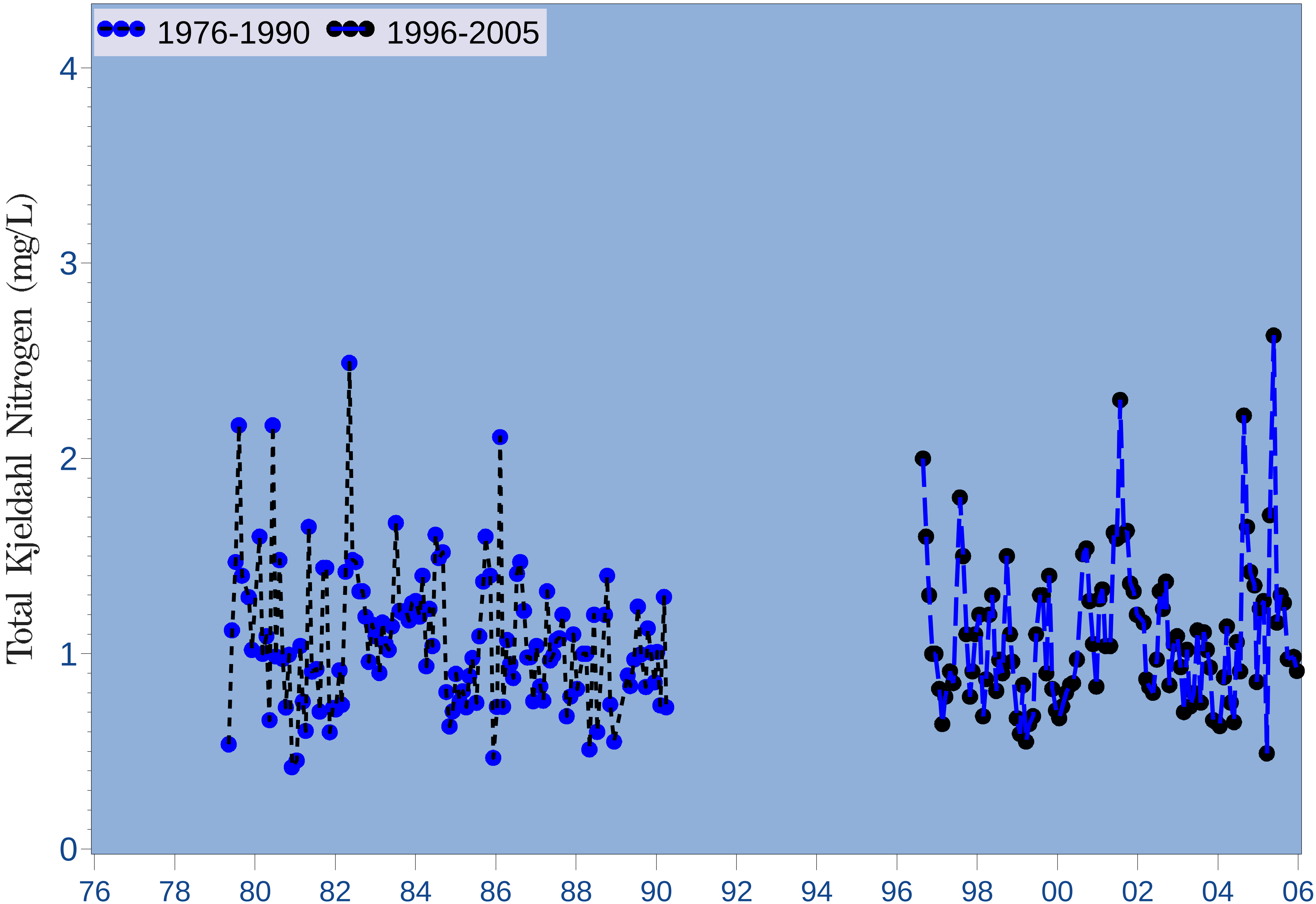


Figure 4.23d Monthly long-term bottom total Kjeldhal nitrogen at river kilometer 23.6

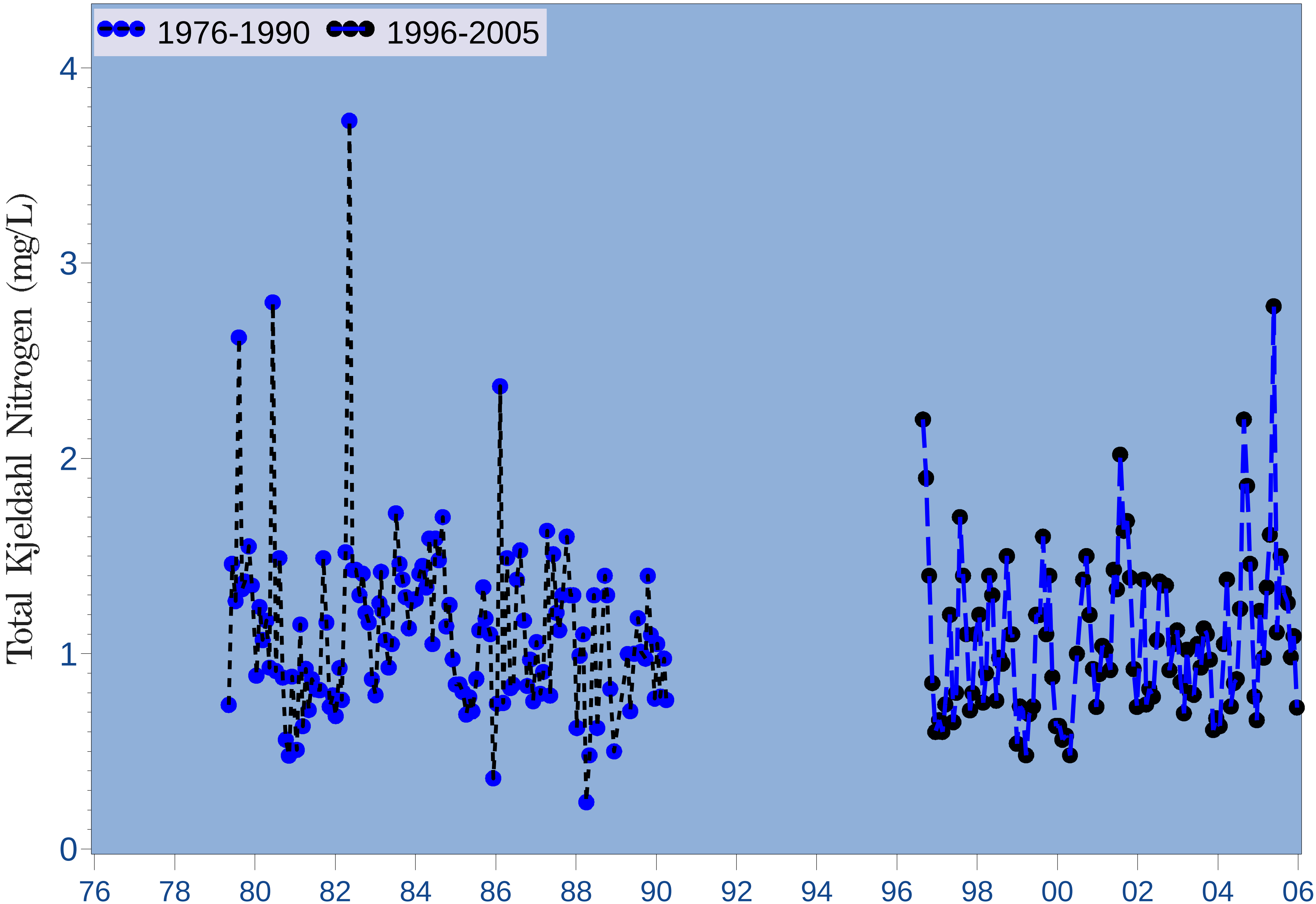


Figure 4.23e Monthly long-term bottom total Kjeldhal nitrogen at river kilometer 30.4

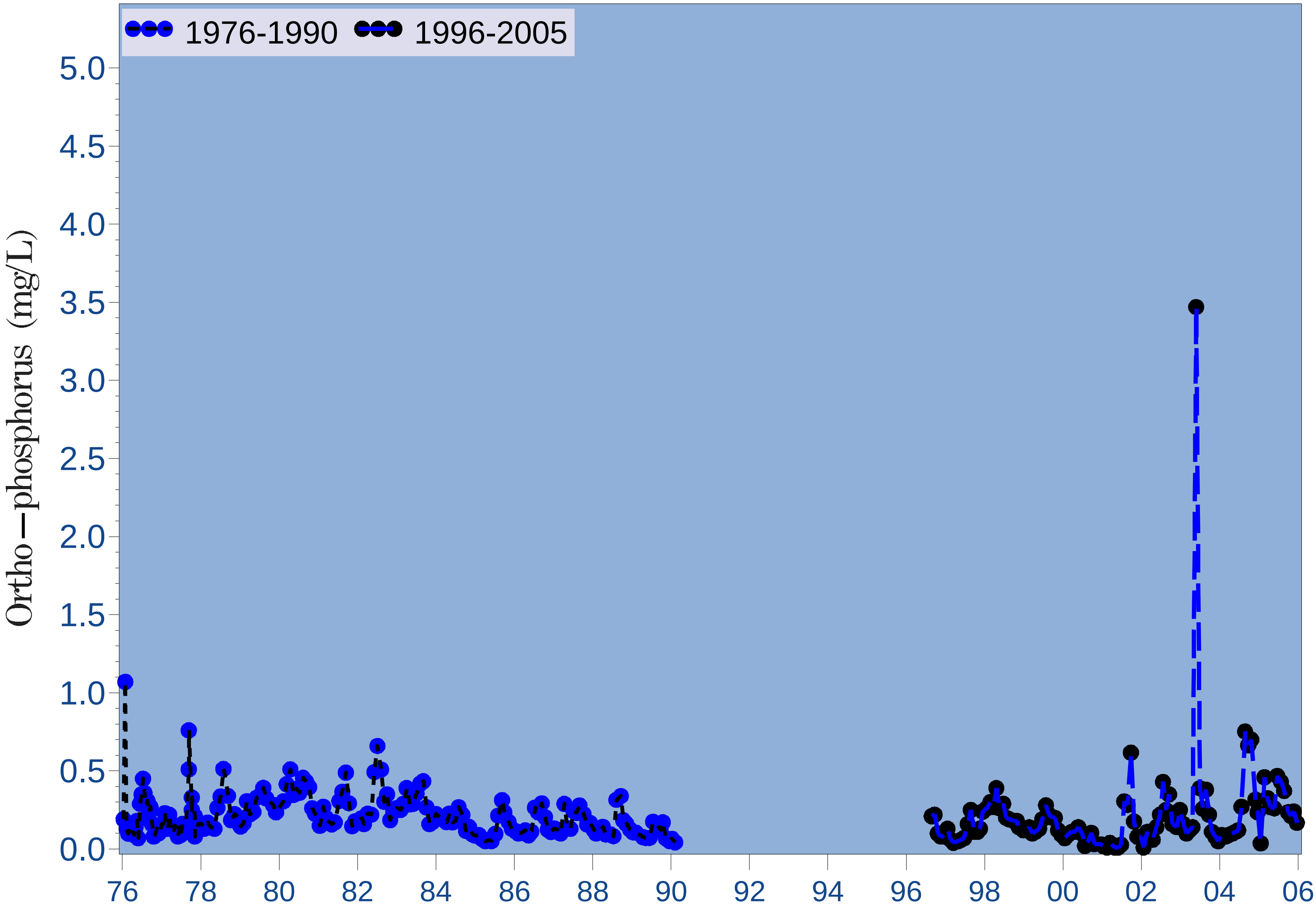


Figure 4.24a Monthly long-term surface ortho-phosphorus at river kilometer -2.4

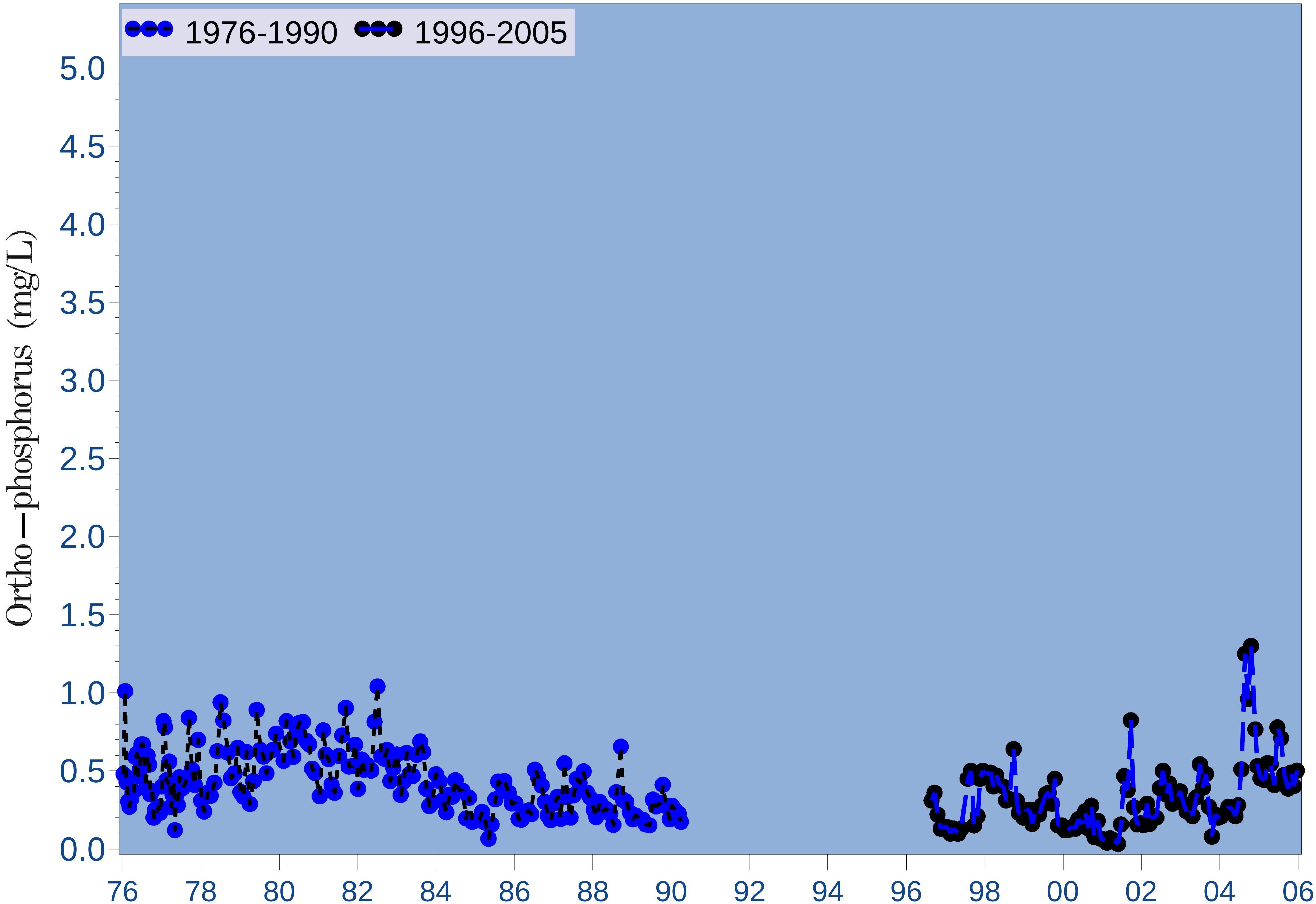


Figure 4.24b Monthly long-term surface ortho-phosphorus at river kilometer 6.6

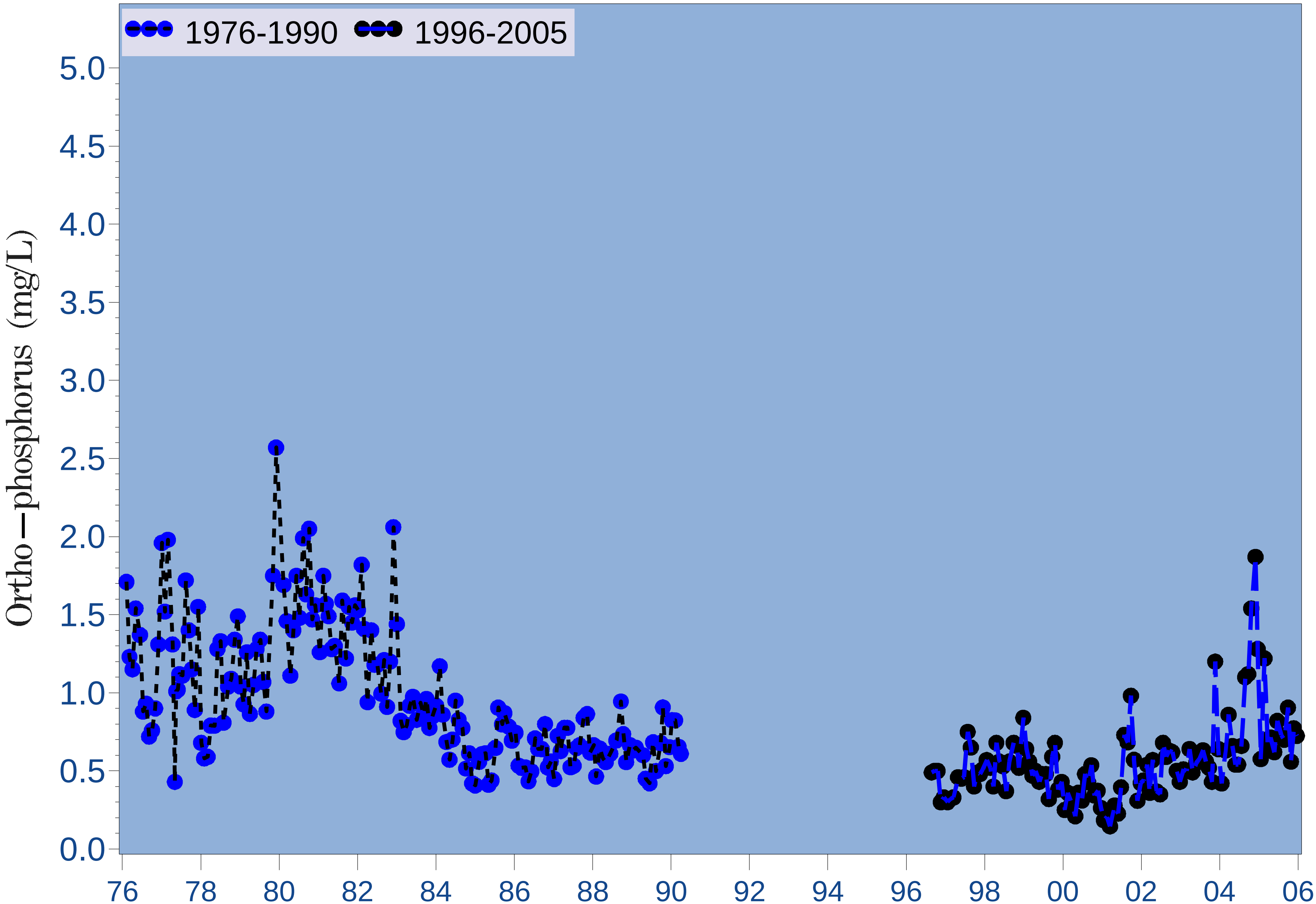


Figure 4.24c Monthly long-term surface ortho-phosphorus at river kilometer 15.5

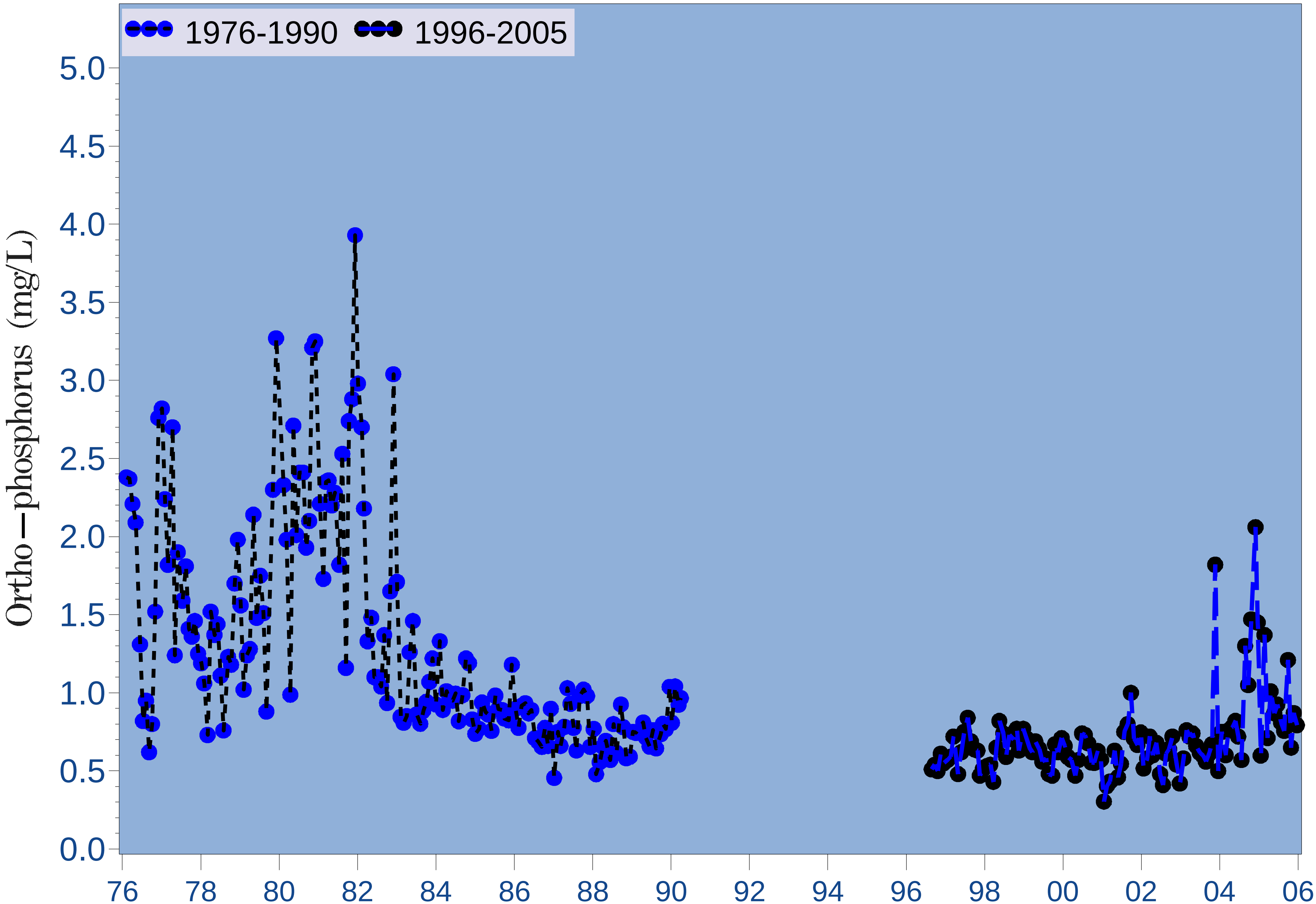


Figure 4.24d Monthly long-term surface ortho-phosphorus at river kilometer 23.6

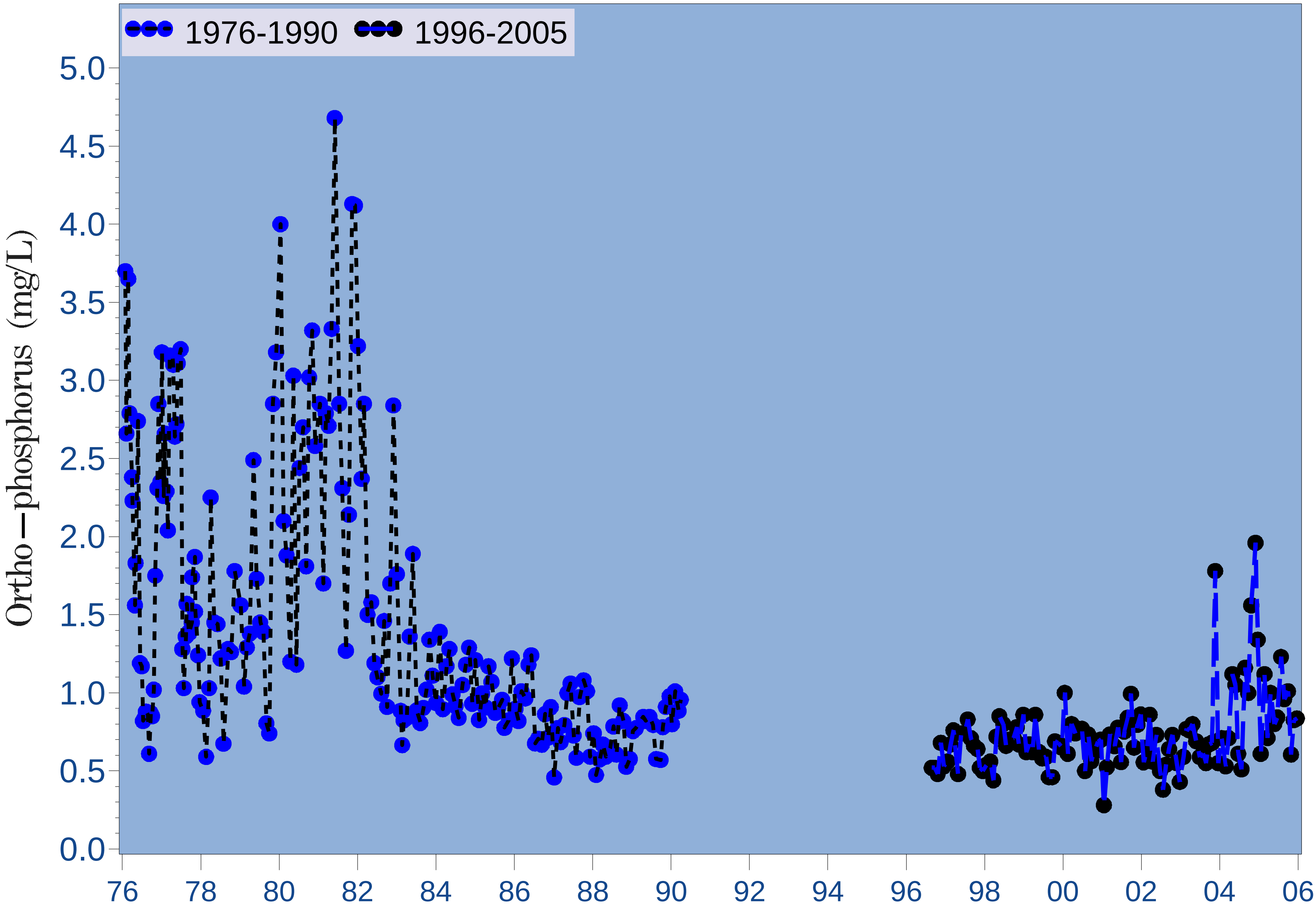


Figure 4.24e Monthly long-term surface ortho-phosphorus at river kilometer 30.4

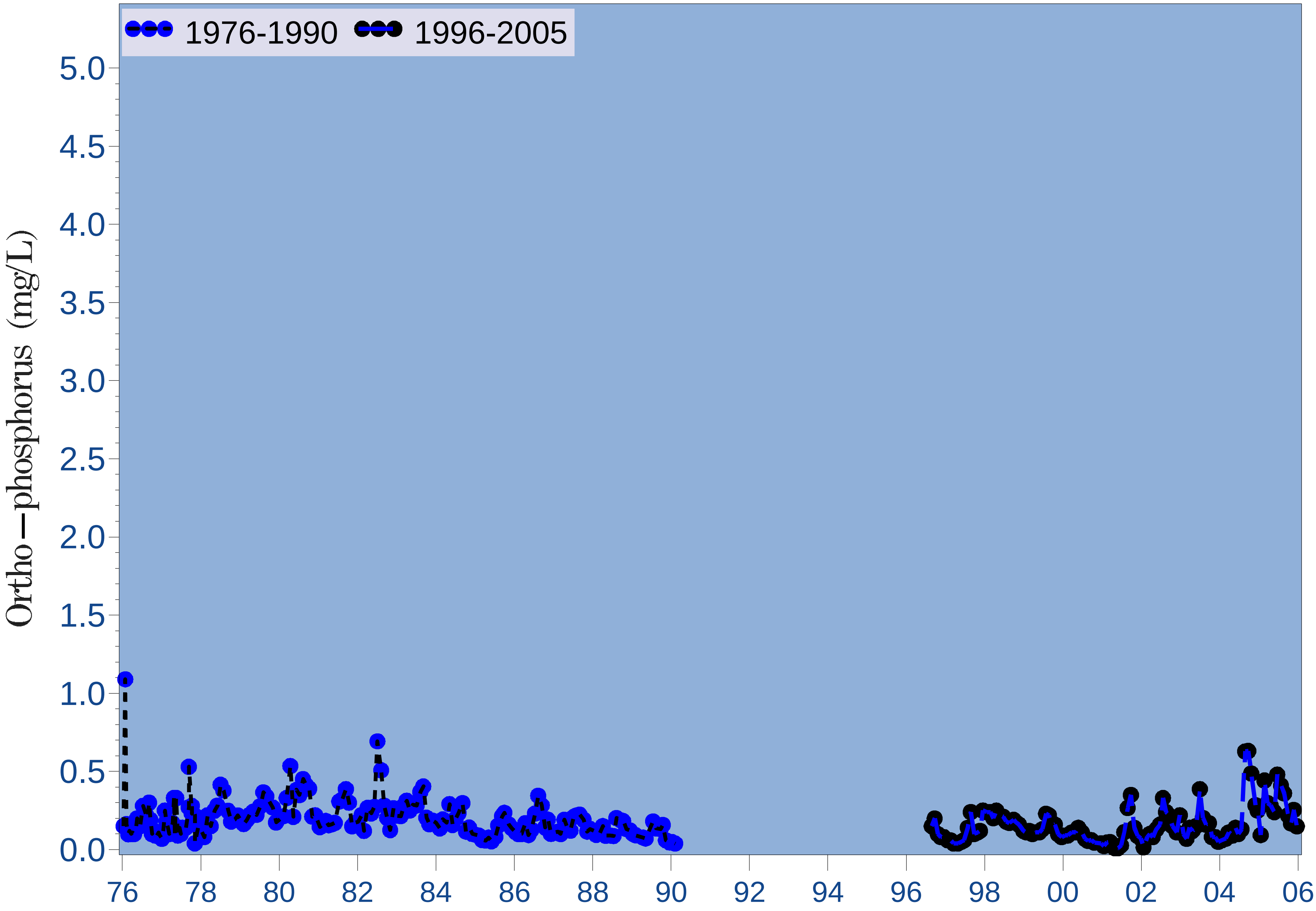


Figure 4.25a Monthly long-term bottom ortho-phosphorus at river kilometer -2.4

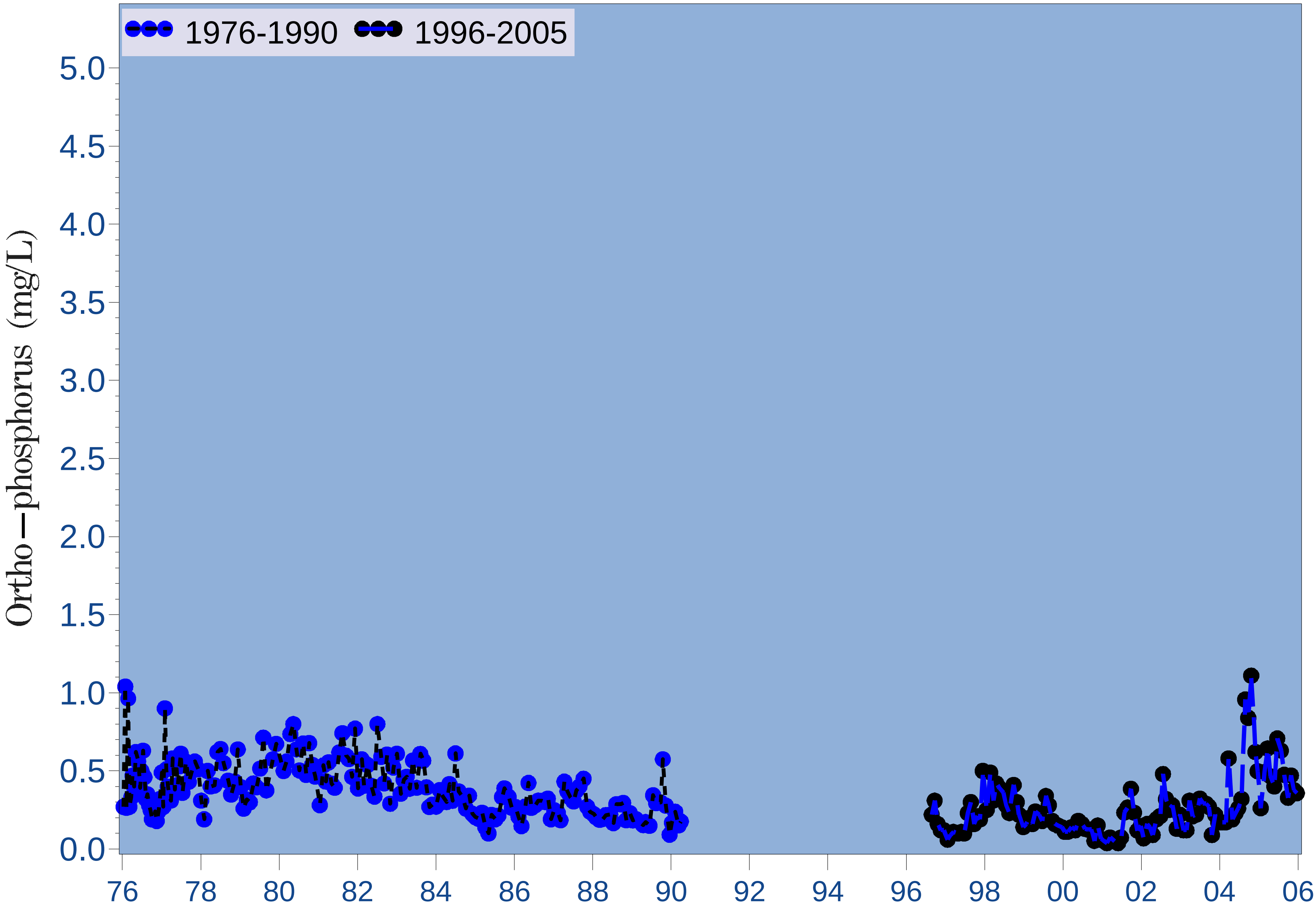


Figure 4.25b Monthly long-term bottom ortho-phosphorus at river kilometer 6.6

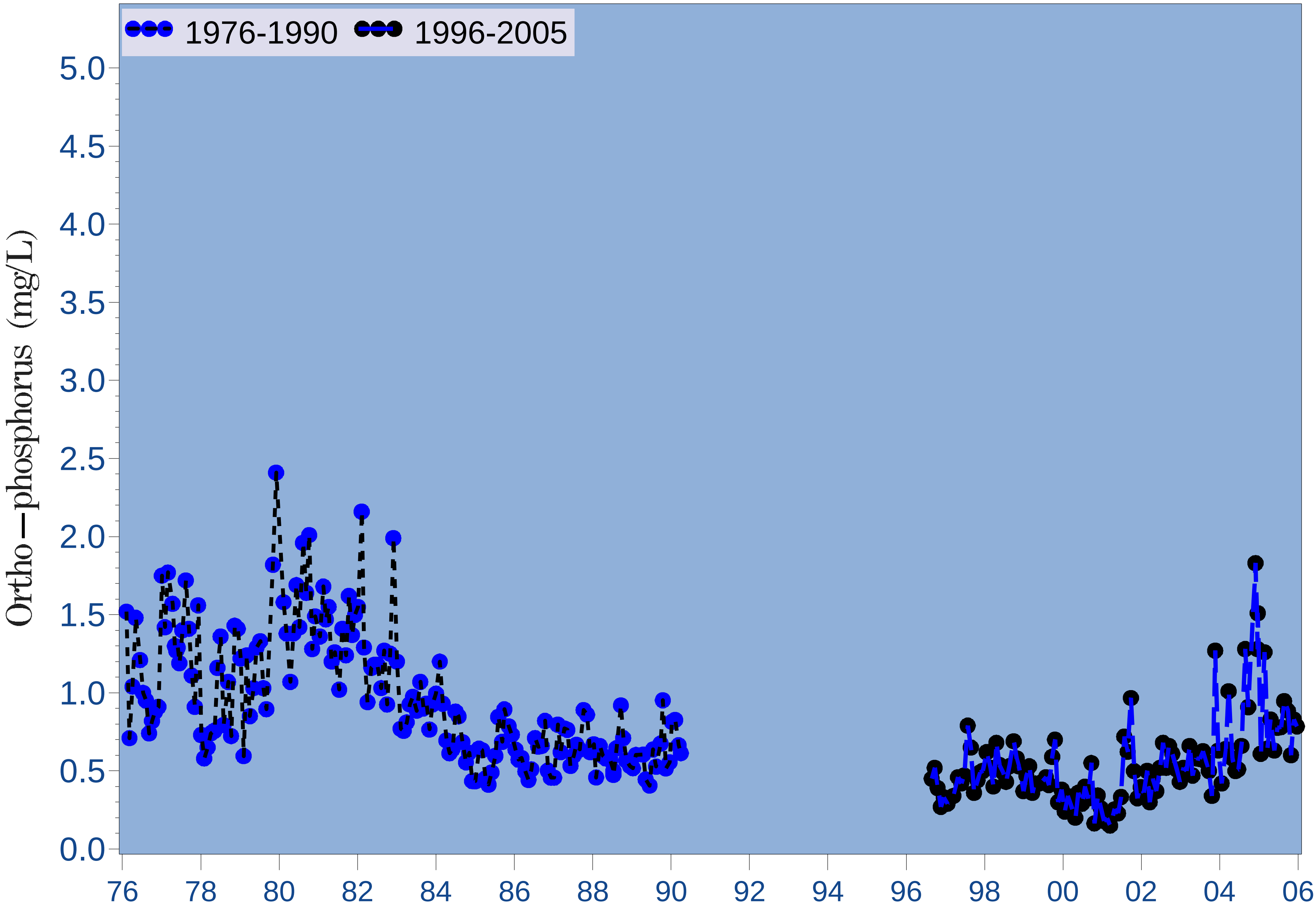


Figure 4.25c Monthly long-term bottom ortho-phosphorus at river kilometer 15.5

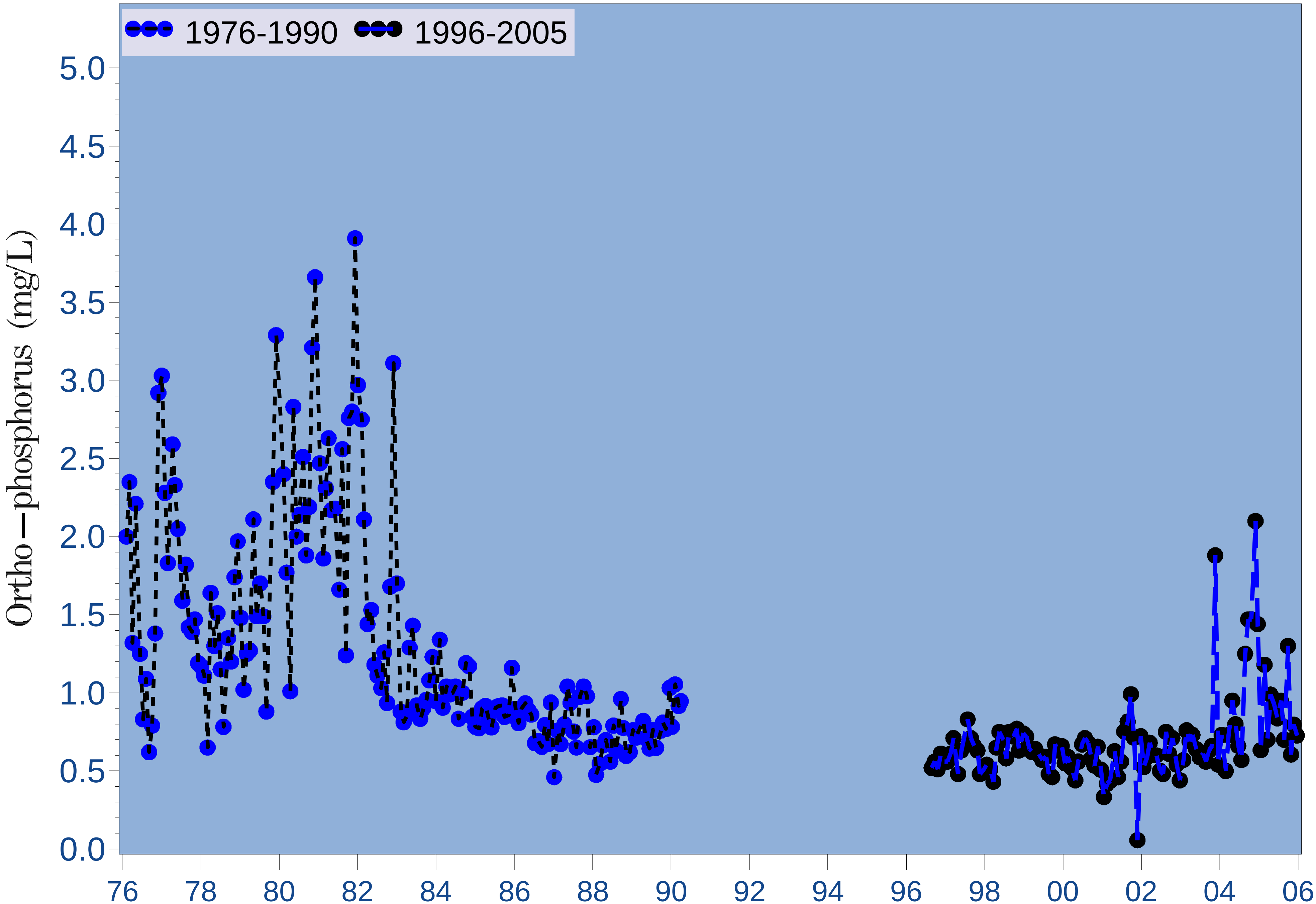


Figure 4.25d Monthly long-term bottom ortho-phosphorus at river kilometer 23.6

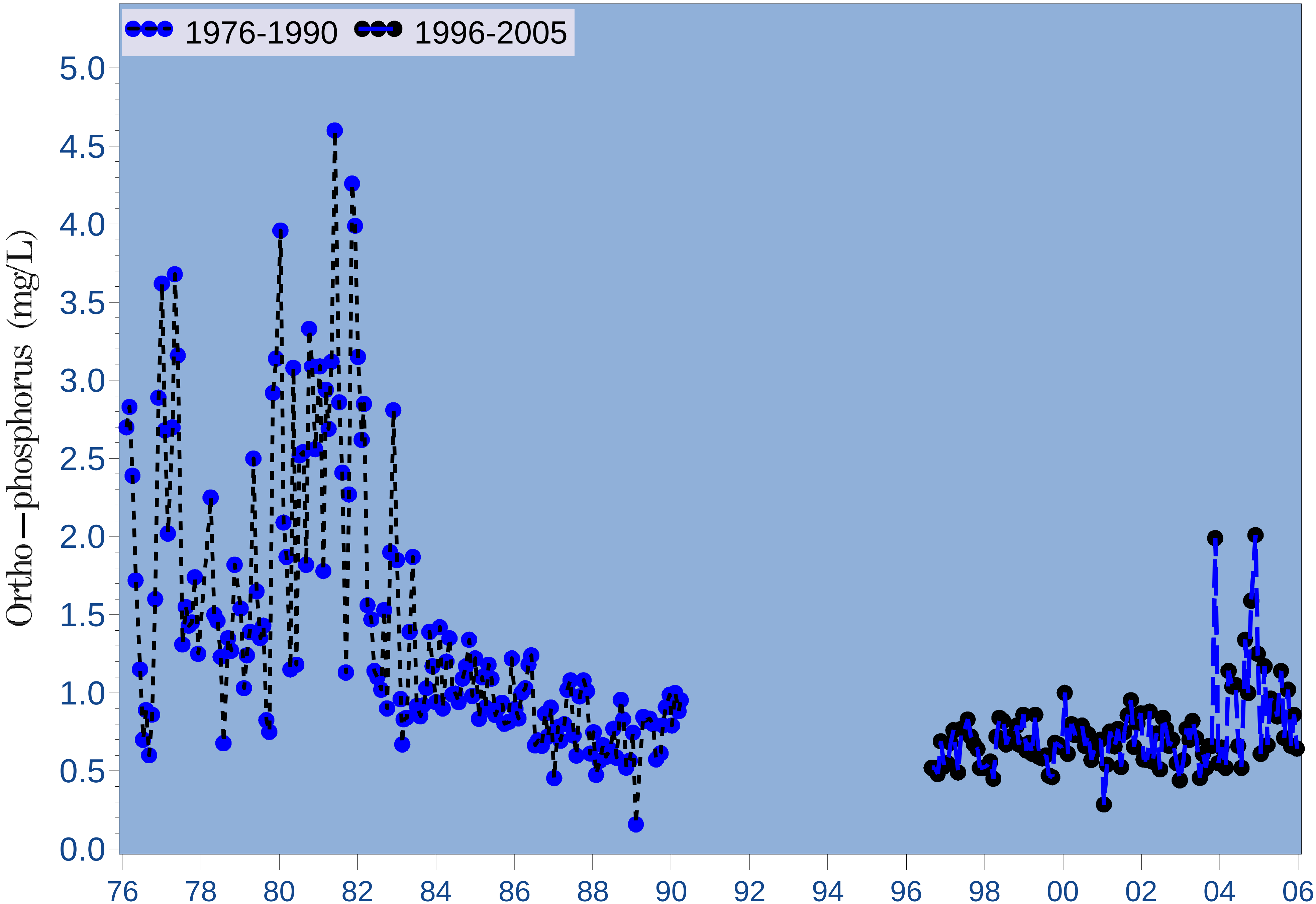


Figure 4.25e Monthly long-term bottom ortho-phosphorus at river kilometer 30.4

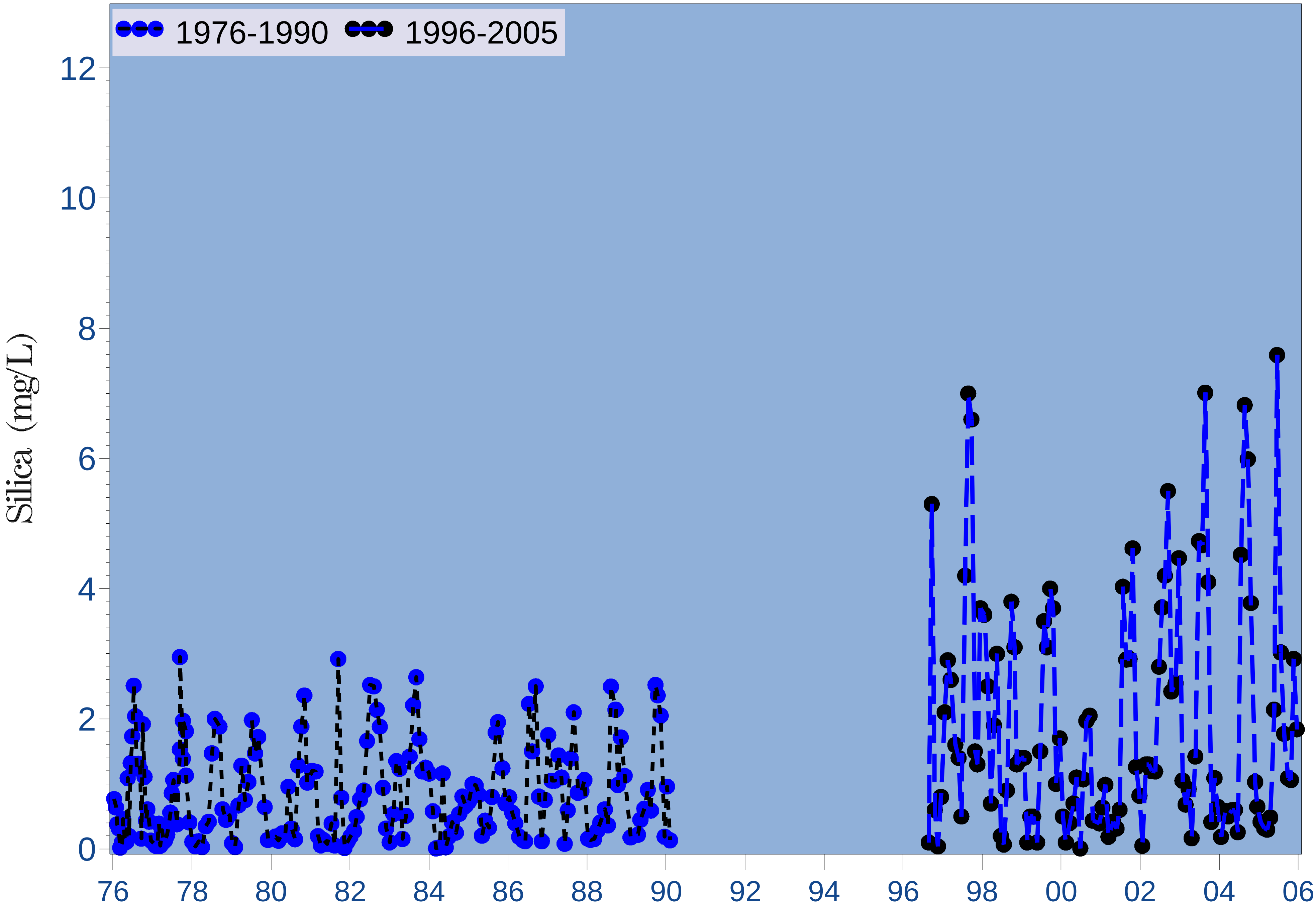


Figure 4.26a Monthly long-term surface silica at river kilometer -2.4

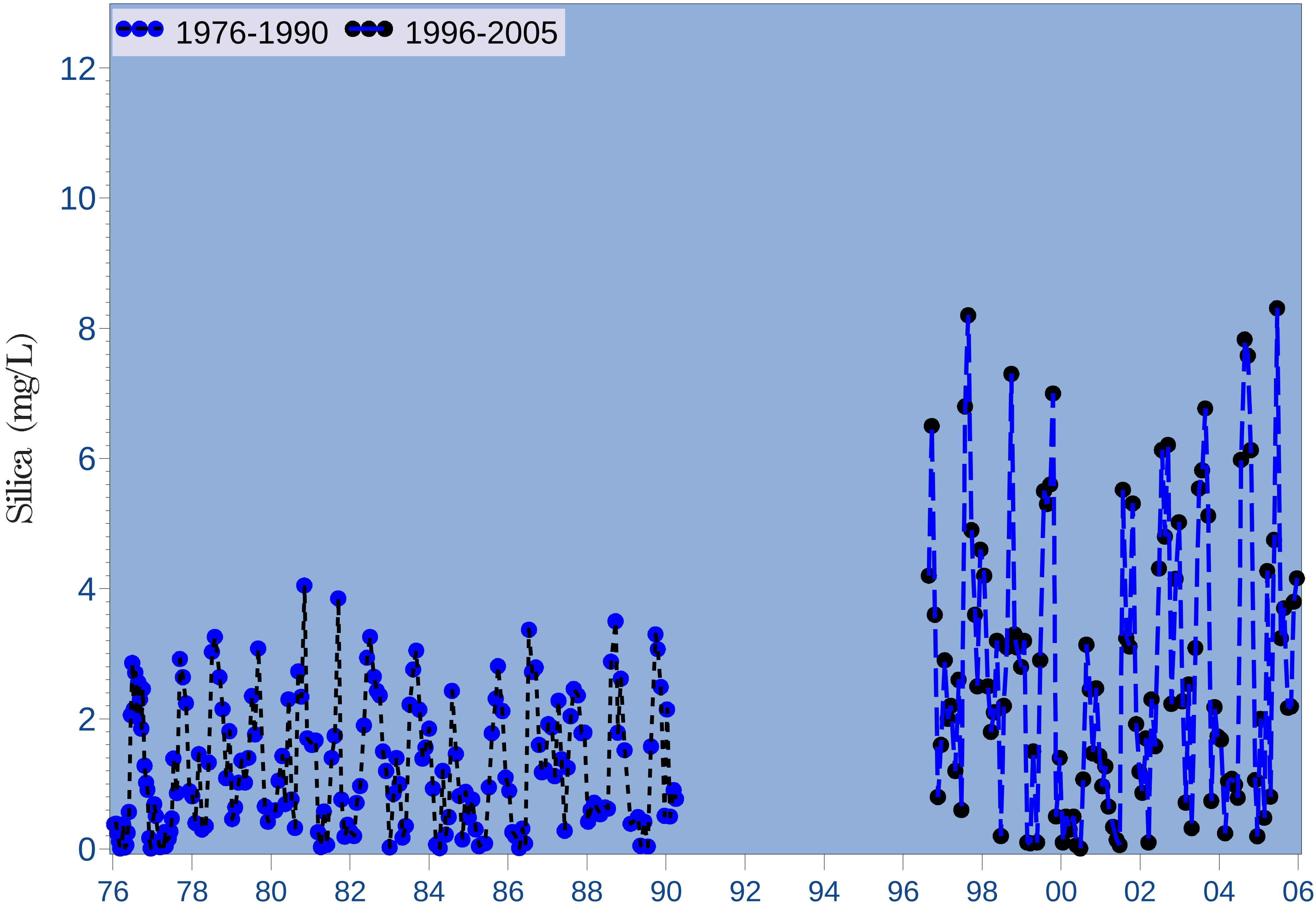


Figure 4.26b Monthly long-term surface silica at river kilometer 6.6

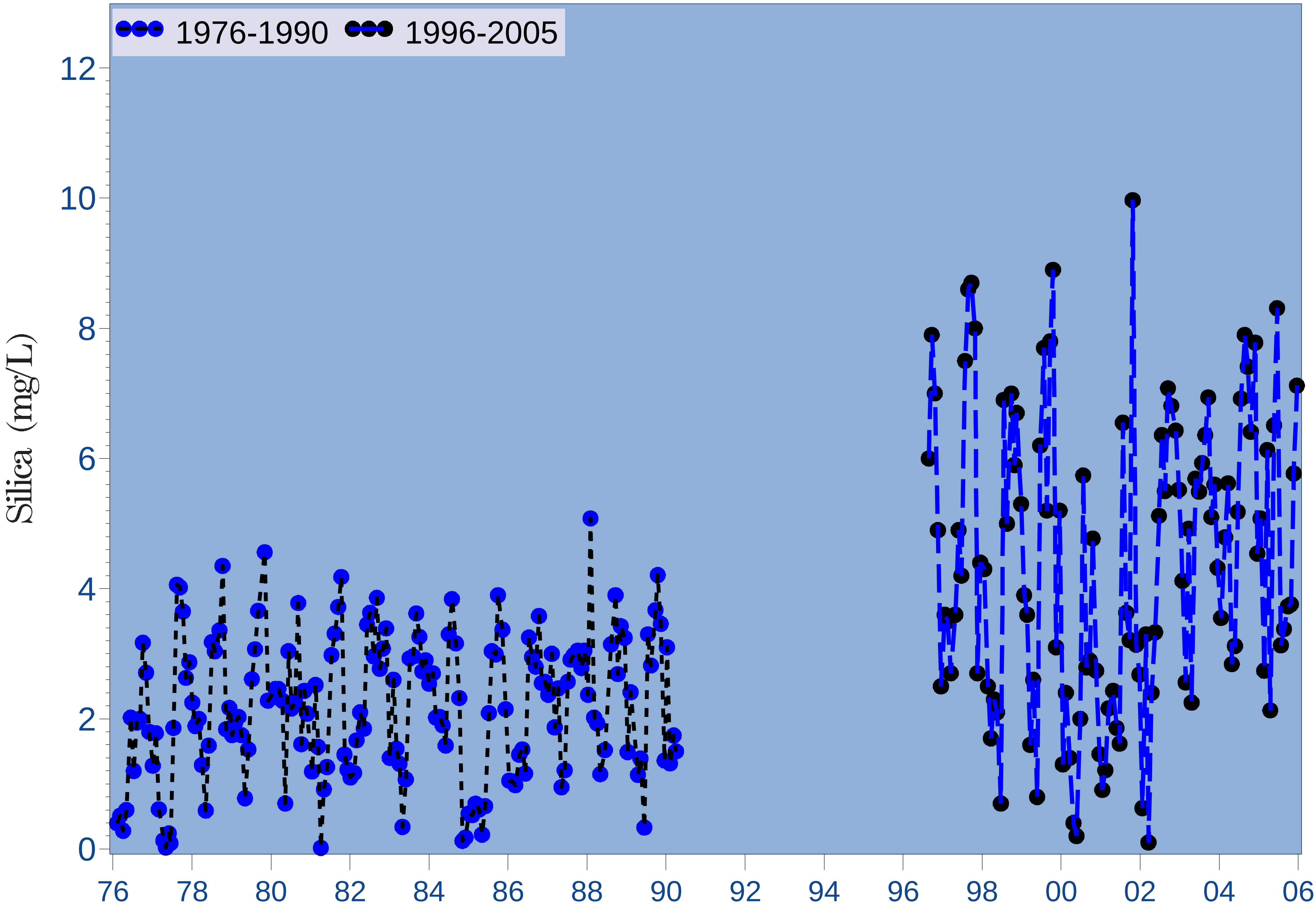


Figure 4.26c Monthly long-term surface silica at river kilometer 15.5

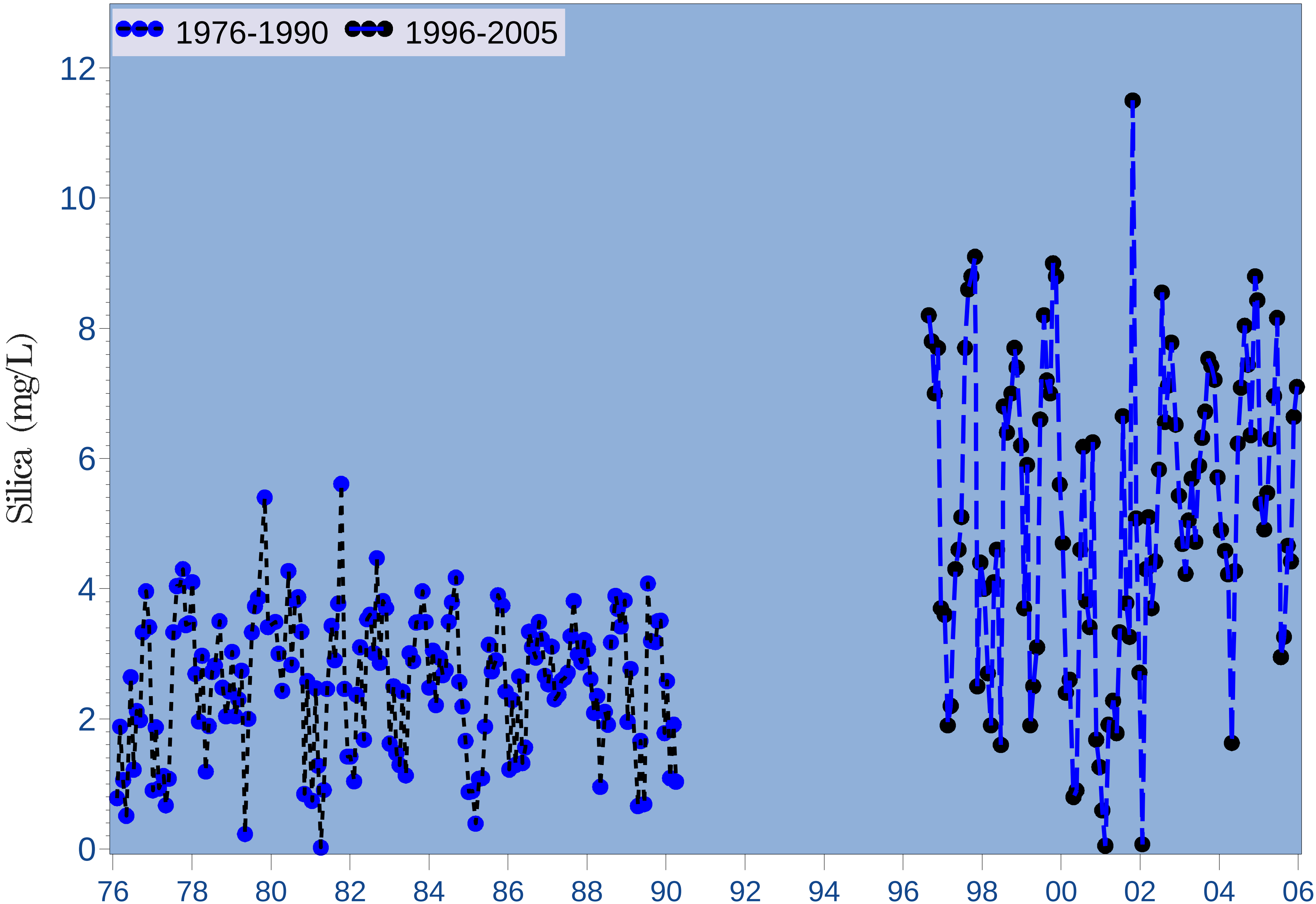


Figure 4.26d Monthly long-term surface silica at river kilometer 23.6

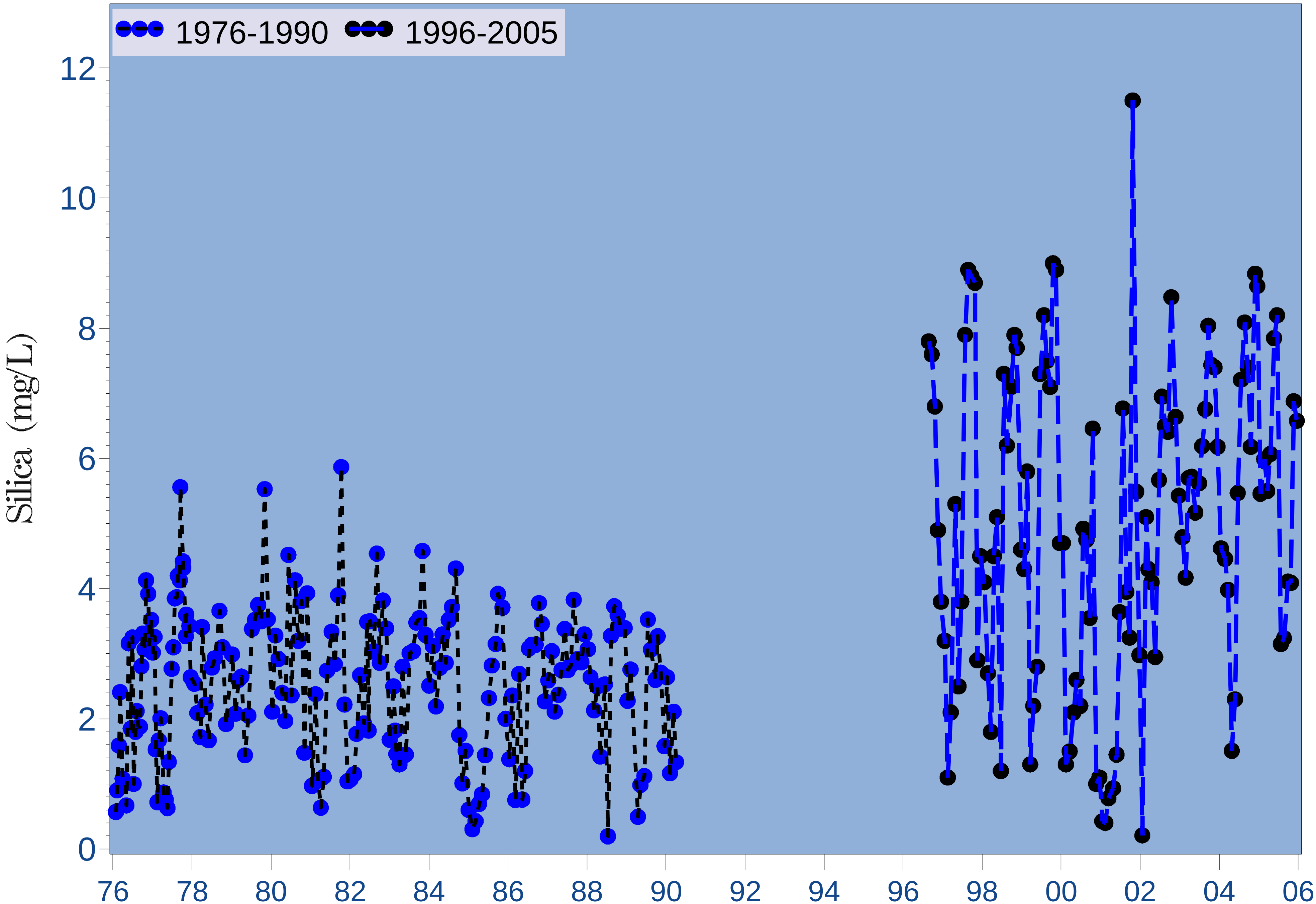


Figure 4.26e Monthly long-term surface silica at river kilometer 30.4

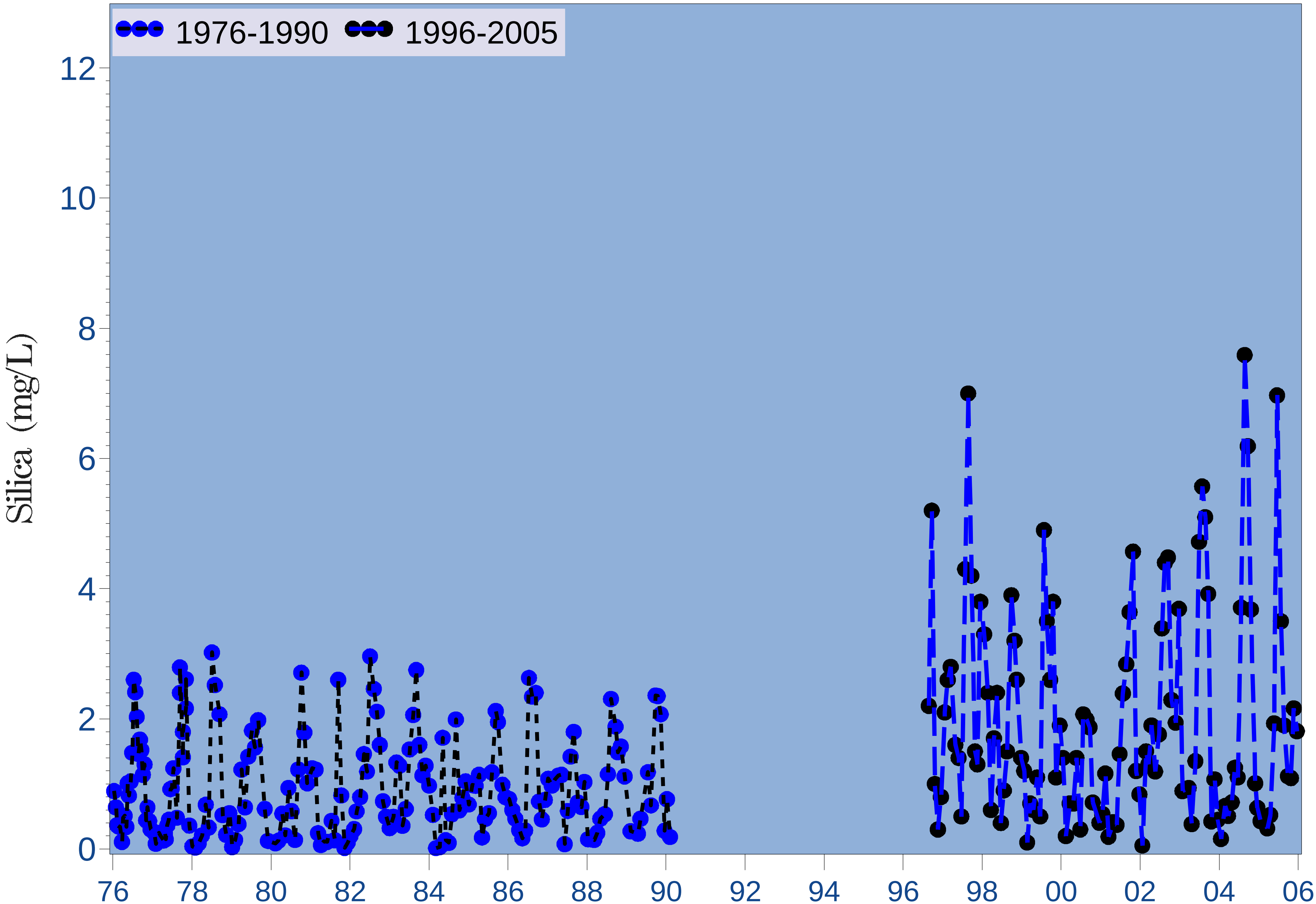


Figure 4.27a Monthly long-term bottom silica at river kilometer -2.4

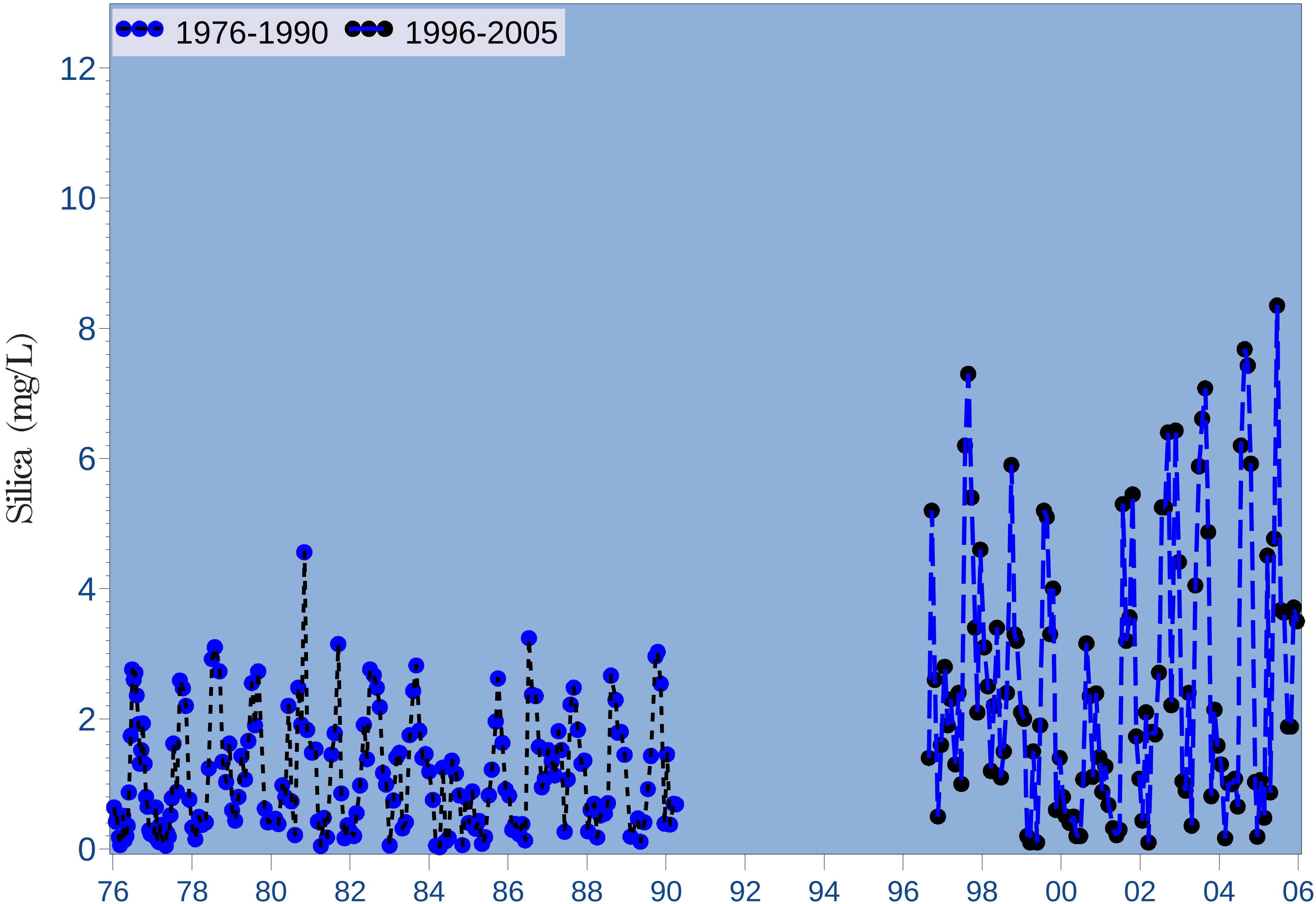


Figure 4.27b Monthly long-term bottom silica at river kilometer 6.6

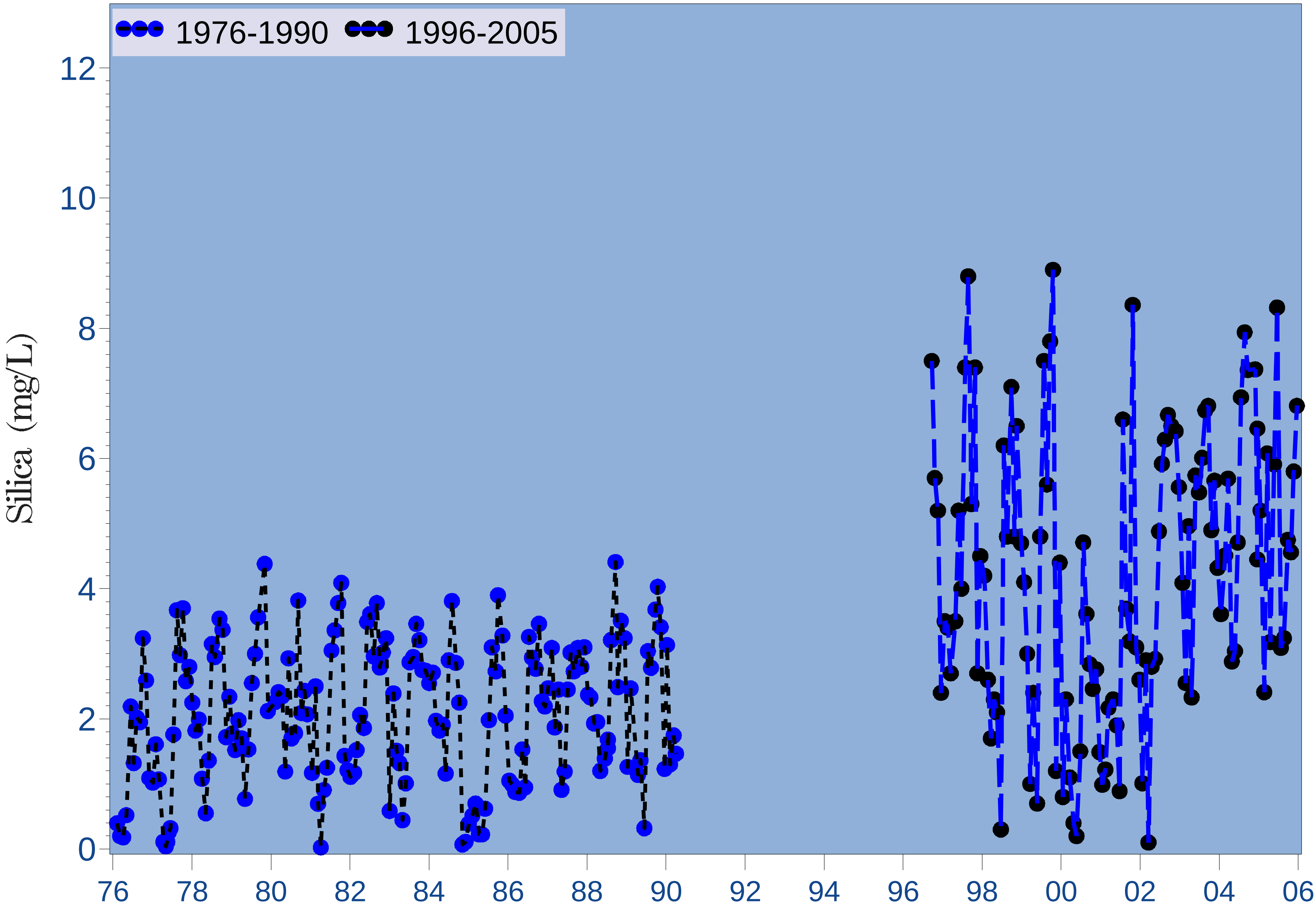


Figure 4.27c Monthly long-term bottom silica at river kilometer 15.5

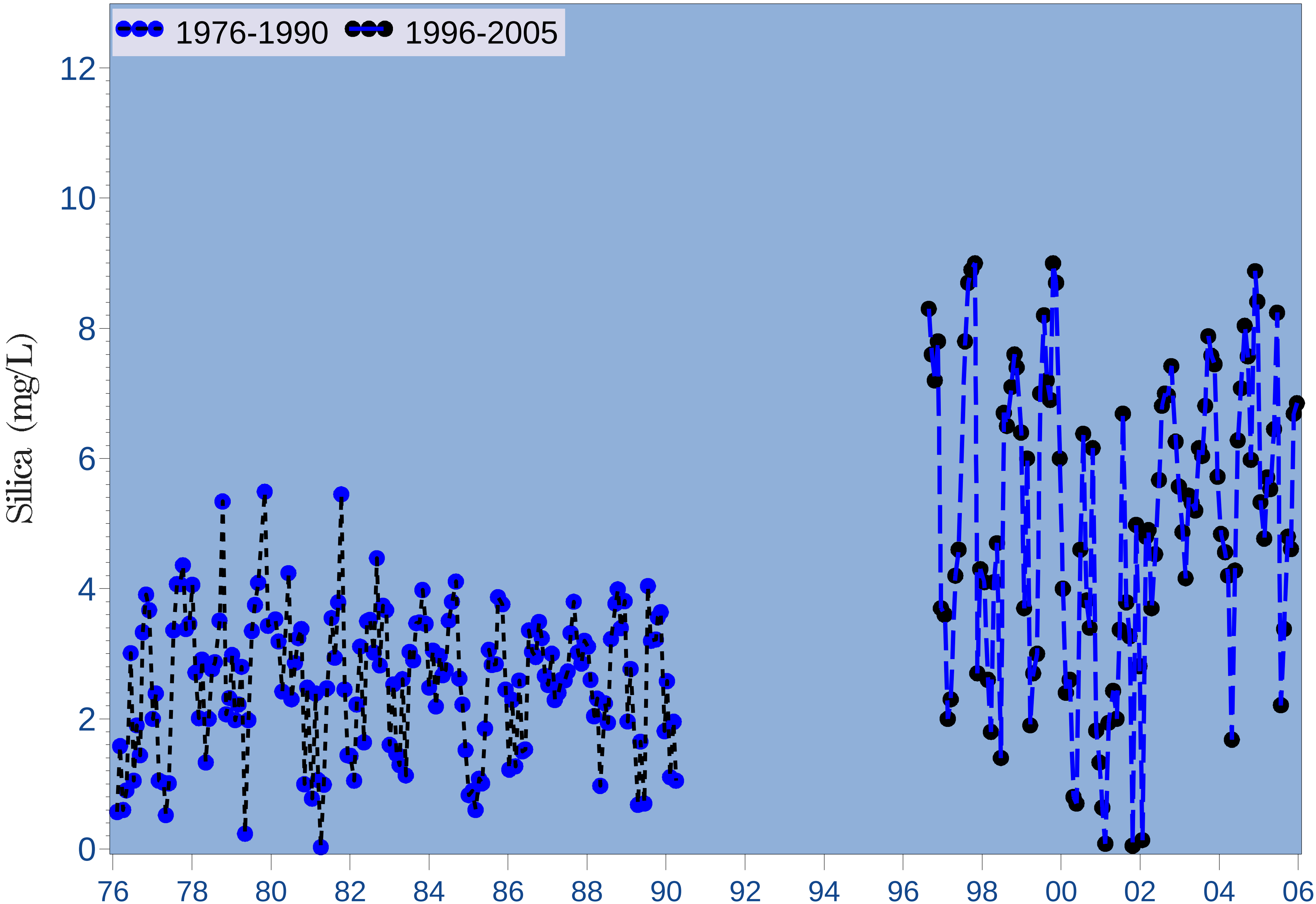


Figure 4.27d Monthly long-term bottom silica at river kilometer 23.6

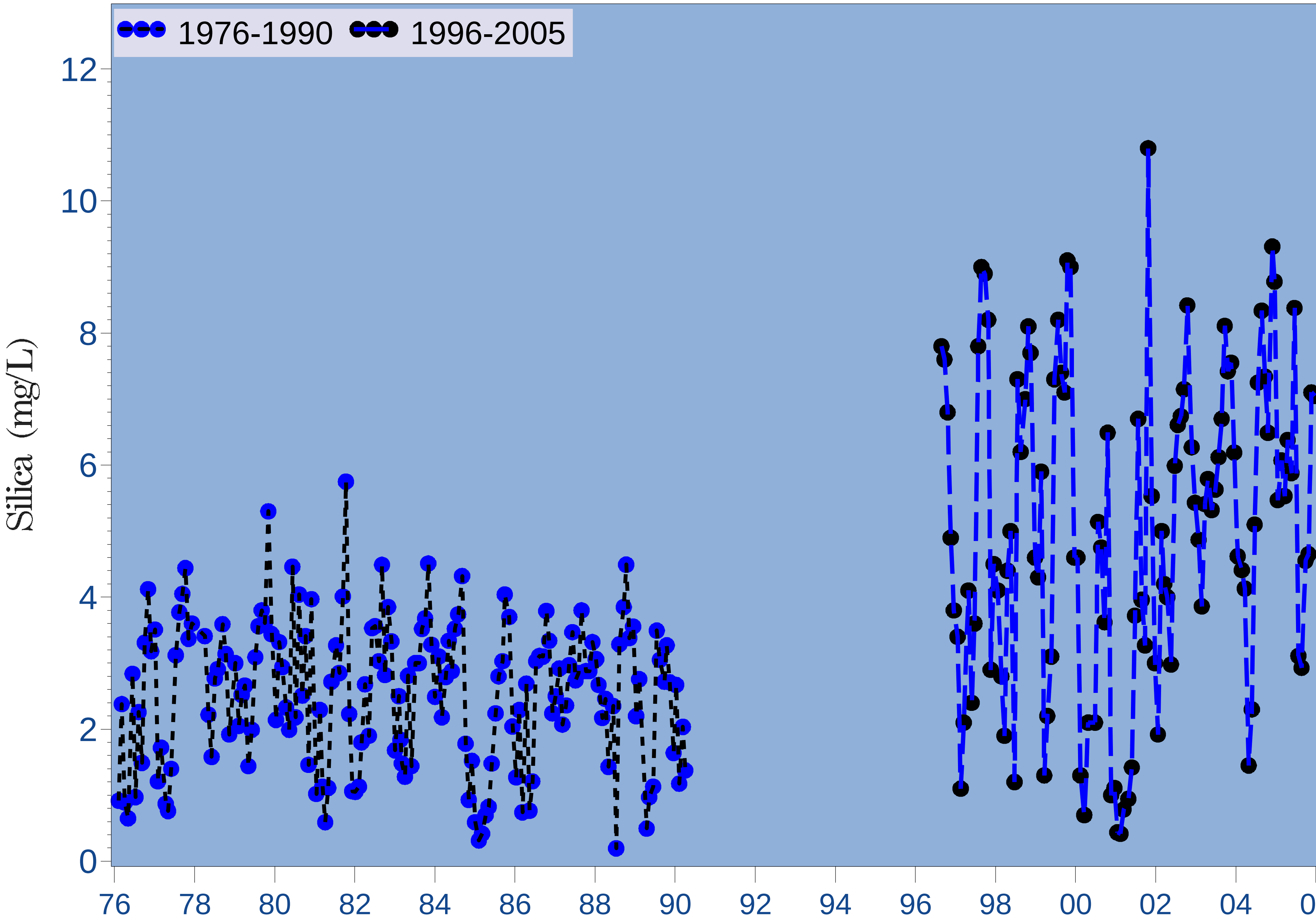


Figure 4.27e Monthly long-term bottom silica at river kilometer 30.4

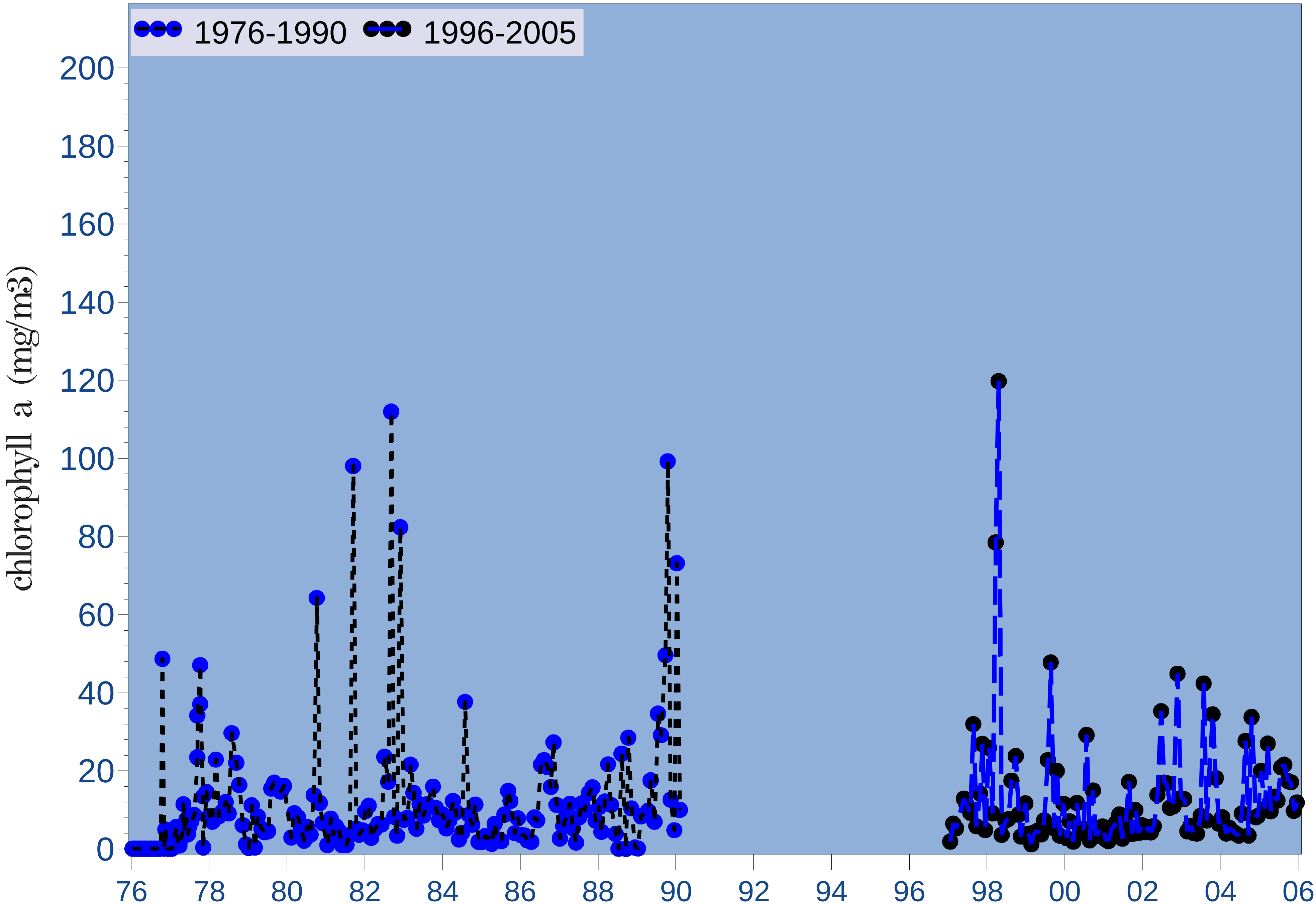


Figure 4.28a Monthly long-term surface chlorophyll a at river kilometer -2.4

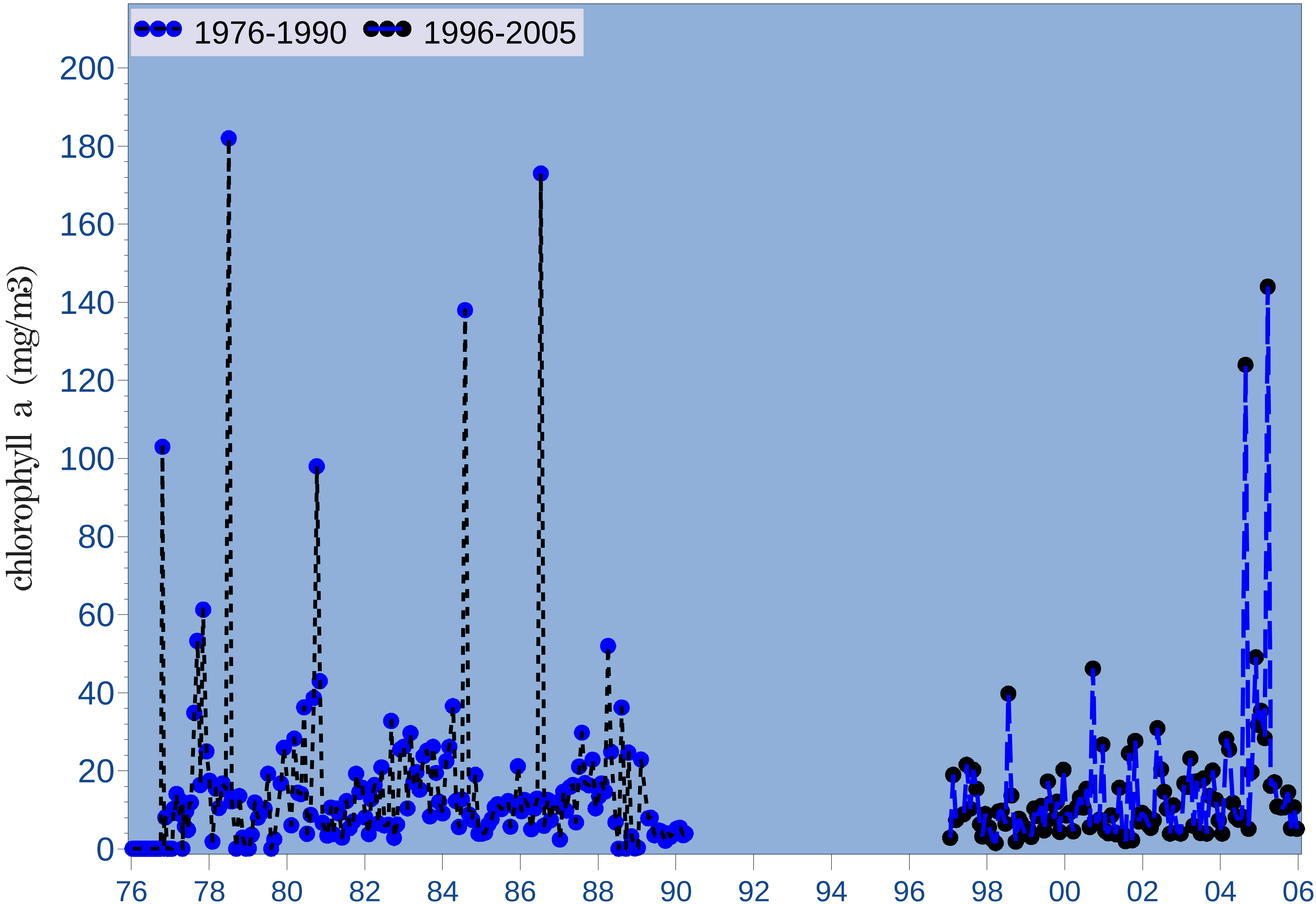


Figure 4.28b Monthly long-term surface chlorophyll a at river kilometer 6.6

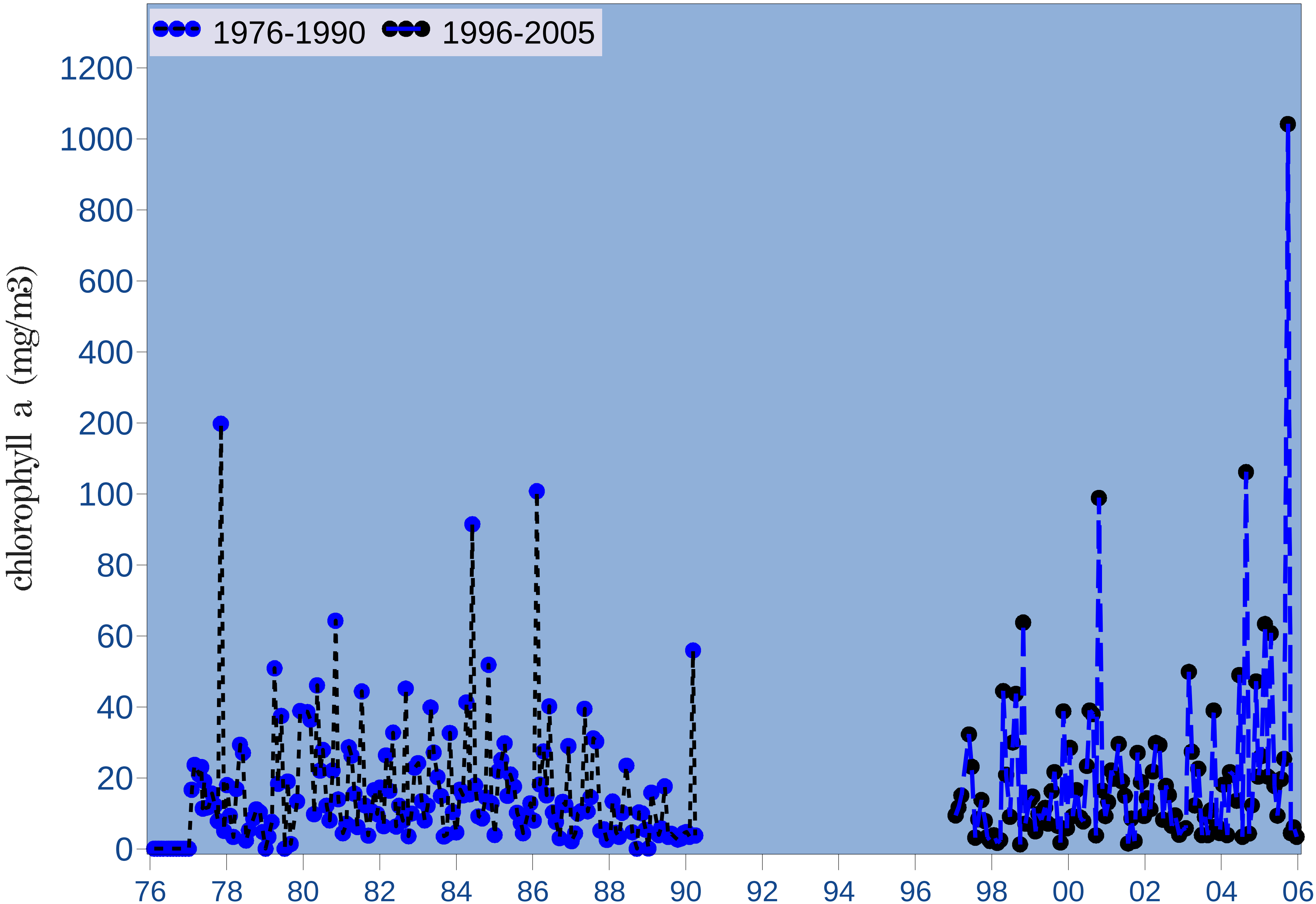


Figure 4.28c Monthly long-term surface chlorophyll a at river kilometer 15.5

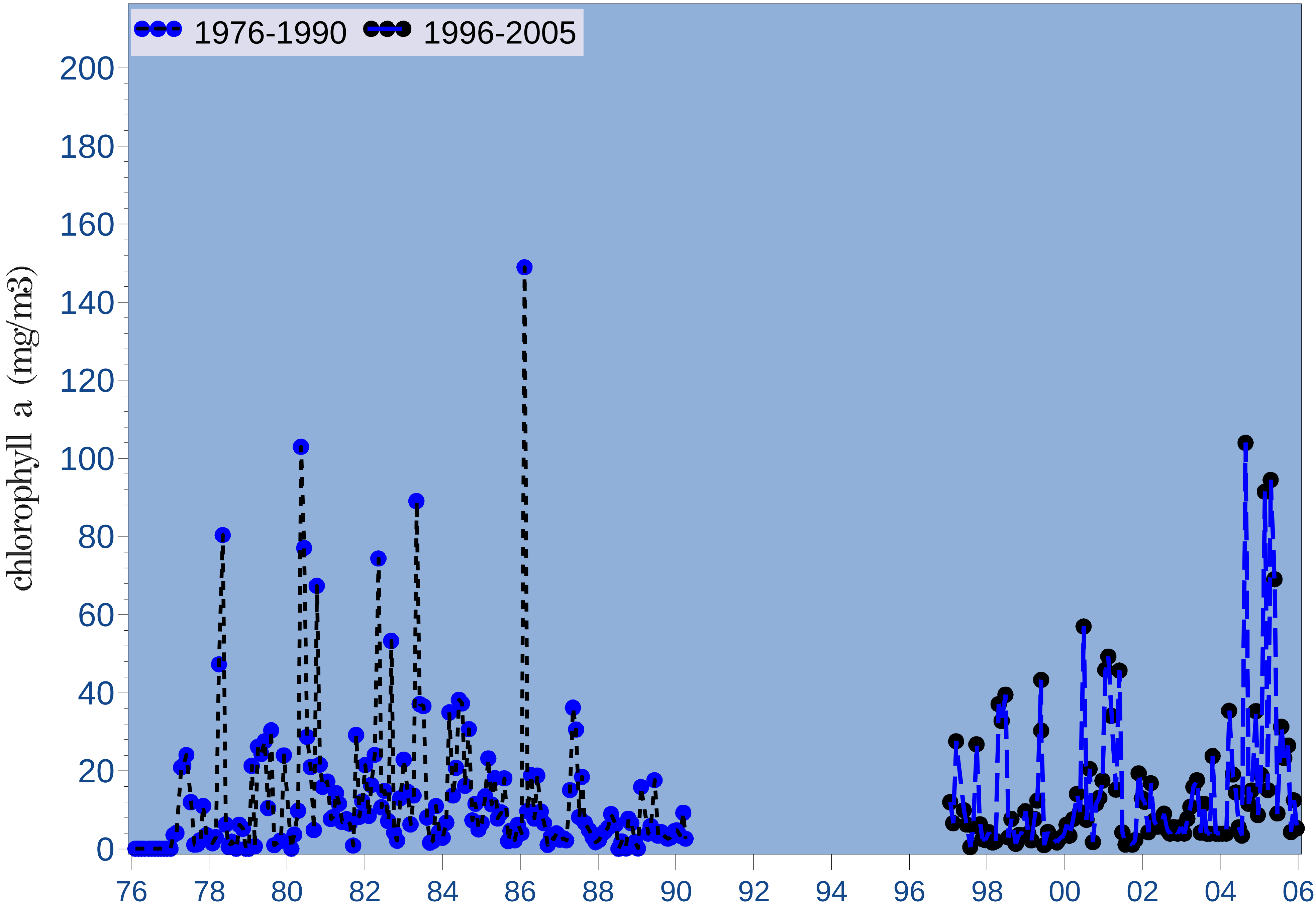


Figure 4.28d Monthly long-term surface chlorophyll a at river kilometer 23.6

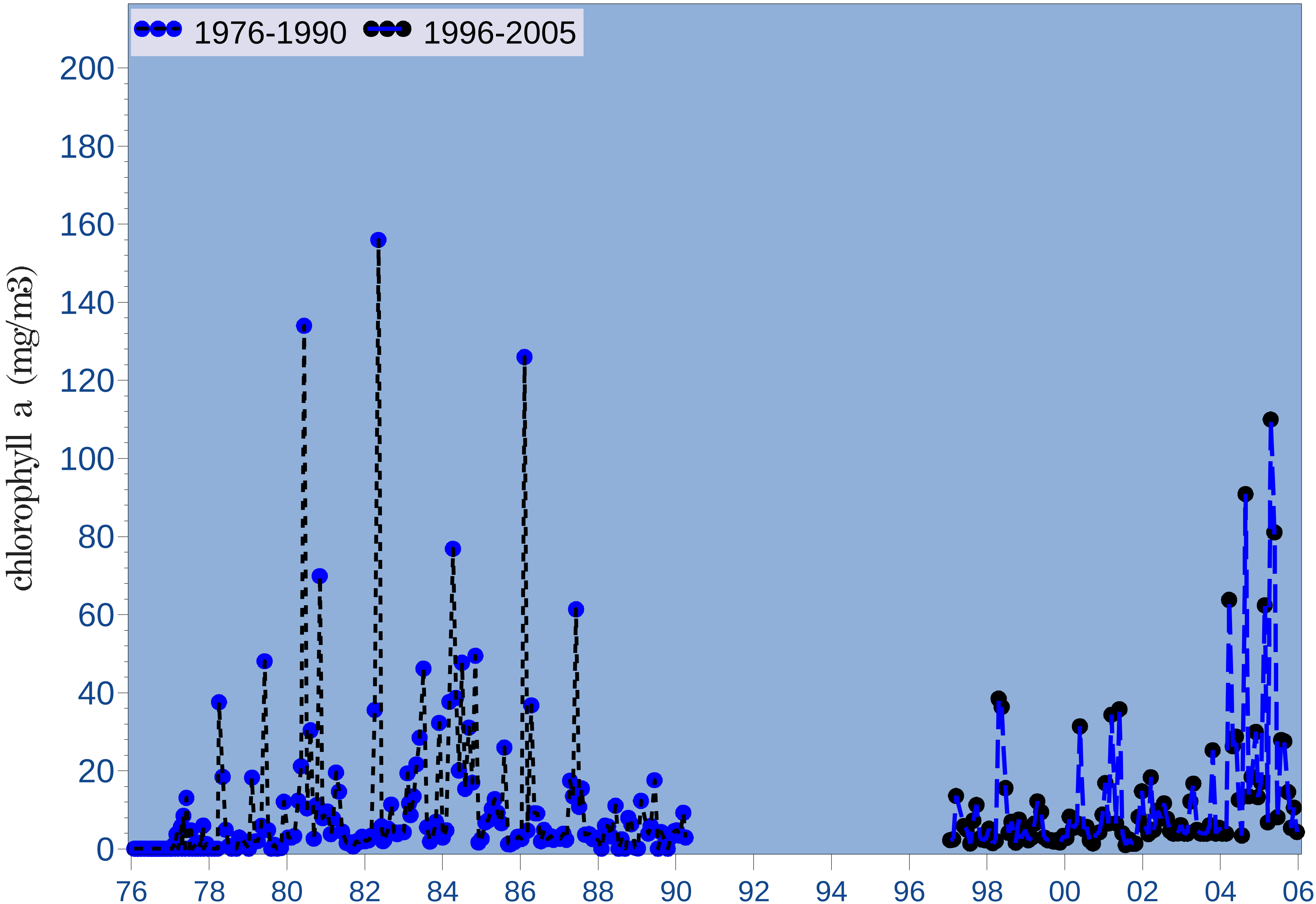


Figure 4.28e Monthly long-term surface chlorophyll a at river kilometer 30.4

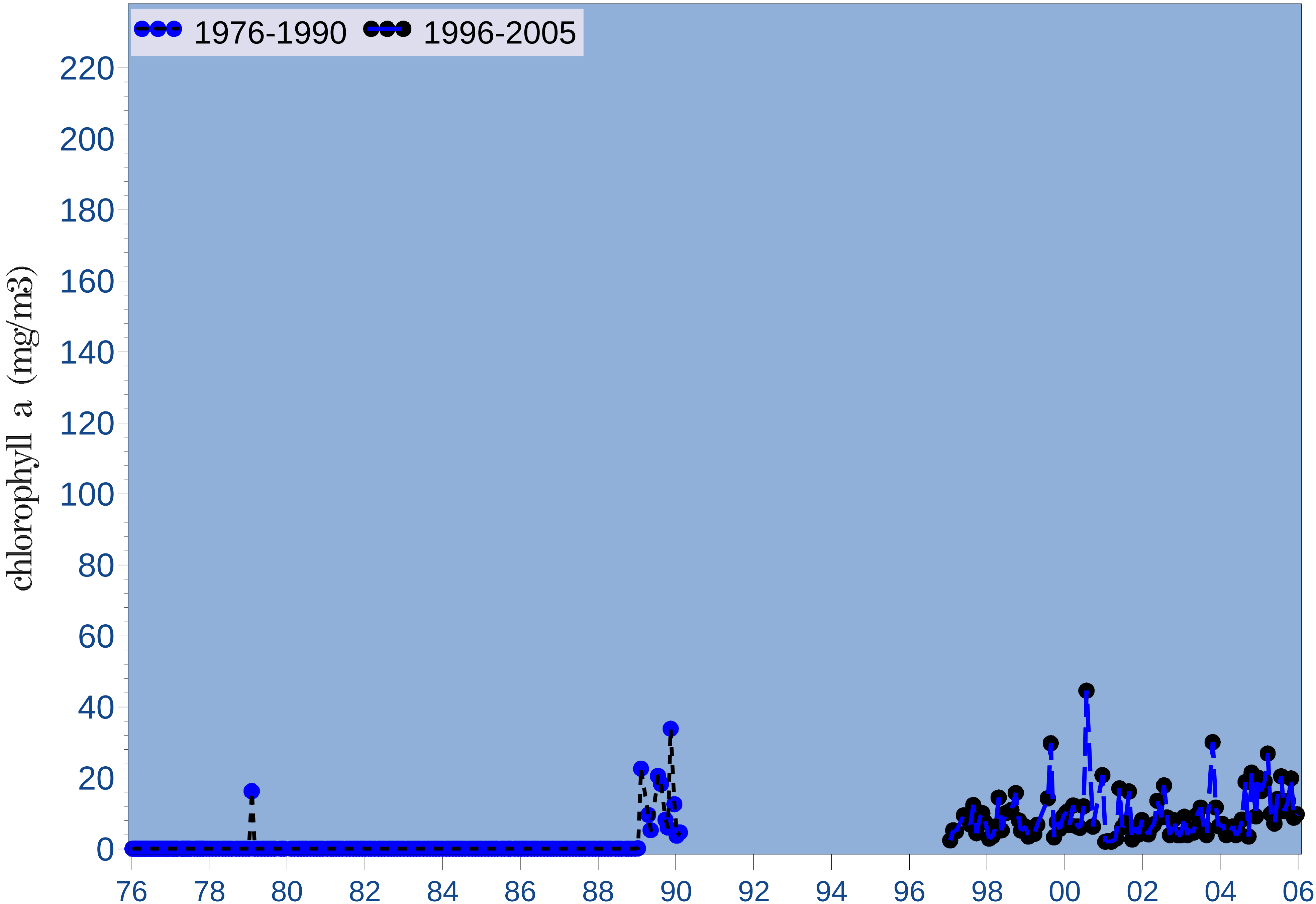


Figure 4.29a Monthly long-term bottom chlorophyll a at river kilometer -2.4

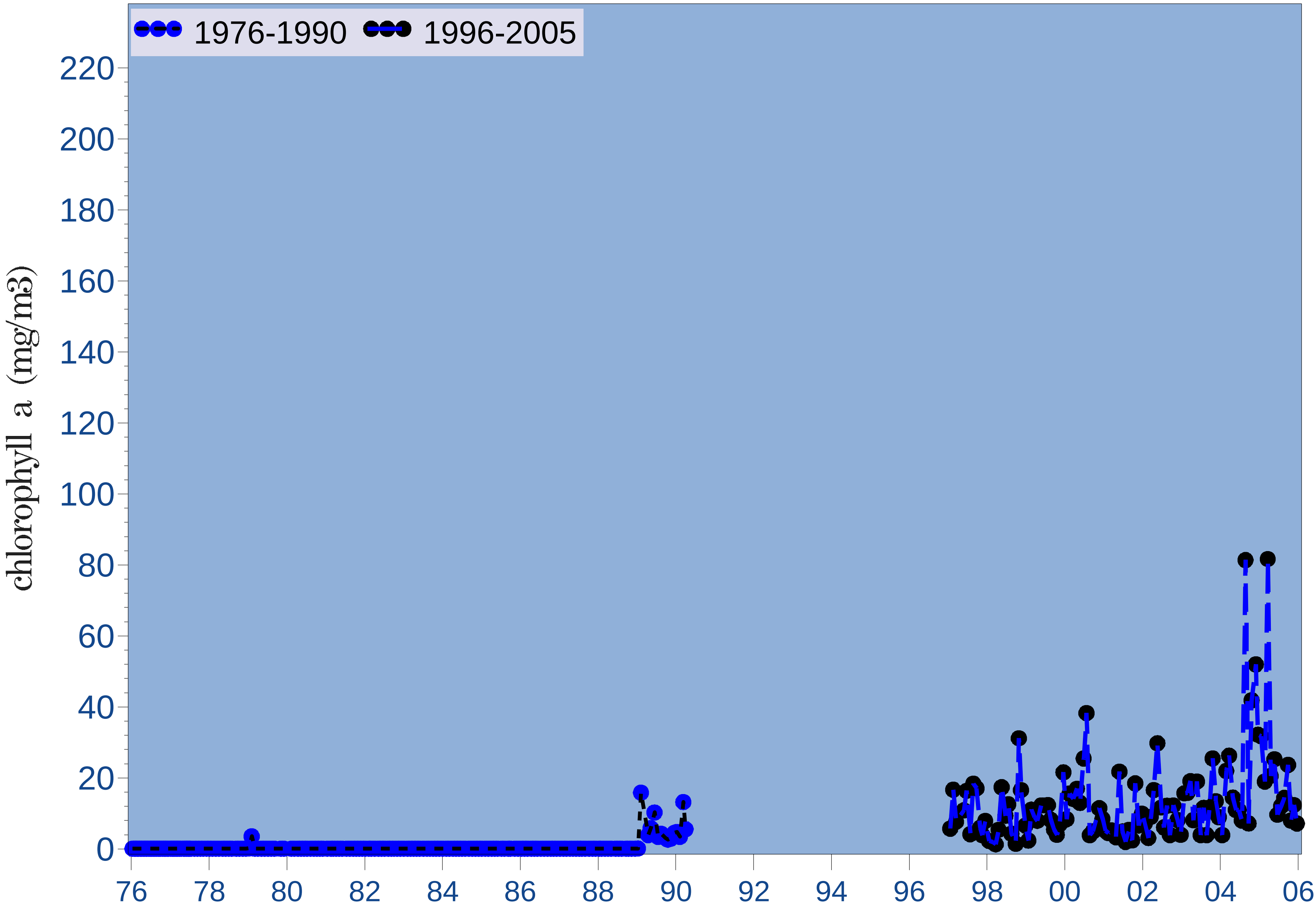


Figure 4.29b Monthly long-term bottom chlorophyll a at river kilometer 6.6

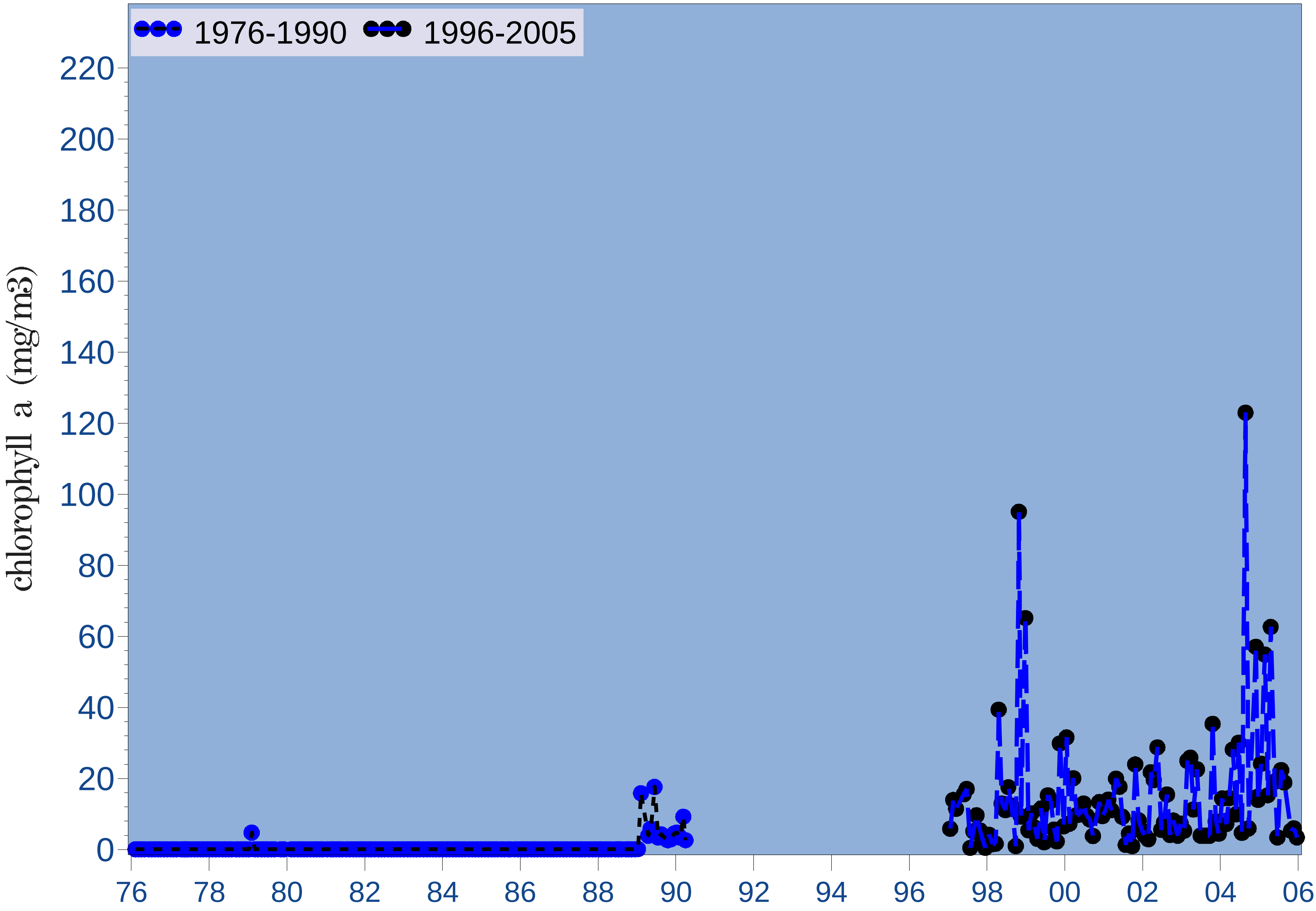


Figure 4.29c Monthly long-term bottom chlorophyll a at river kilometer 15.5

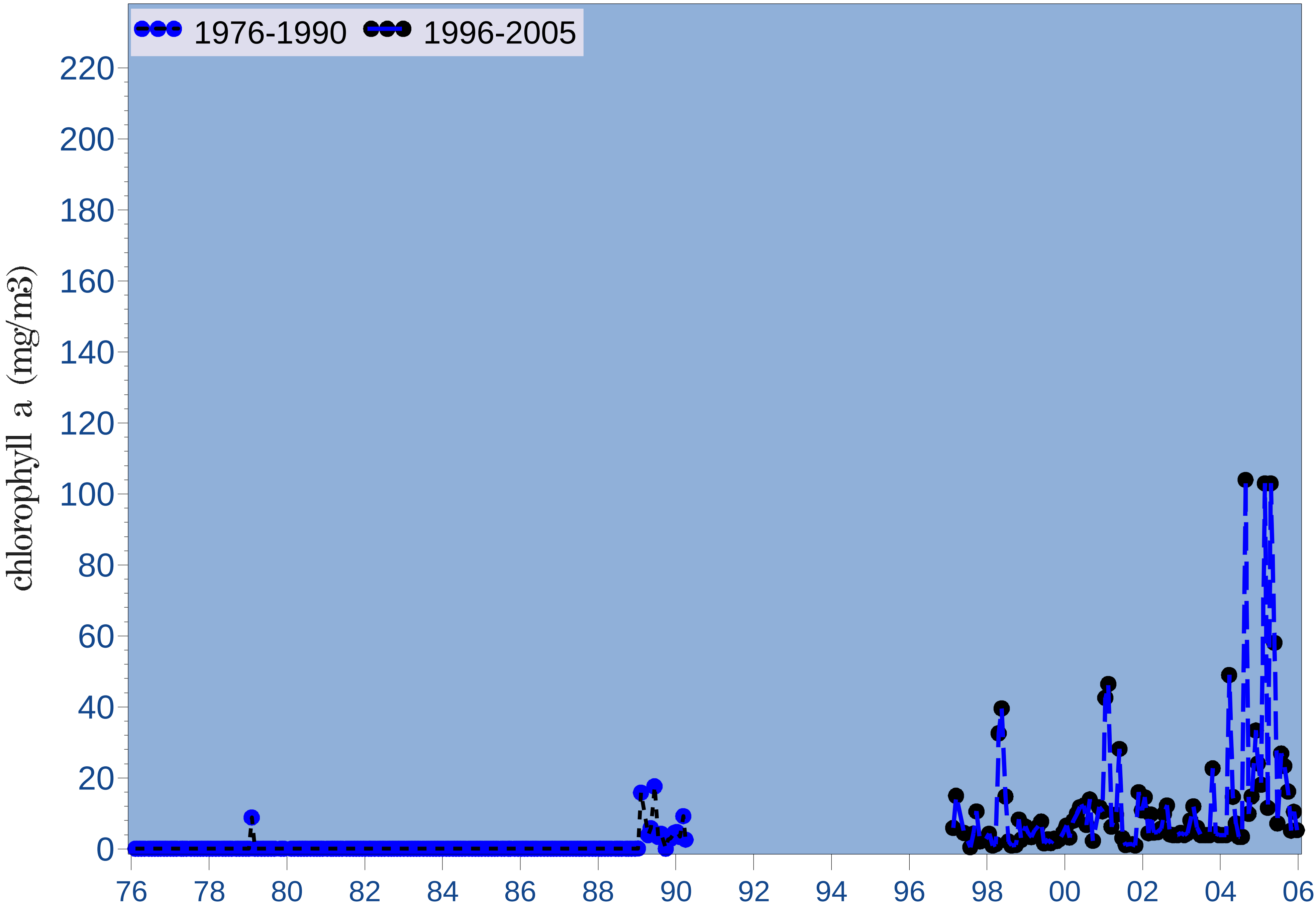


Figure 4.29d Monthly long-term bottom chlorophyll a at river kilometer 23.6

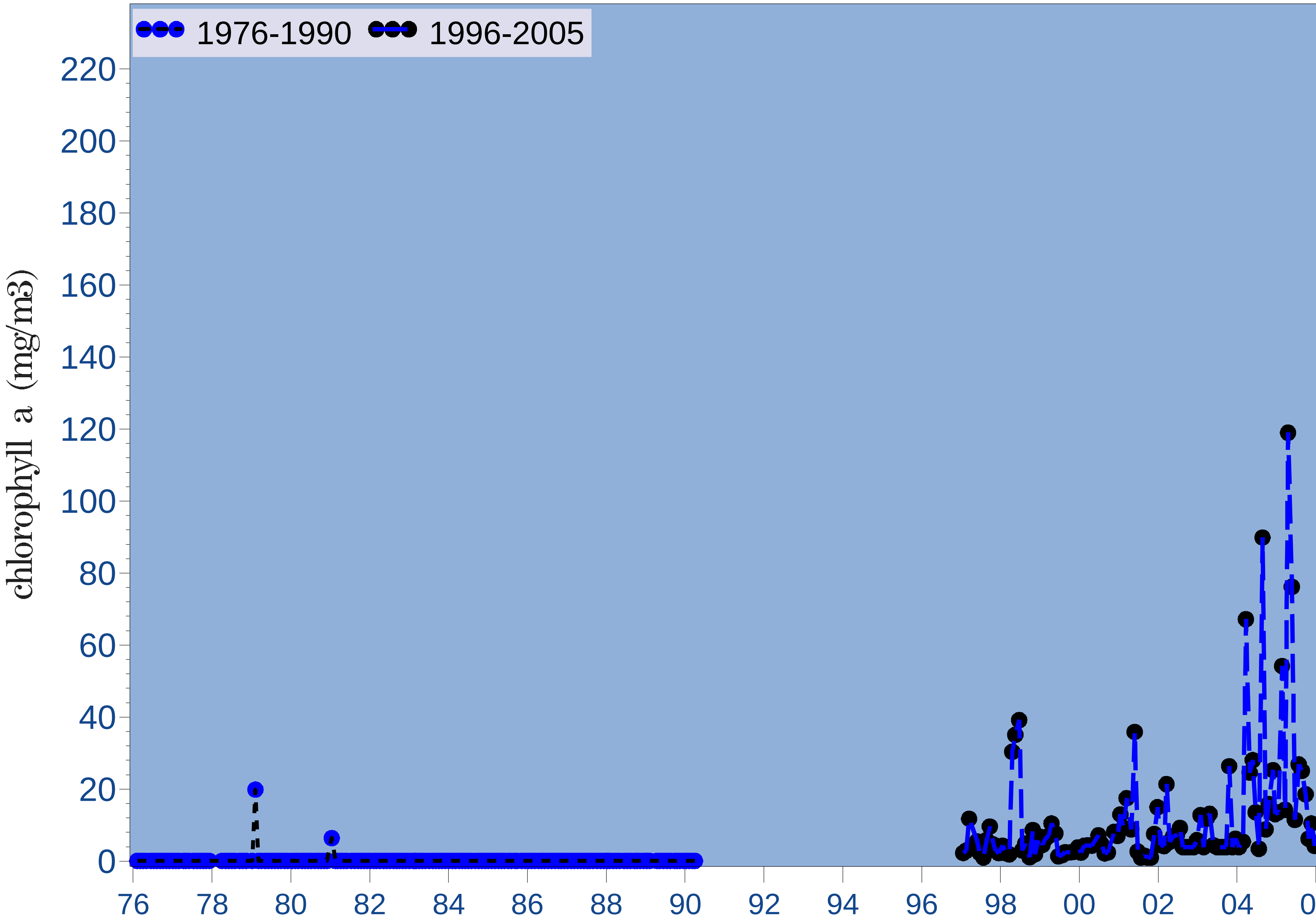


Figure 4.29e Monthly long-term bottom chlorophyll a at river kilometer 30.4

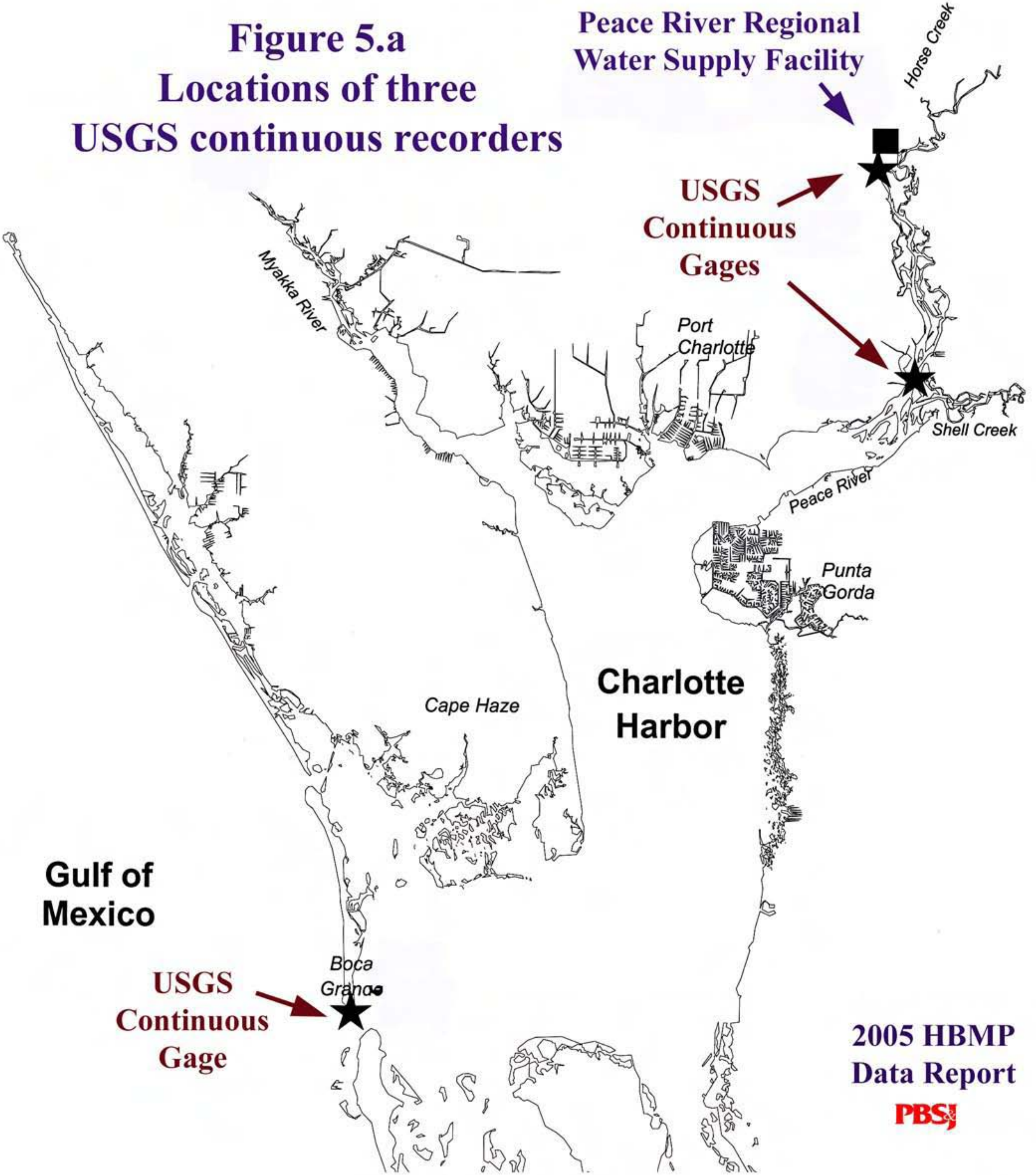


Figure 5.a
Locations of three
USGS continuous recorders

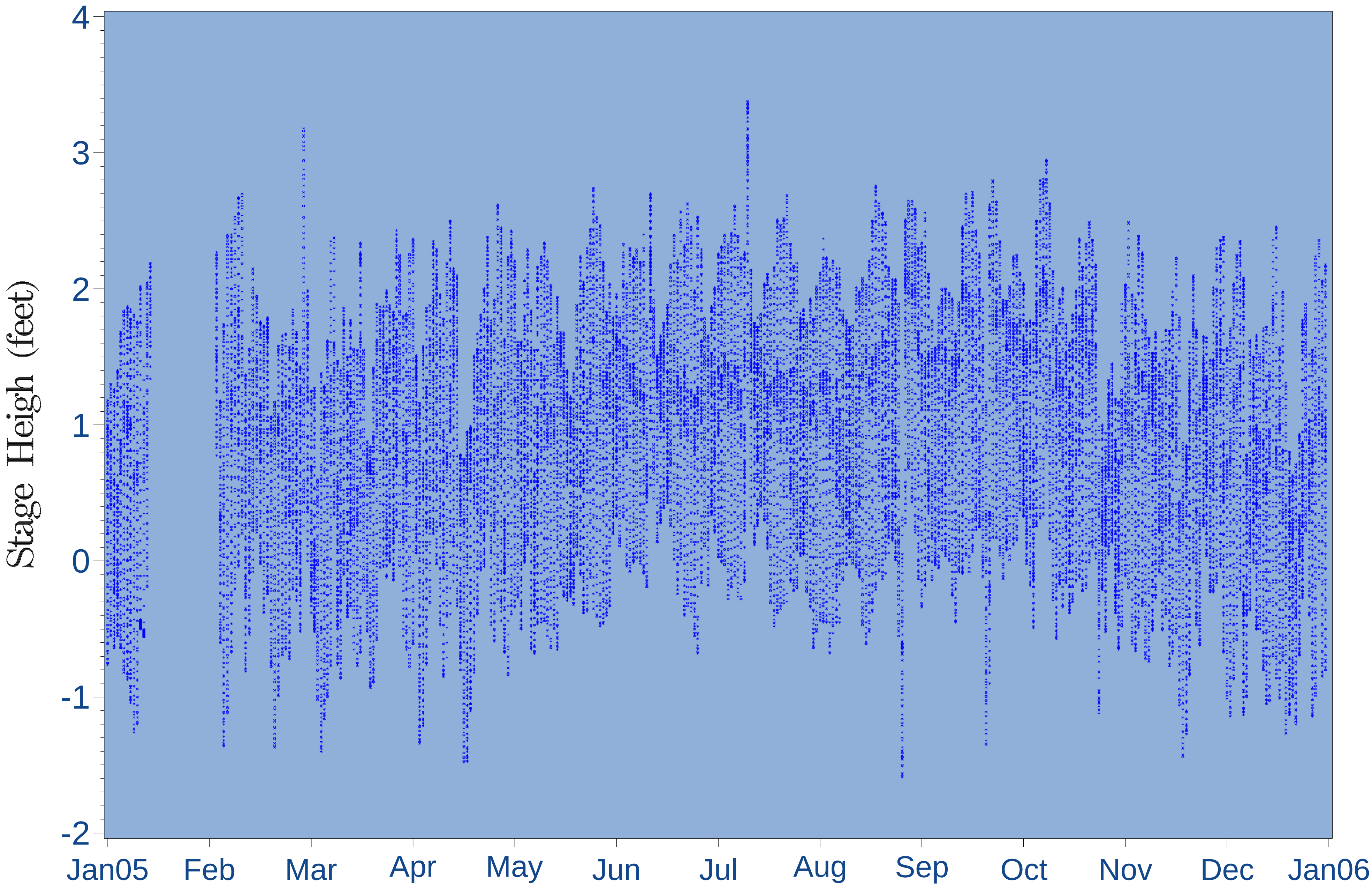


Figure 5.1 2005 Stage height (15-min intervals) for Peace River fixed station at Harbour Heights - USGS Gage 02297460 (River Kilometer=15.5)

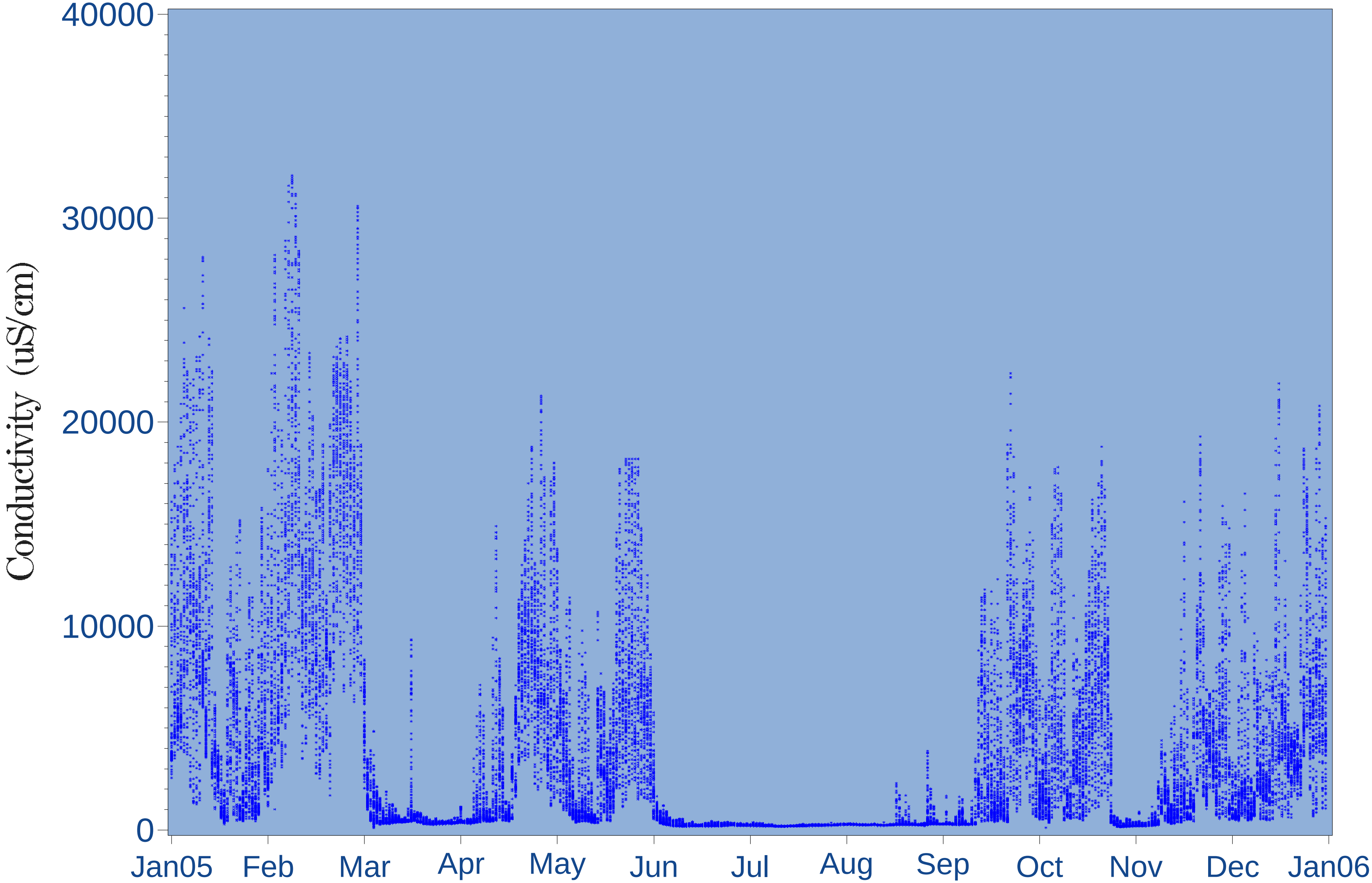


Figure 5.2 2005 Surface conductivity (15-min intervals) for Peace River fixed station at Harbour Heights - USGS Gage 02297460 (River Kilometer=15.5)

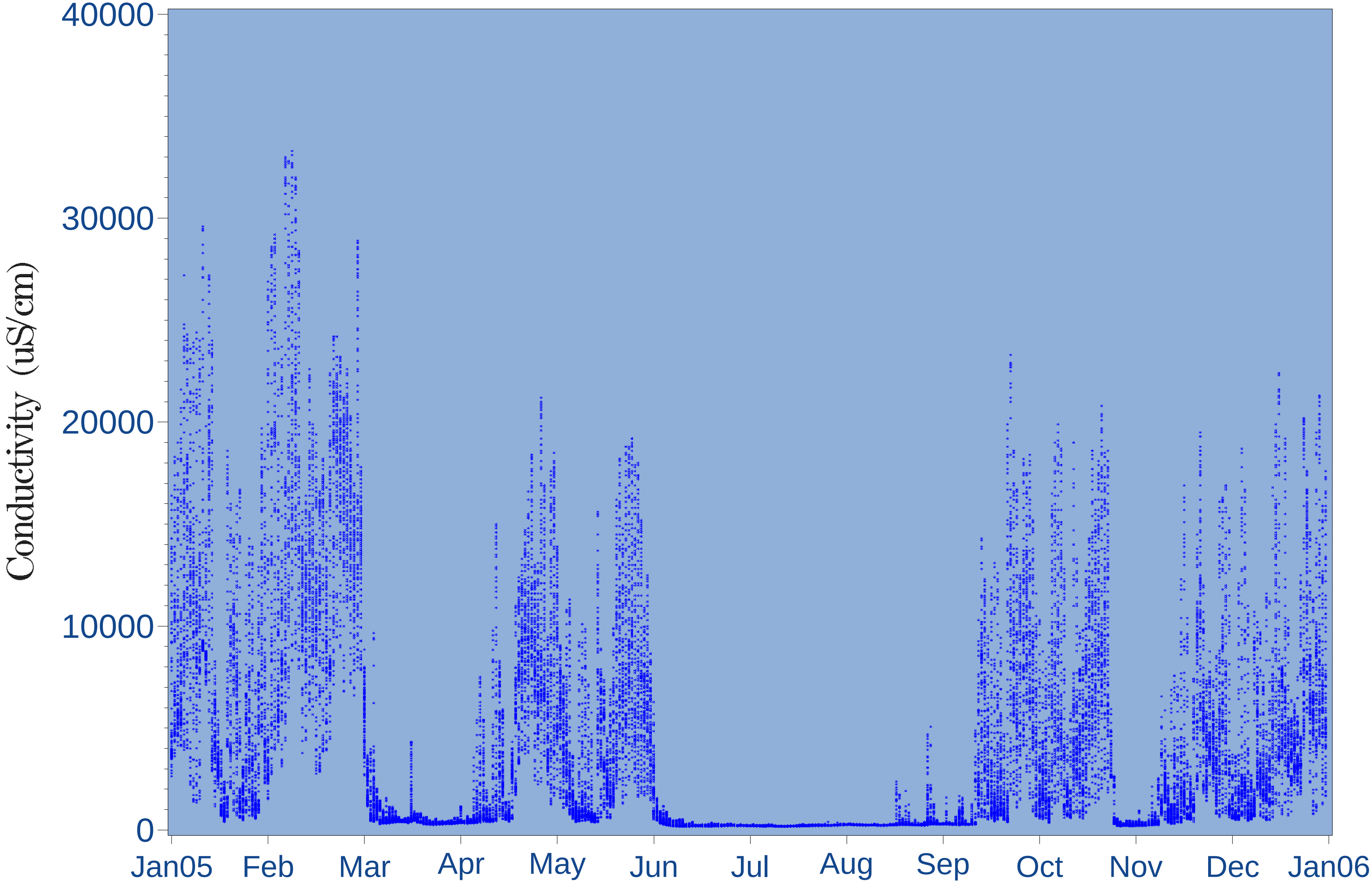


Figure 5.3 2005 Bottom conductivity (15-min intervals) for Peace River fixed station at Harbour Heights - USGS Gage 02297460 (River Kilometer=15.5)

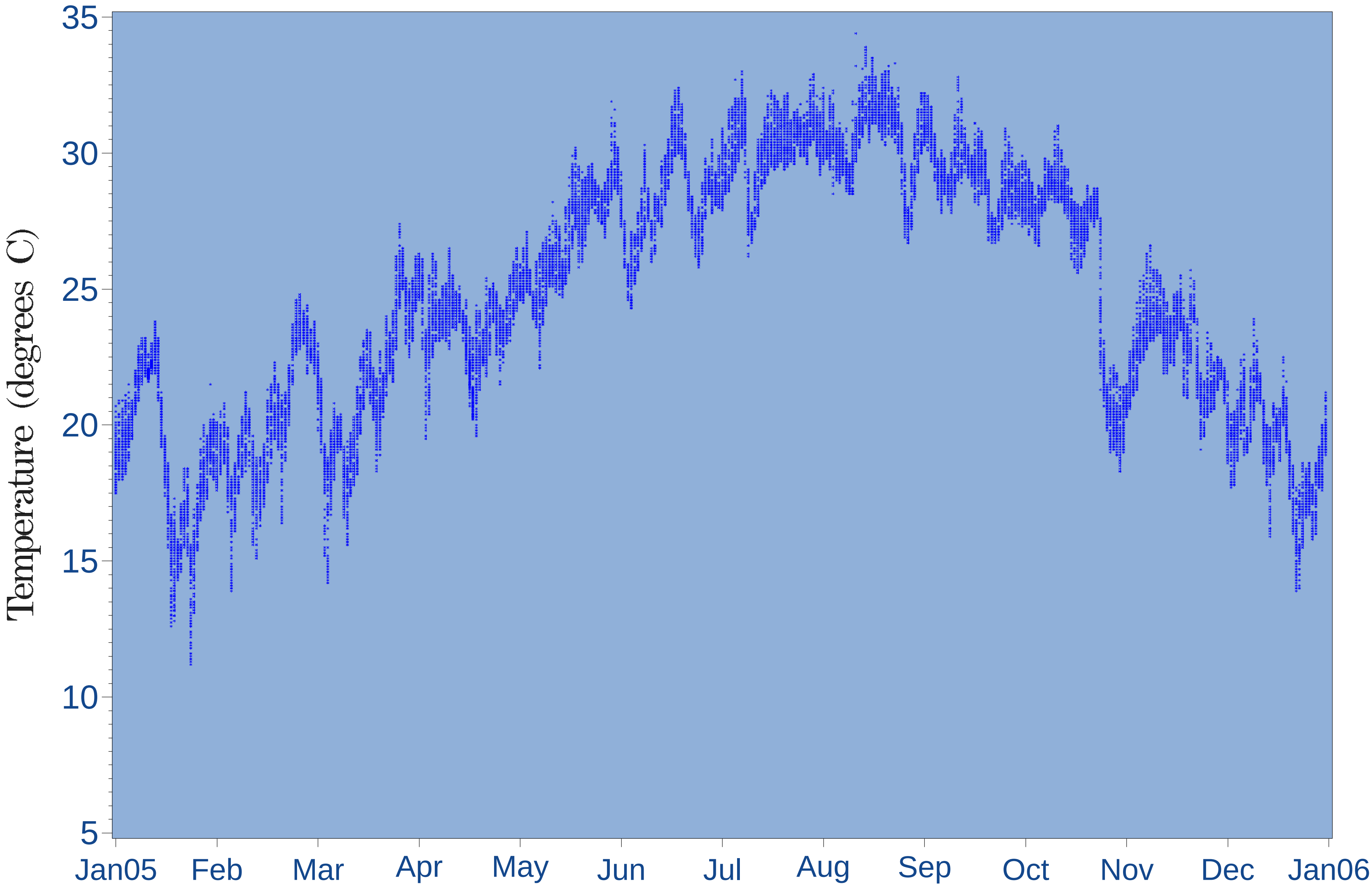


Figure 5.4 2005 Surface temperature (15-min intervals) for Peace River fixed station at Harbour Heights - USGS Gage 02297460 (River Kilometer=15.5)

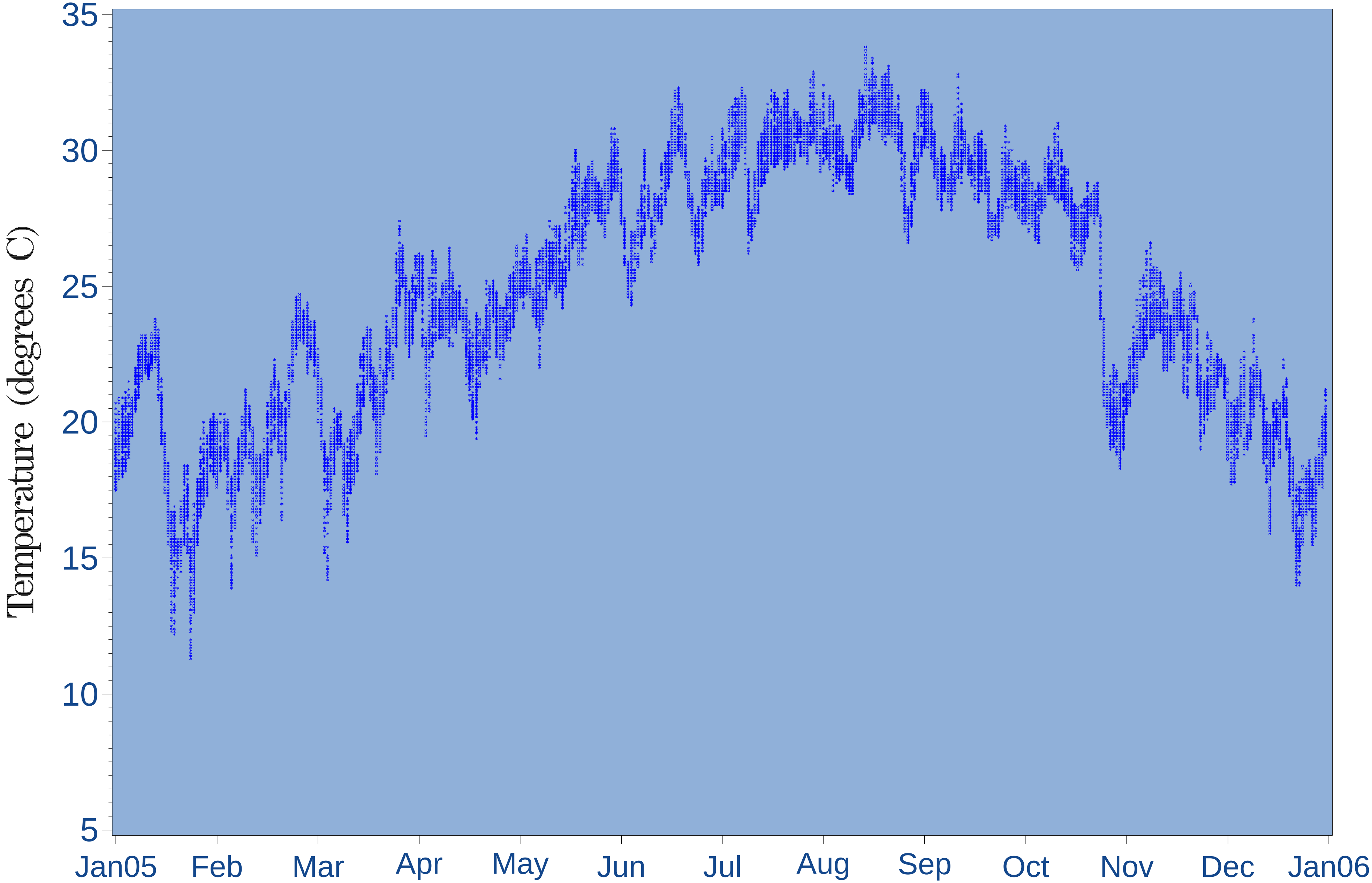


Figure 5.5 2005 Bottom temperature (15-min intervals) for Peace River fixed station at Harbour Heights - USGS Gage 02297460 (River Kilometer=15.5)

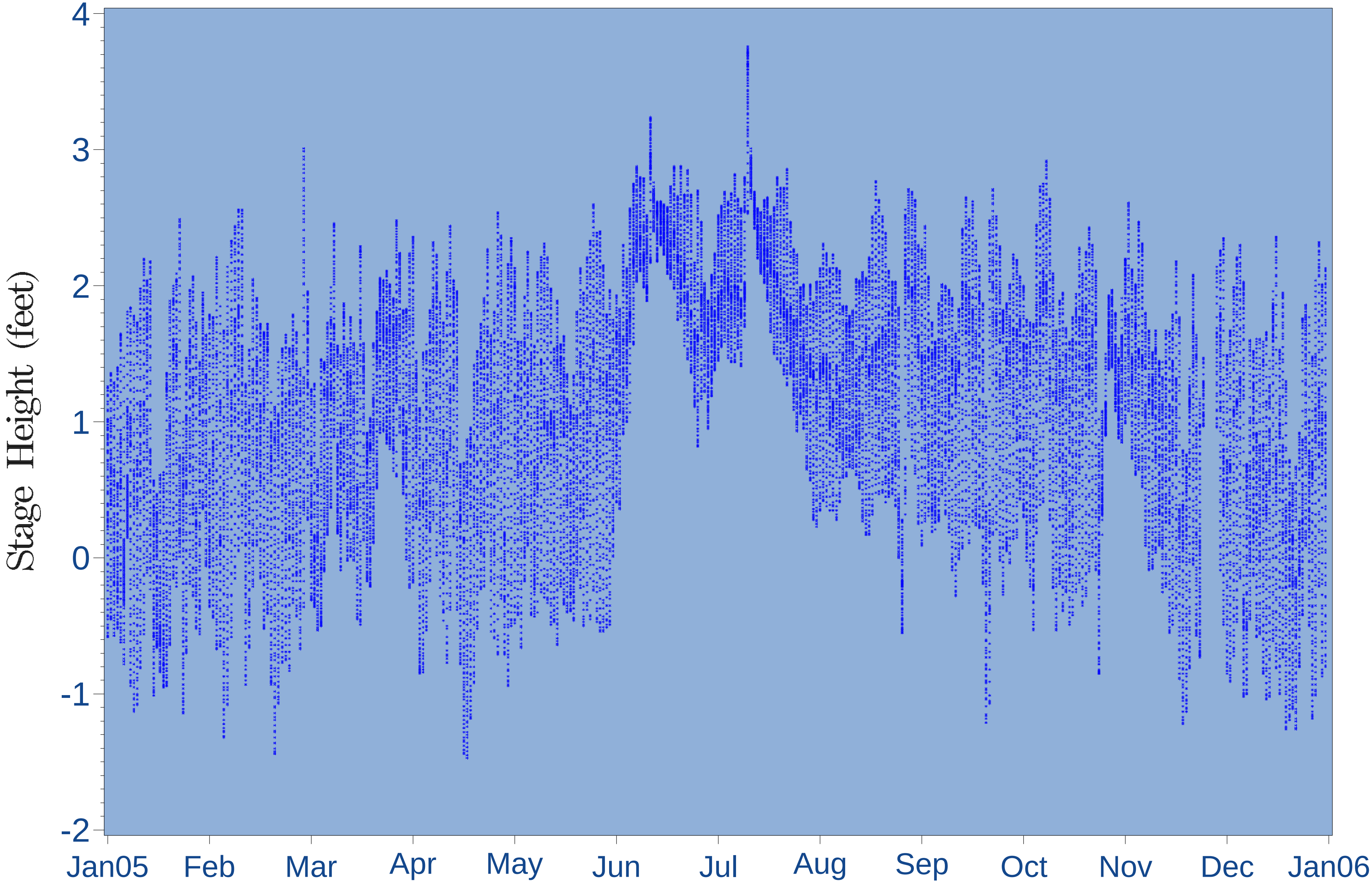


Figure 5.6 2005 Stage height (15-min intervals) for Peace River fixed station at Peace River Heights - USGS gage 02297350 (River Kilometer=26.7)

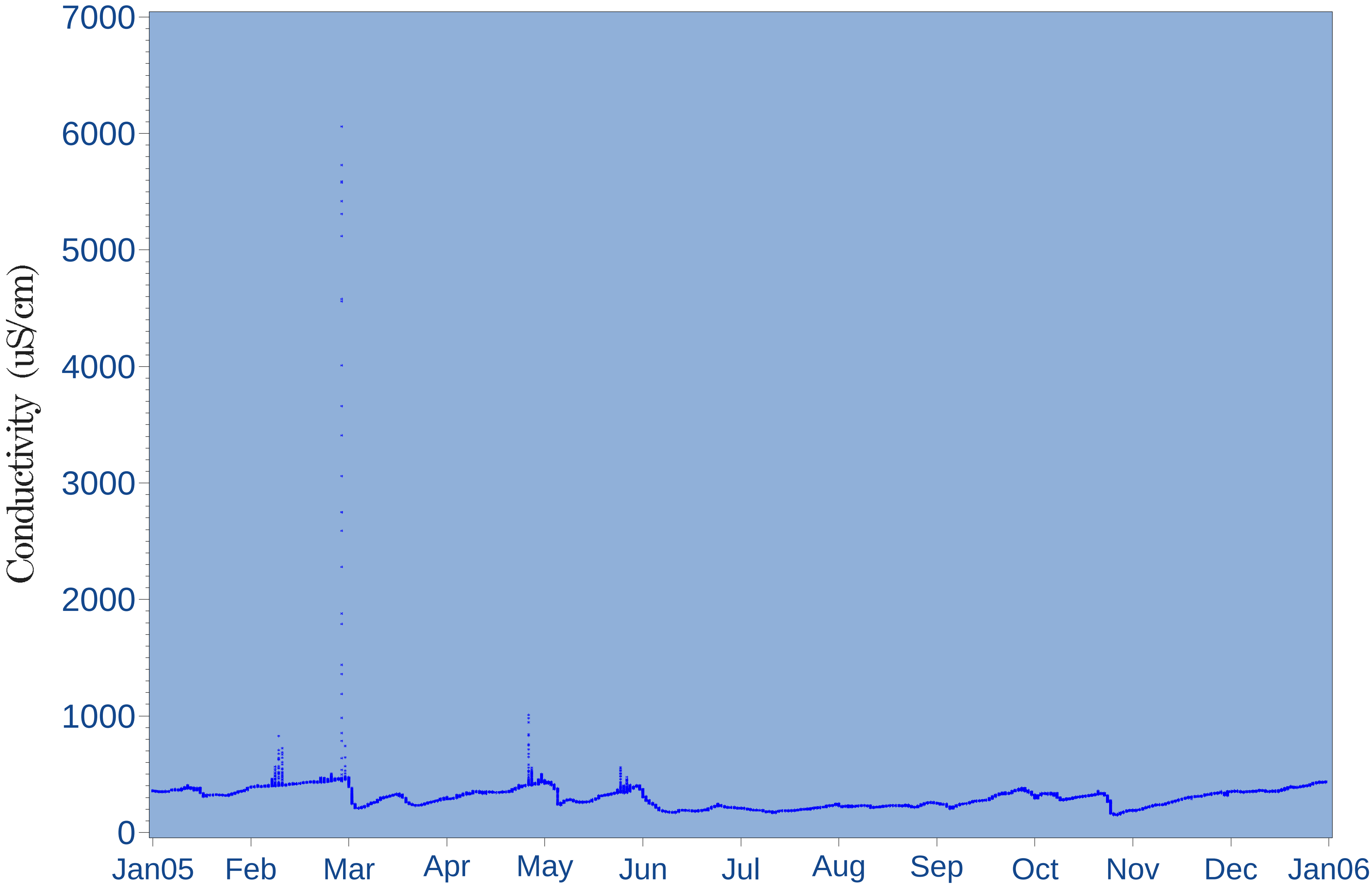


Figure 5.7 2005 Surface conductivity (15-min intervals) for Peace River fixed station at Peace River Heights - USGS gage 02297350 (River Kilometer=26.7)

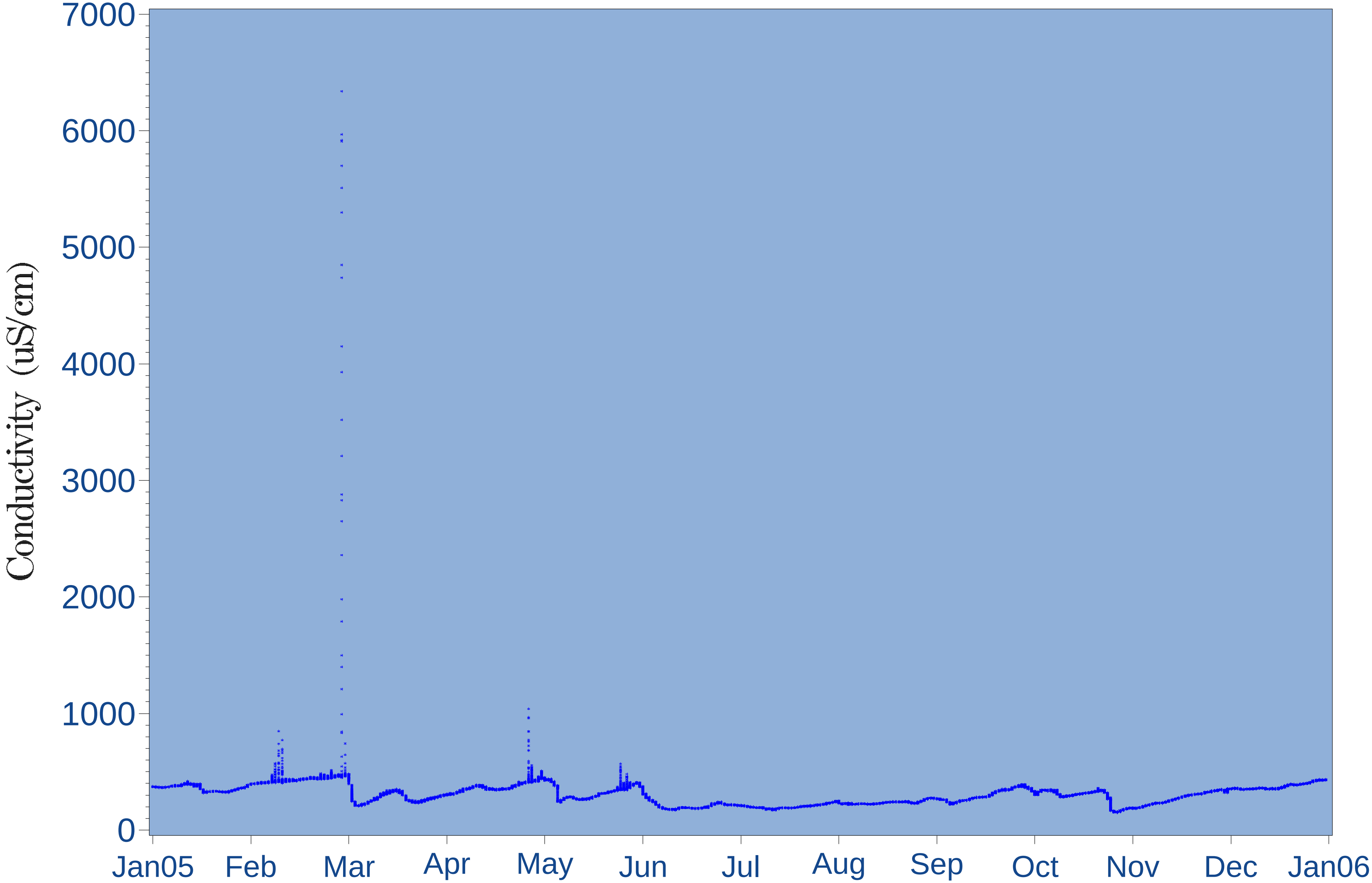


Figure 5.8 2005 Bottom conductivity (15-min intervals) for Peace River fixed station at Peace River Heights - USGS gage 02297350 (River Kilometer=26.7)

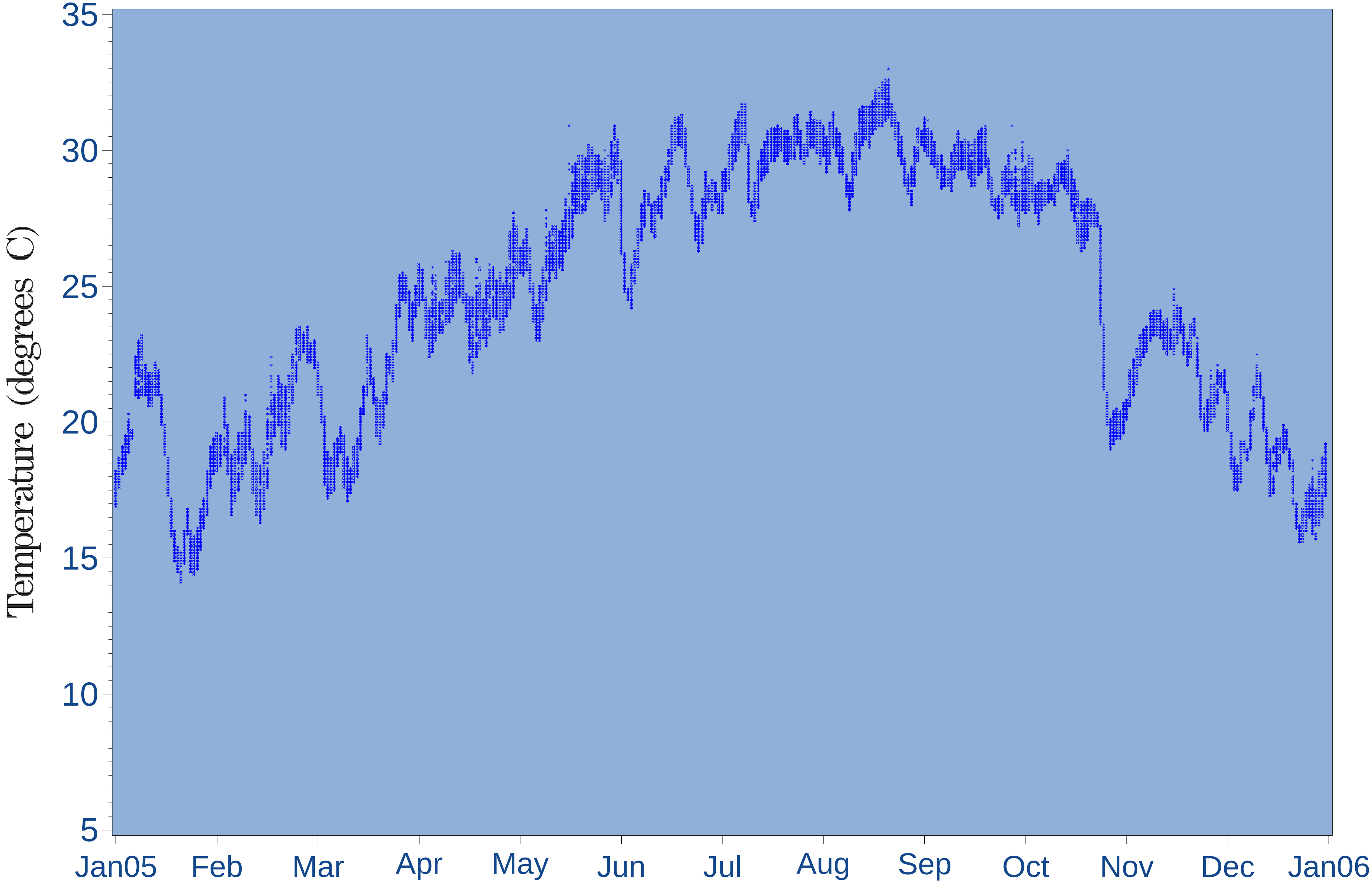


Figure 5.9 2005 Surface temperature (15-min intervals) for Peace River fixed station at Peace River Heights - USGS gage 02297350 (River Kilometer=26.7)

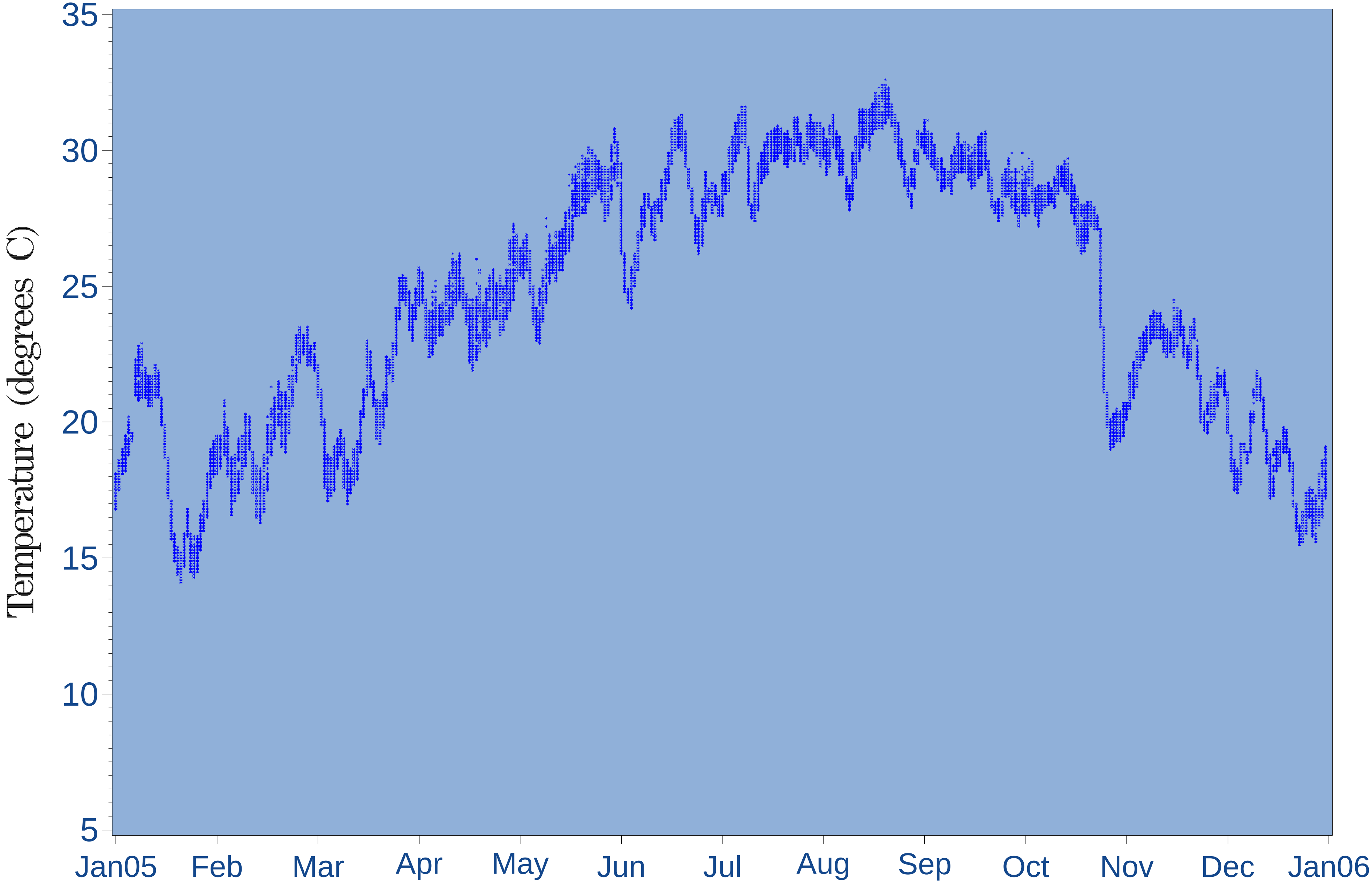


Figure 5.10 2005 Bottom temperature (15-min intervals) for Peace River fixed station at Peace River Heights - USGS gage 02297350 (River Kilometer=26.7)

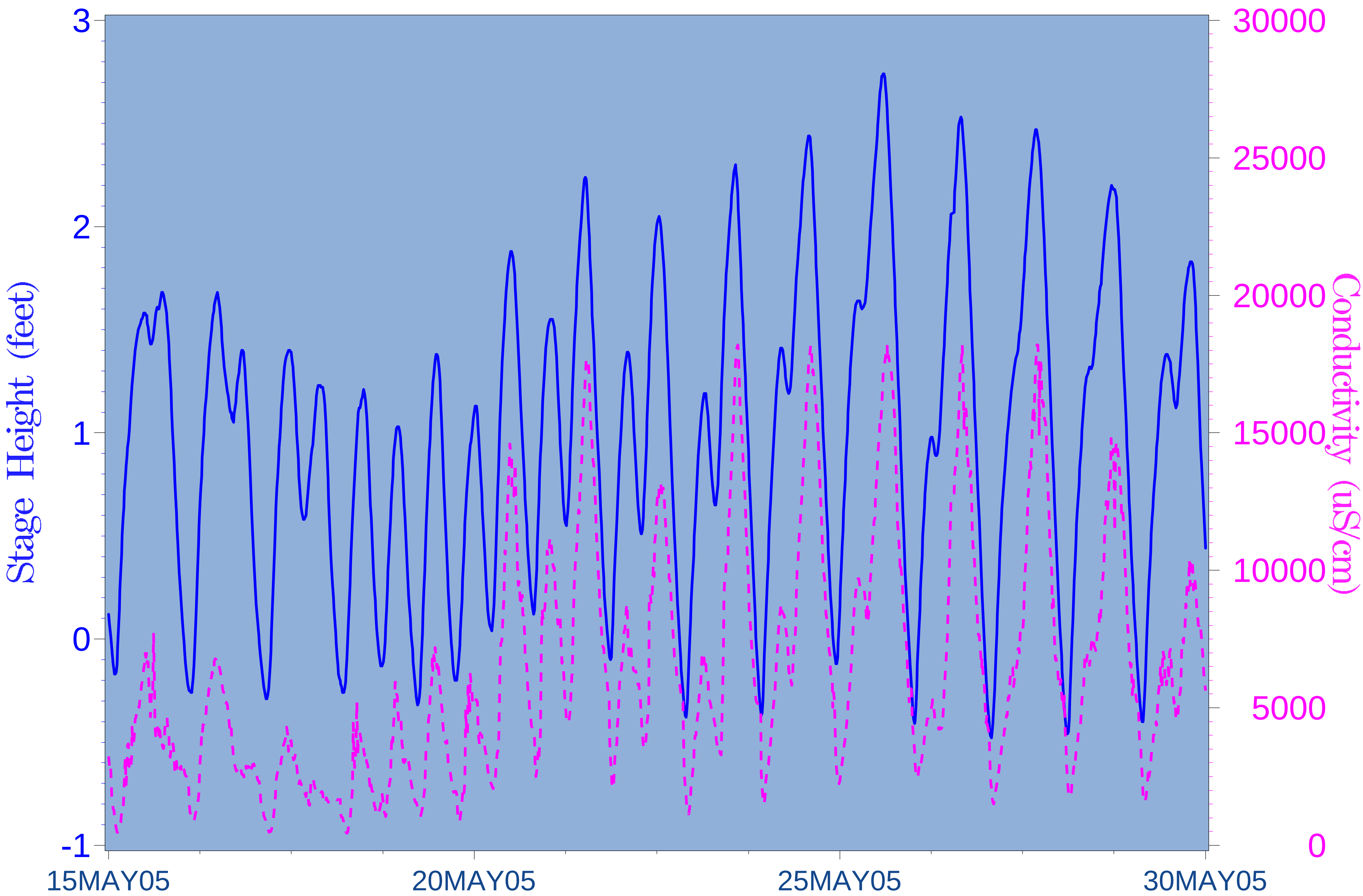


Figure 5.11 Surface conductivity and stage height in May at Harbour Heights - USGS Gage 02297460 (River Kilometer 15.5)

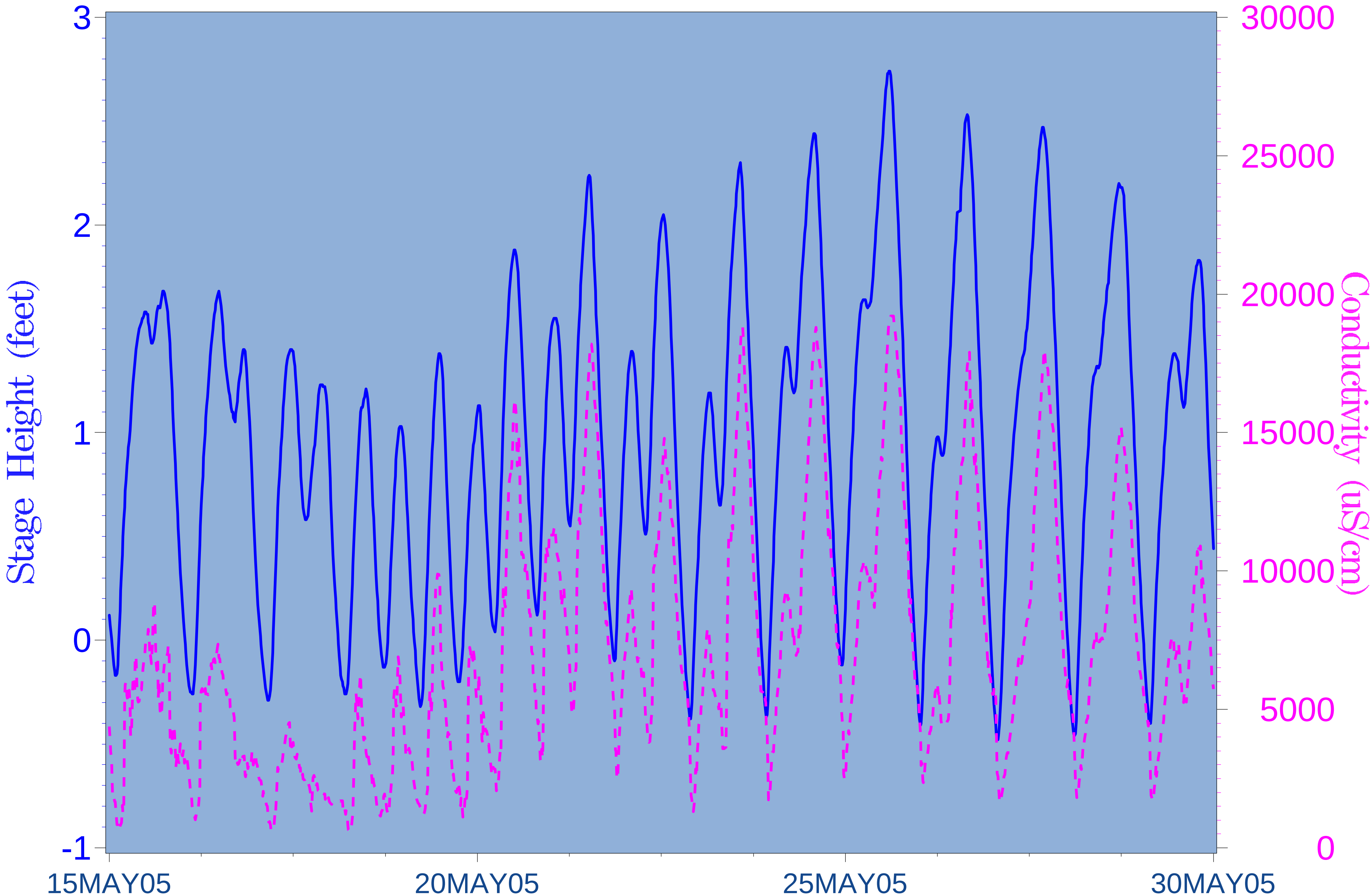


Figure 5.12 Bottom conductivity and stage height in May at Harbour Heights - USGS Gage 02297460 (River Kilometer 15.5)

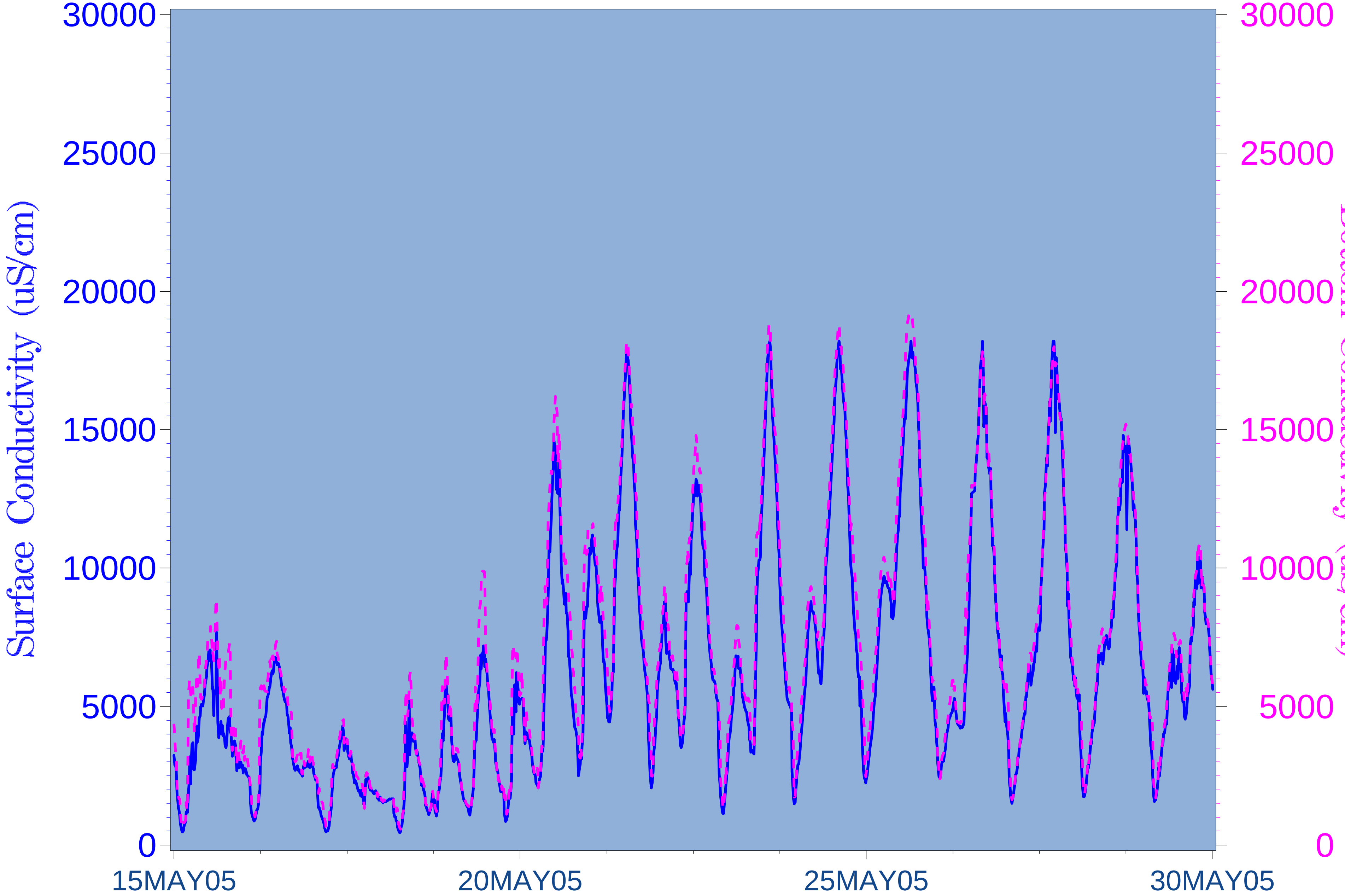


Figure 5.13 Surface & bottom conductivity in May at Harbour Heights - USGS Gage 02297460 (River Kilometer 15.5)

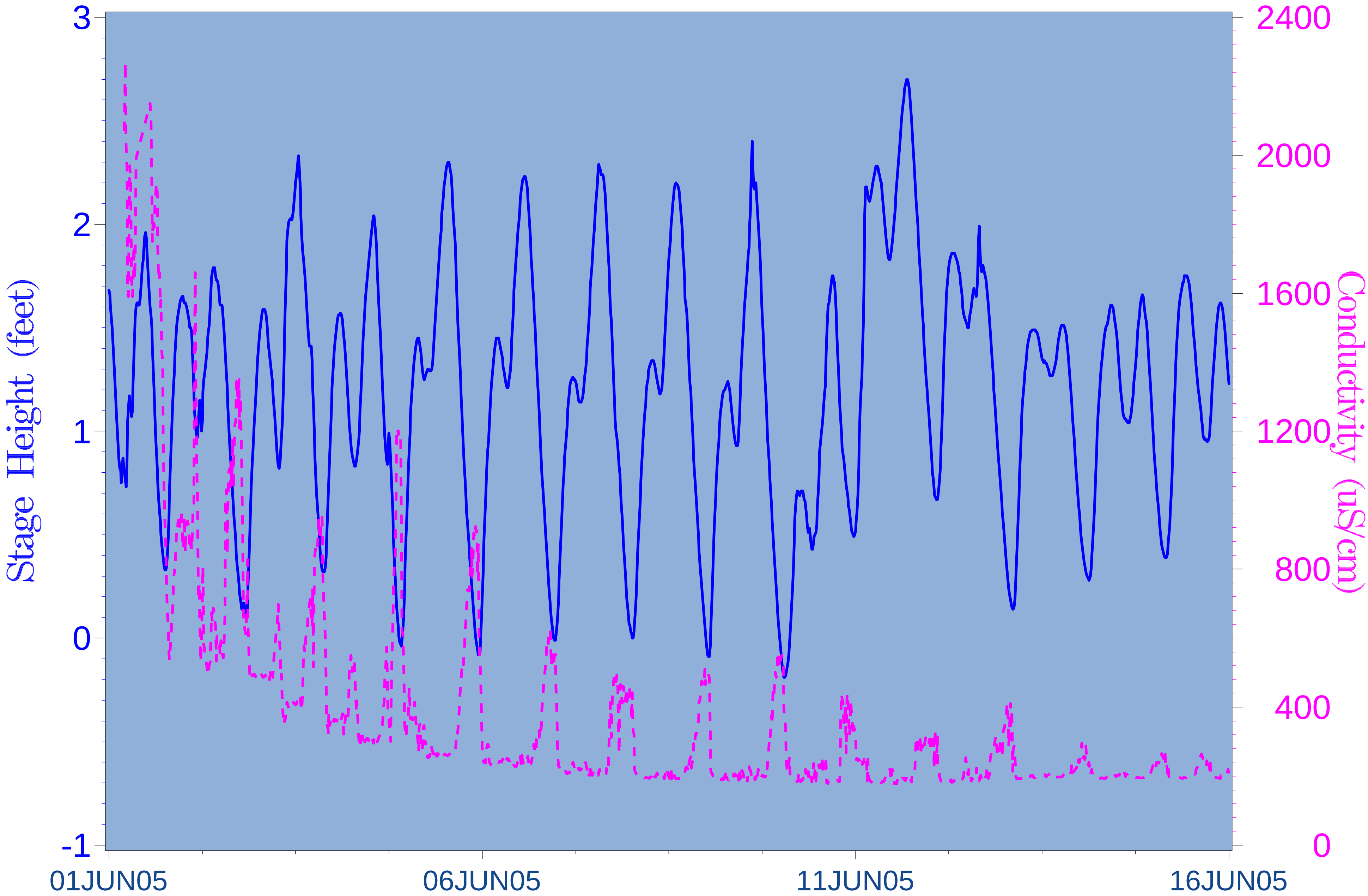


Figure 5.14 Surface conductivity and stage height in June at Harbour Heights - USGS Gage 02297460 (River Kilometer 15.5)

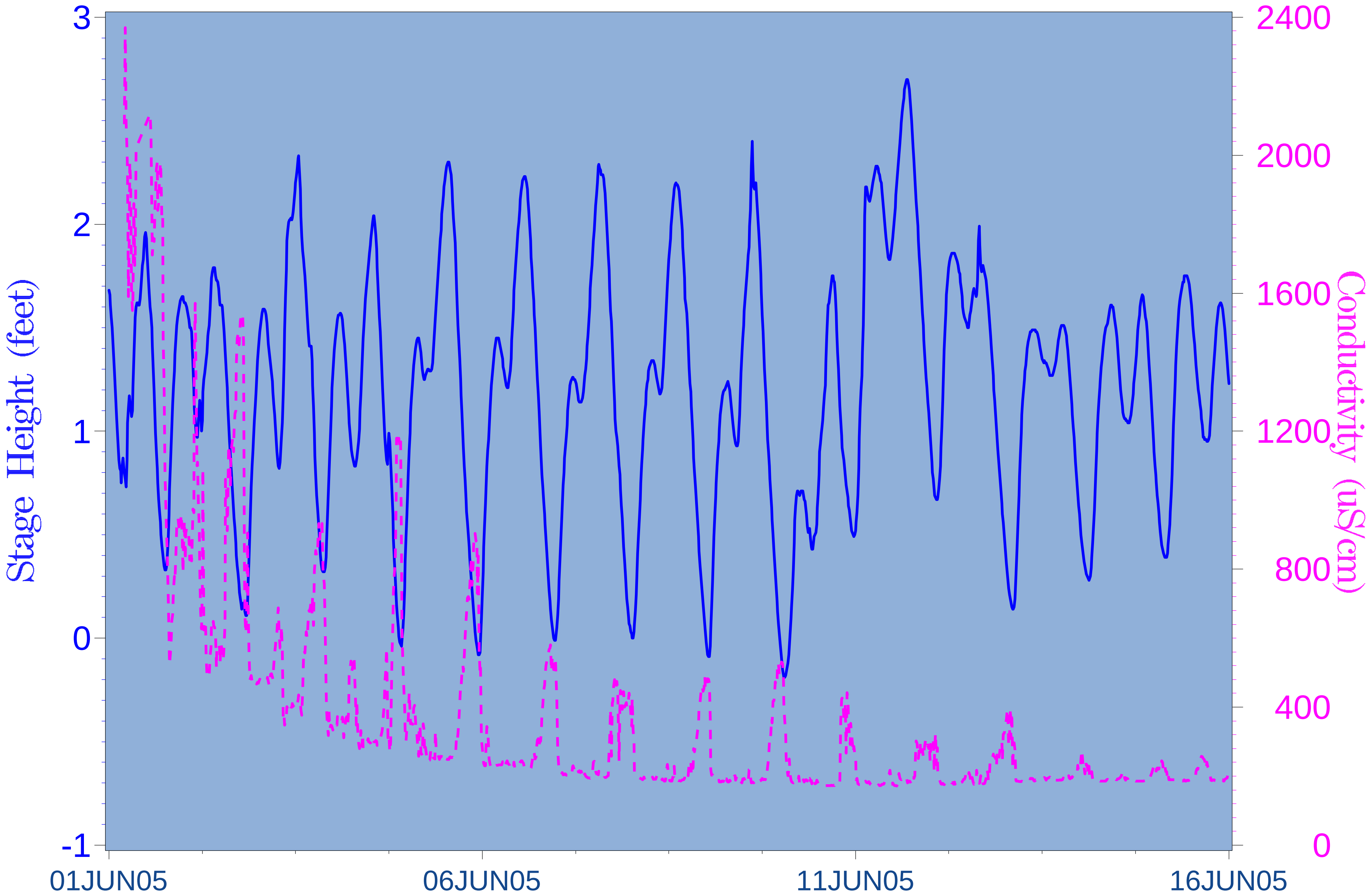


Figure 5.15 Bottom conductivity and stage height in June at Harbour Heights - USGS Gage 02297460 (River Kilometer 15.5)

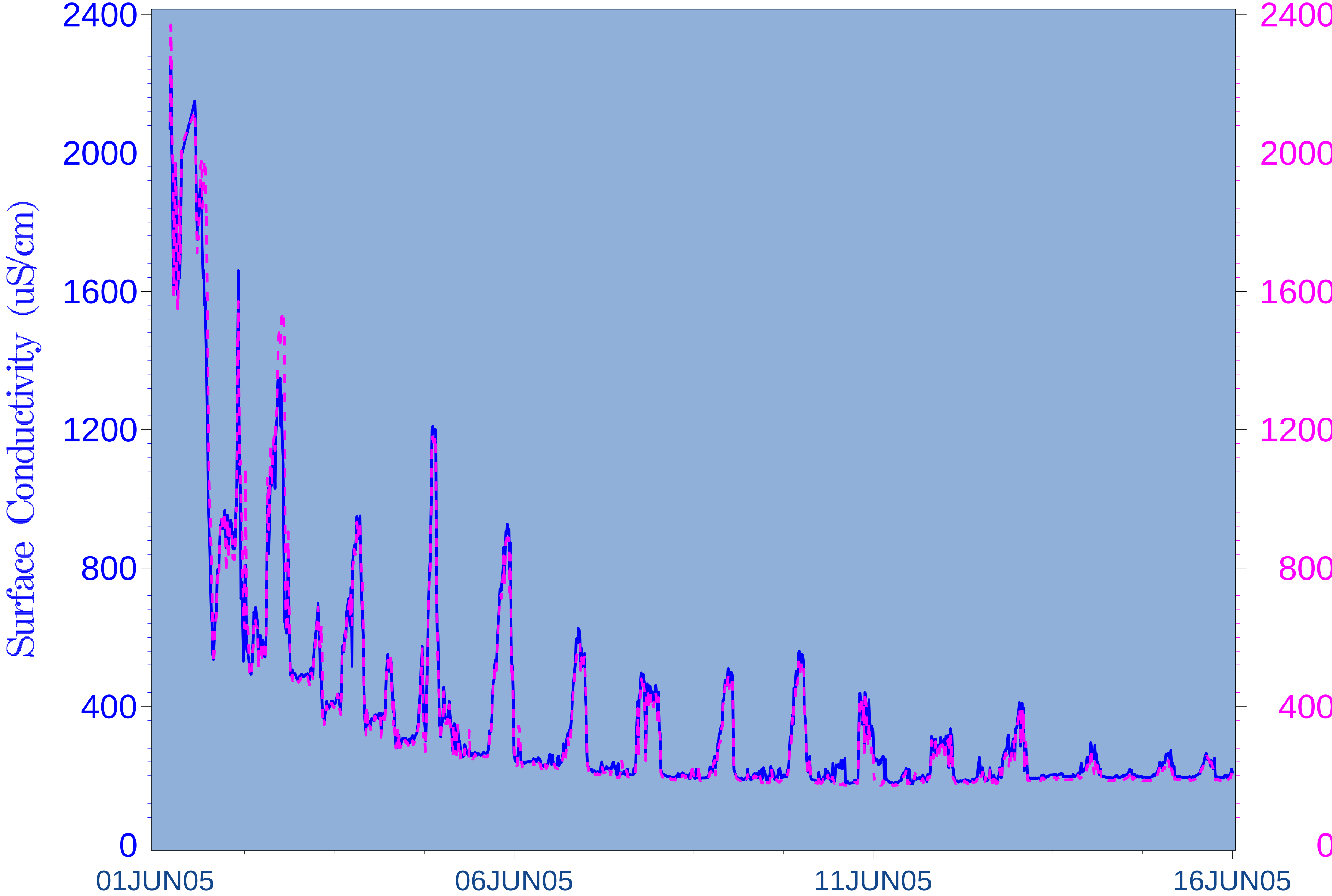


Figure 5.16 Surface and bottom conductivity in June at Harbour Heights - USGS Gage 02297460 (River Kilometer 15.5)

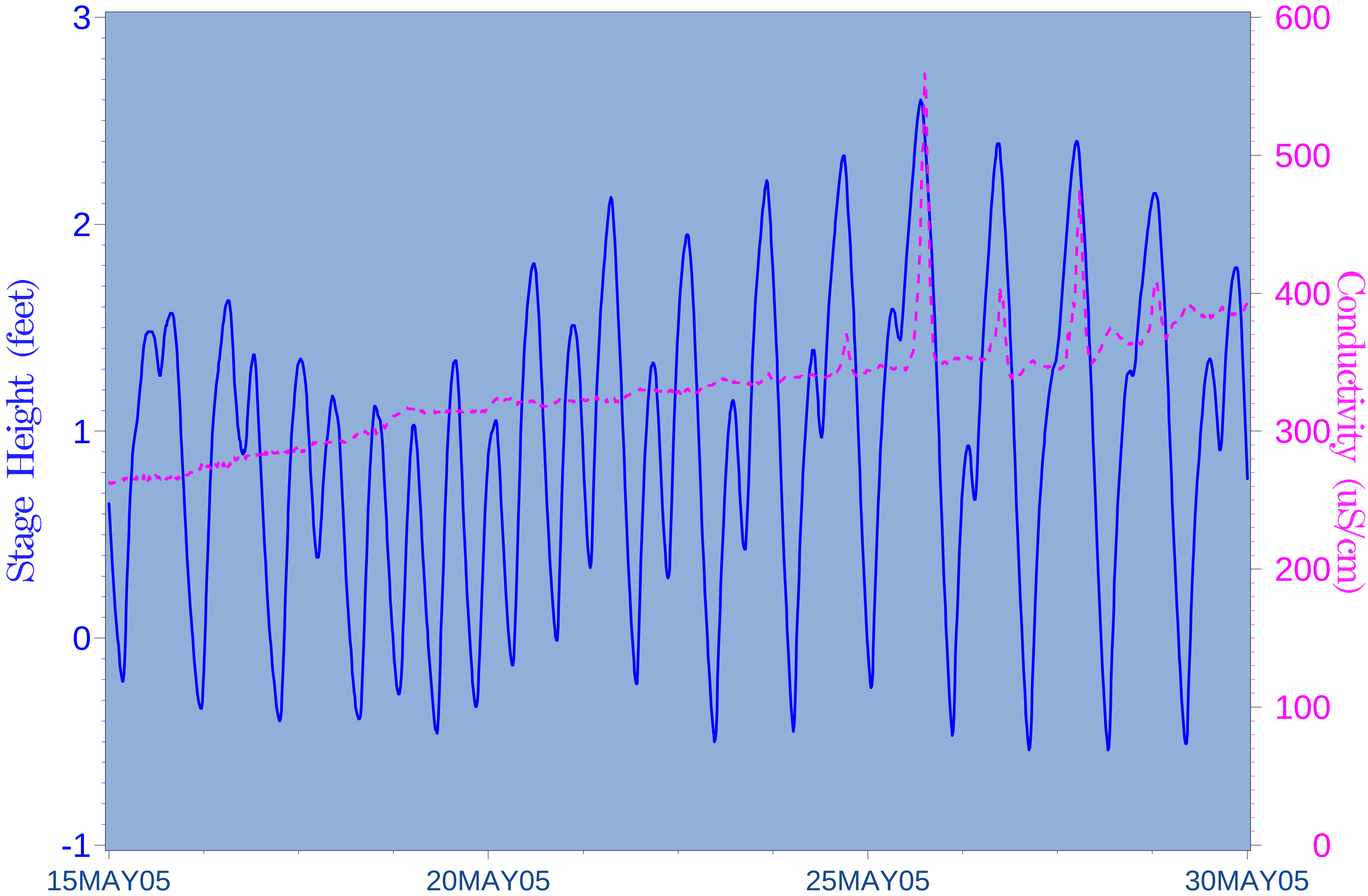


Figure 5.17 Surface conductivity and stage height in May - USGS Gage 02297350 (River Kilometer 26.7)

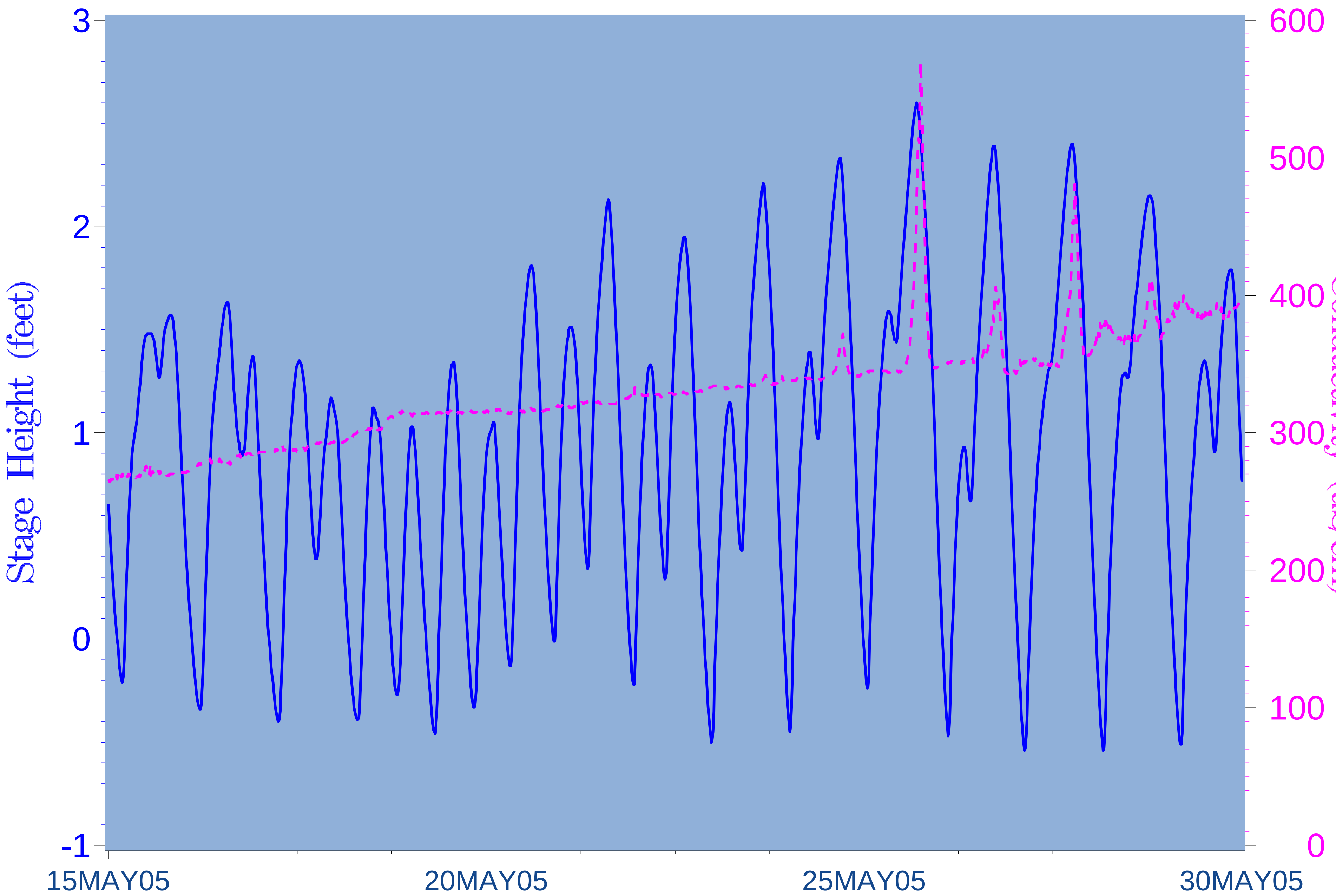


Figure 5.18 Bottom conductivity and stage height in May - USGS Gage 02297350 (River Kilometer 26.7)

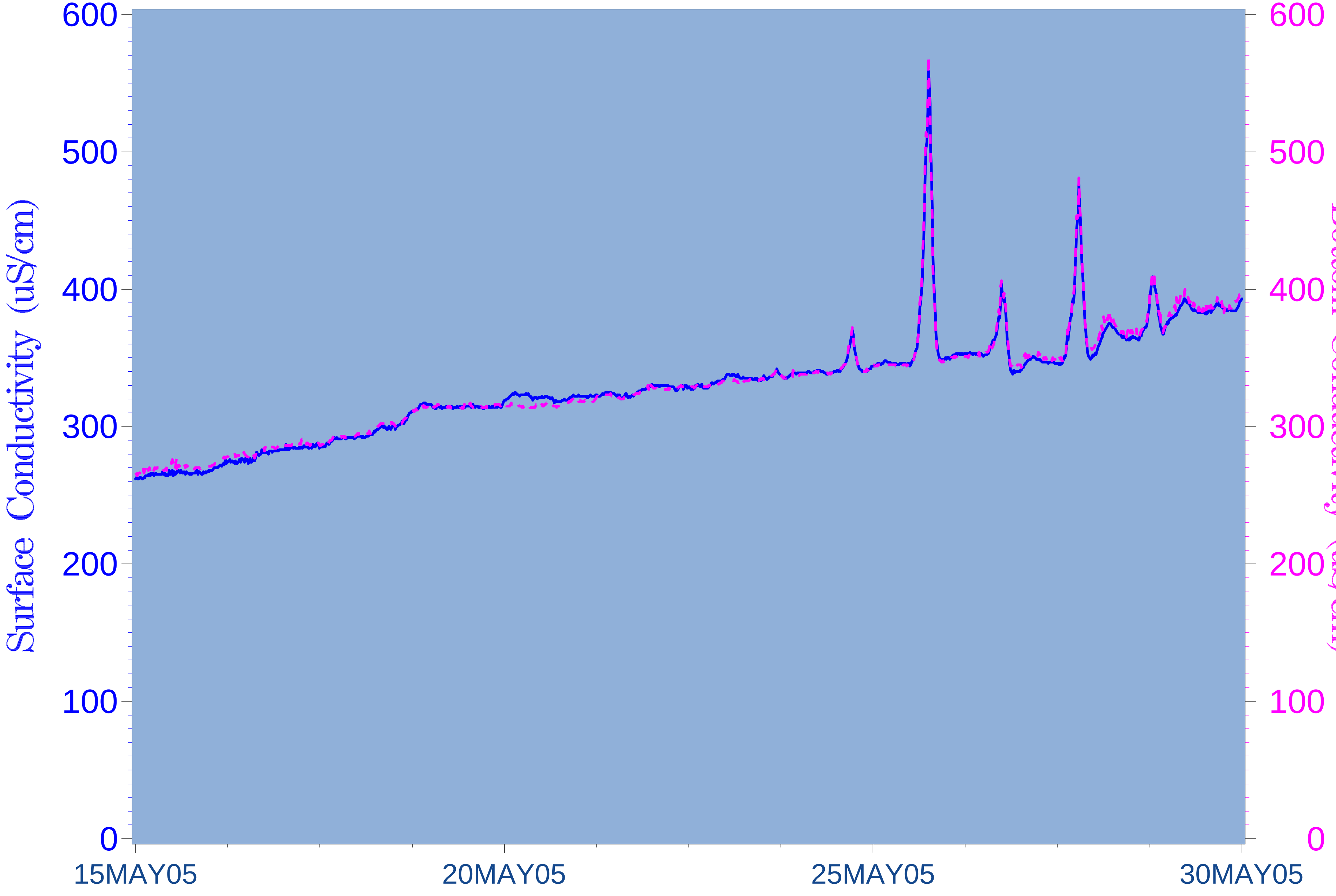


Figure 5.19 Surface and bottom conductivity in May
- USGS Gage 02297350 (River Kilometer 26.7)

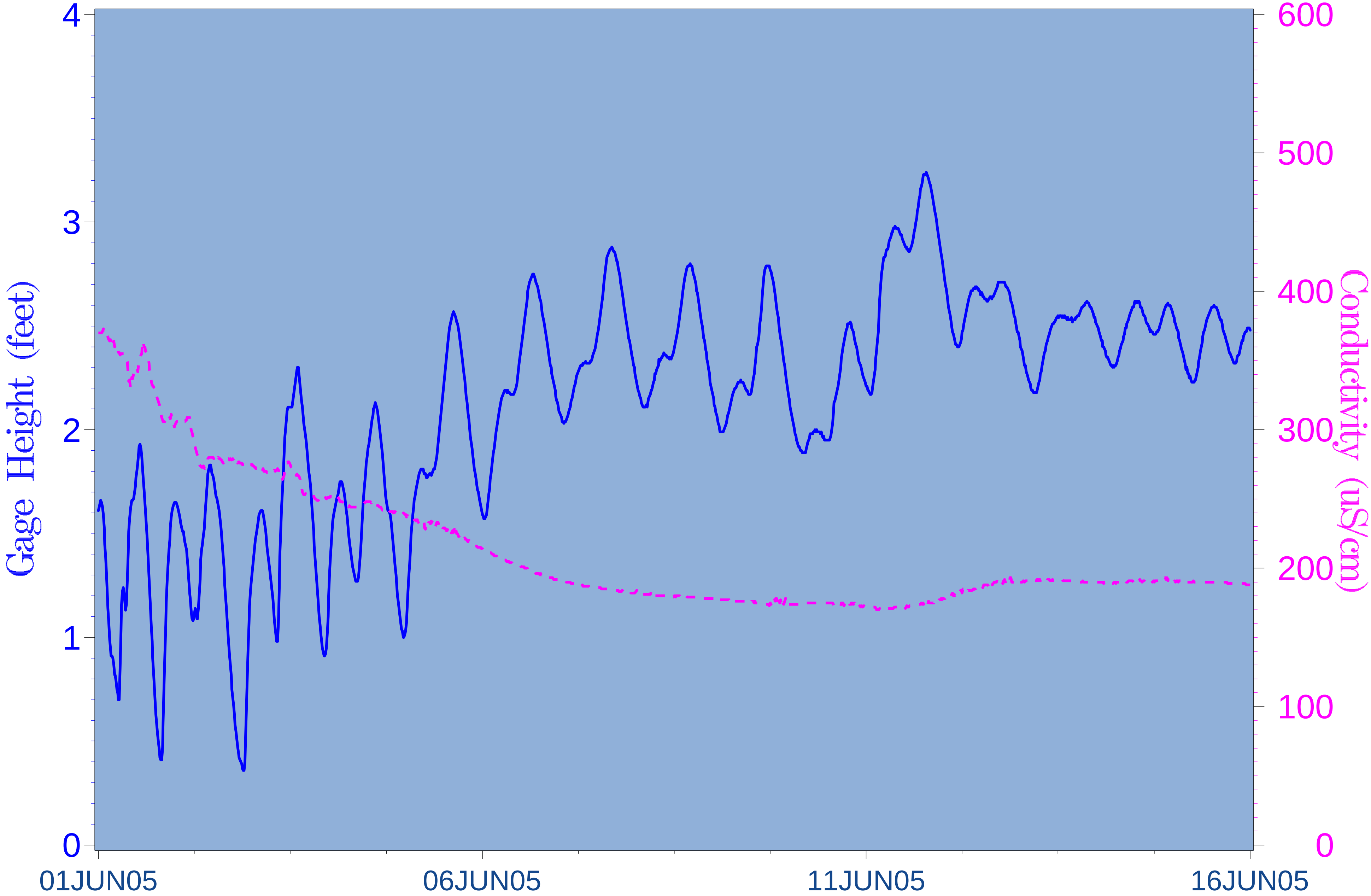


Figure 5.20 Surface conductivity and stage height in June
- USGS Gage 02297350 (River Kilometer 26.7)

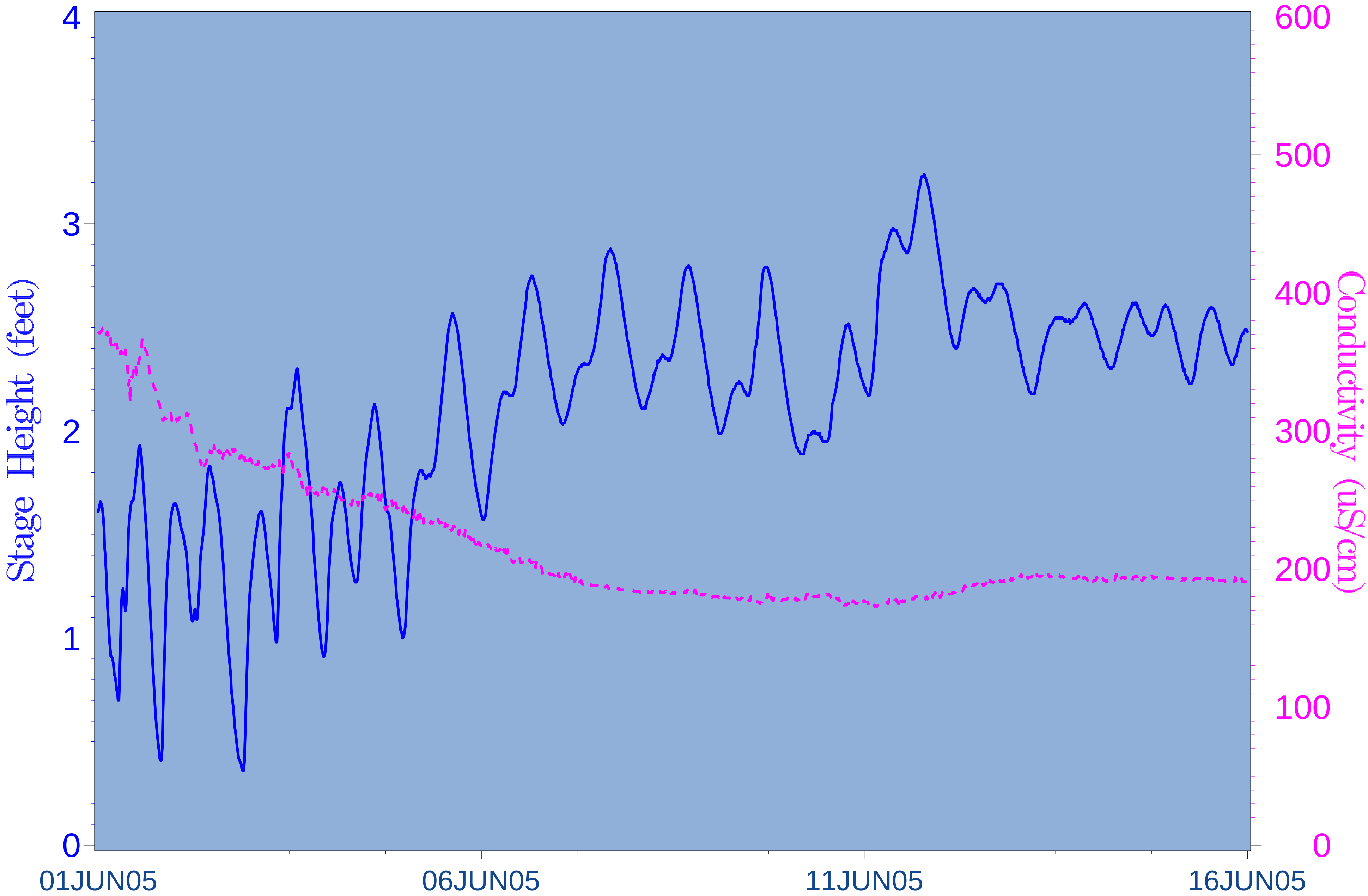


Figure 5.21 Bottom conductivity and stage height in June - USGS Gage 02297350 (River Kilometer 26.7)

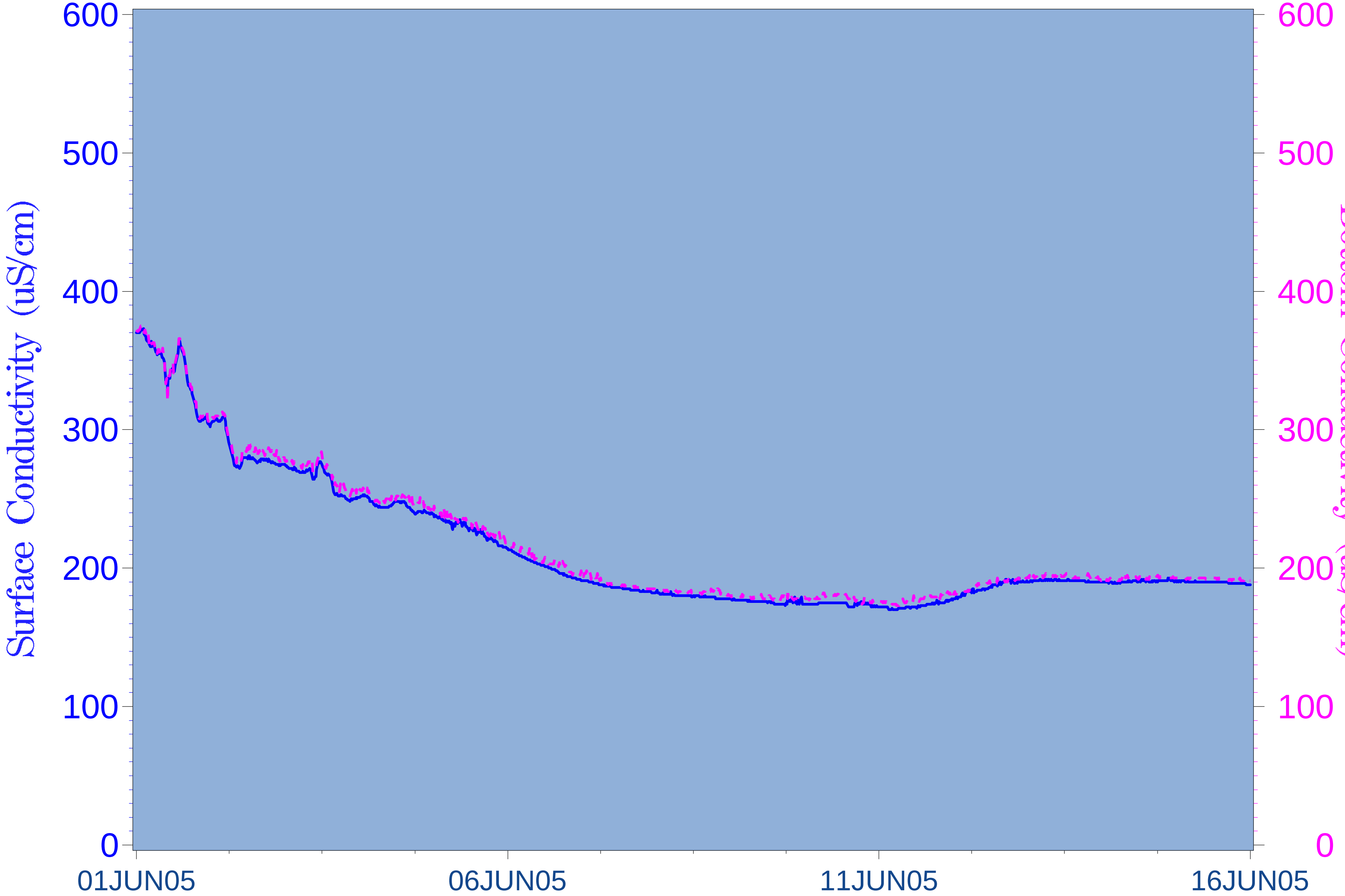


Figure 5.22 Surface and bottom conductivity in June - USGS Gage 02297350 (River Kilometer 26.7)

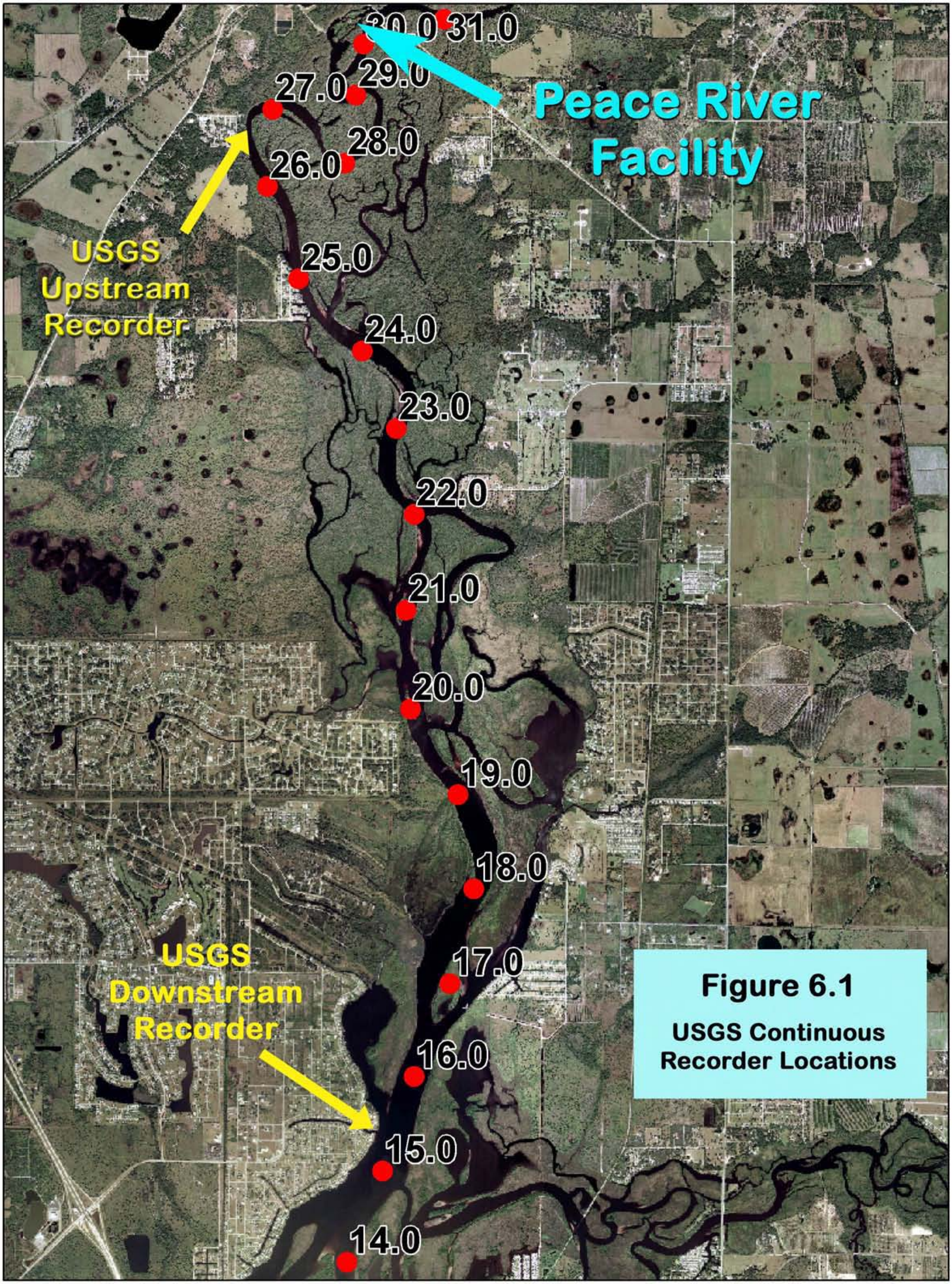


Figure 6.1

USGS Continuous Recorder Locations

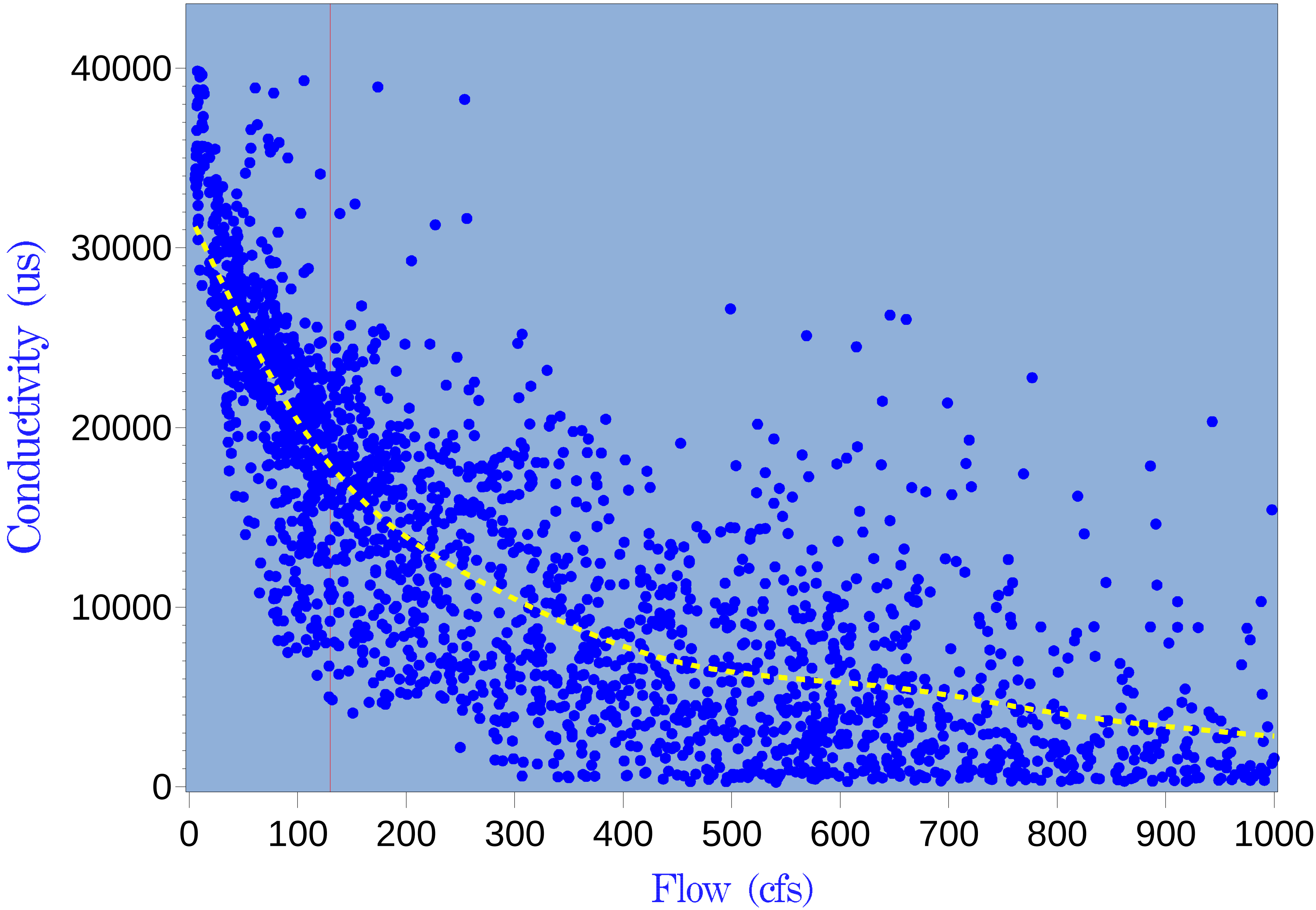


Figure 6.1 Recorder surface conductivity at river kilometer 15.5 versus flow

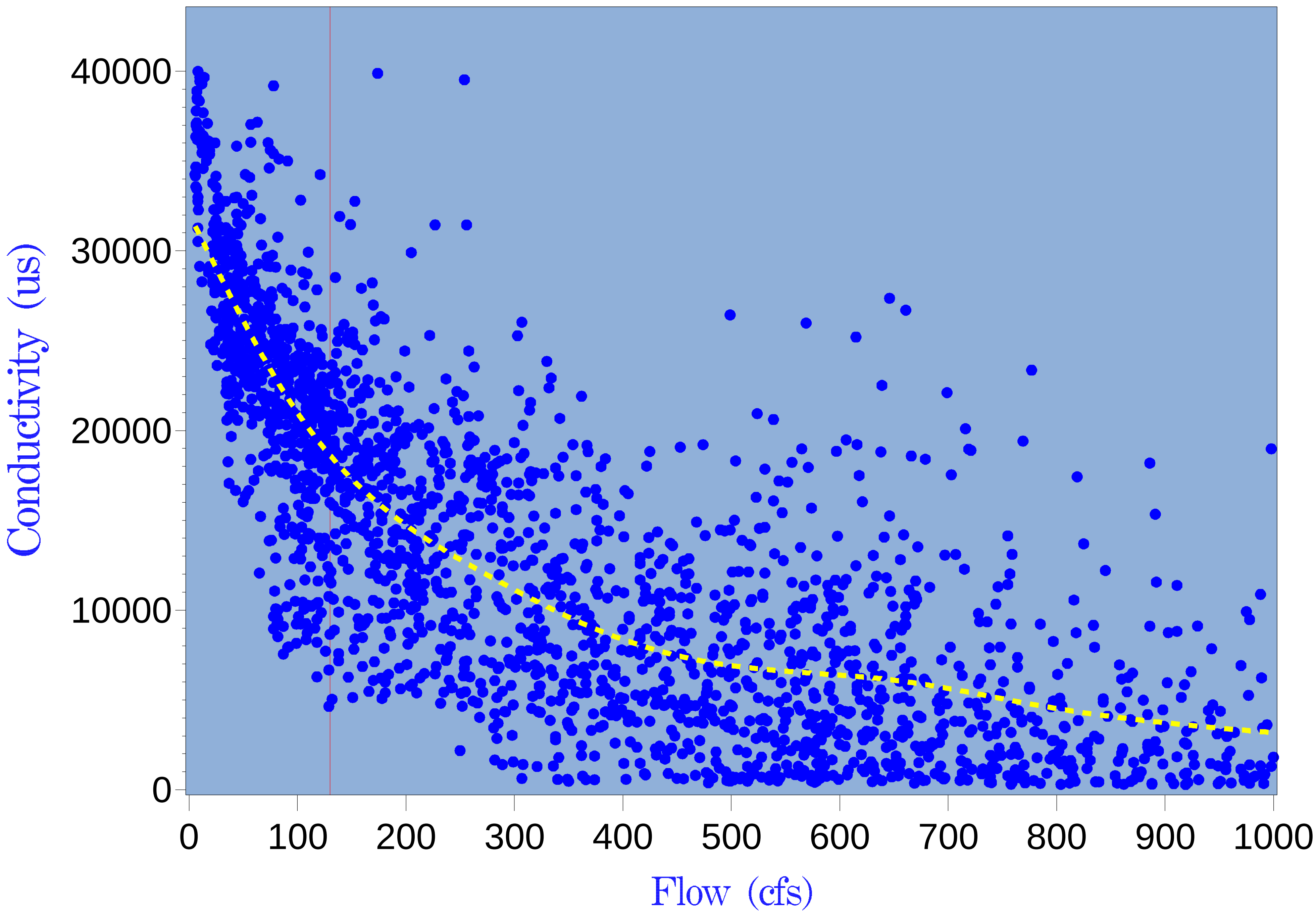


Figure 6.2 Recorder bottom conductivity at river kilometer 15.5 versus flow

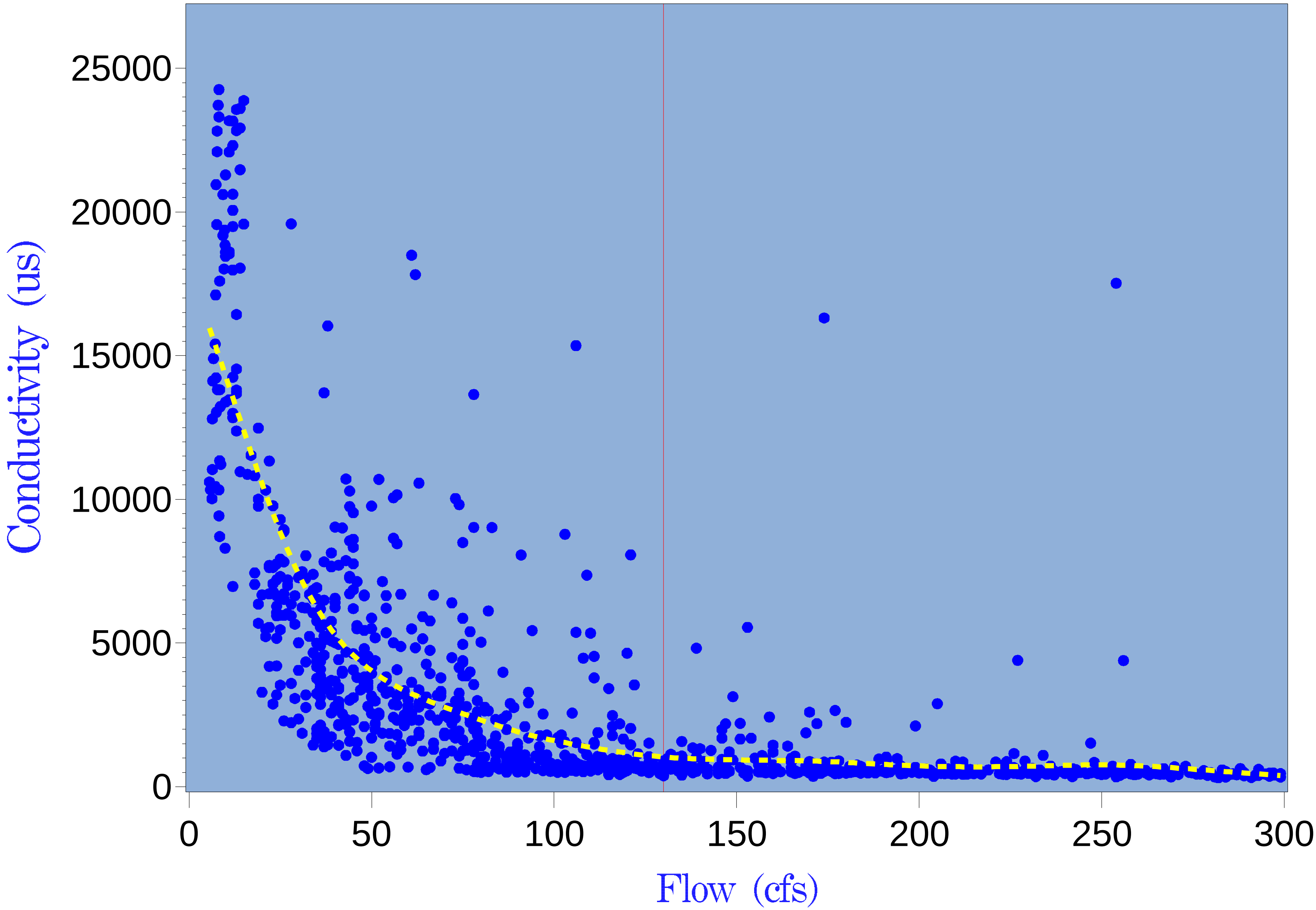


Figure 6.3 Recorder surface conductivity at river kilometer 26.7 versus flow

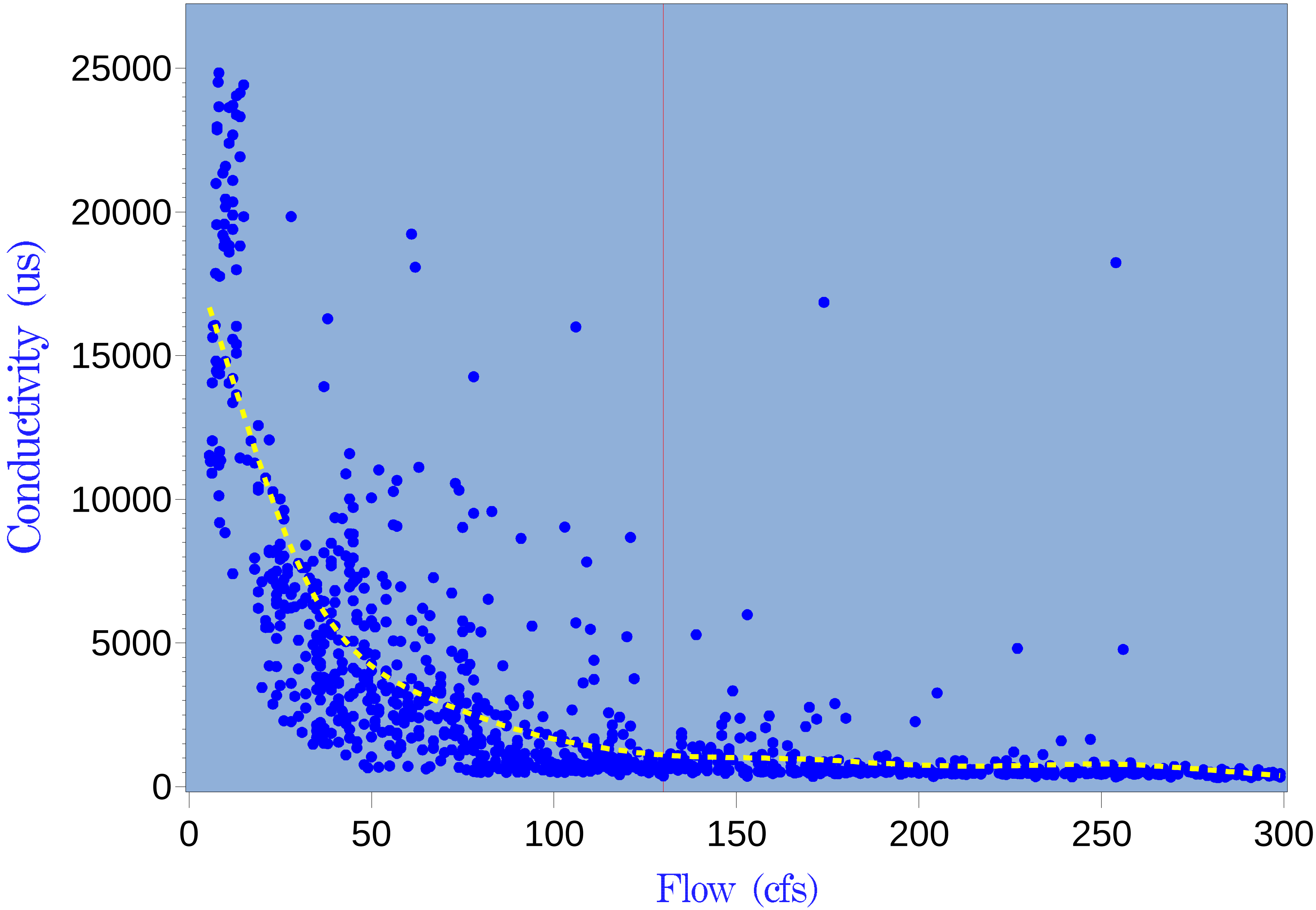
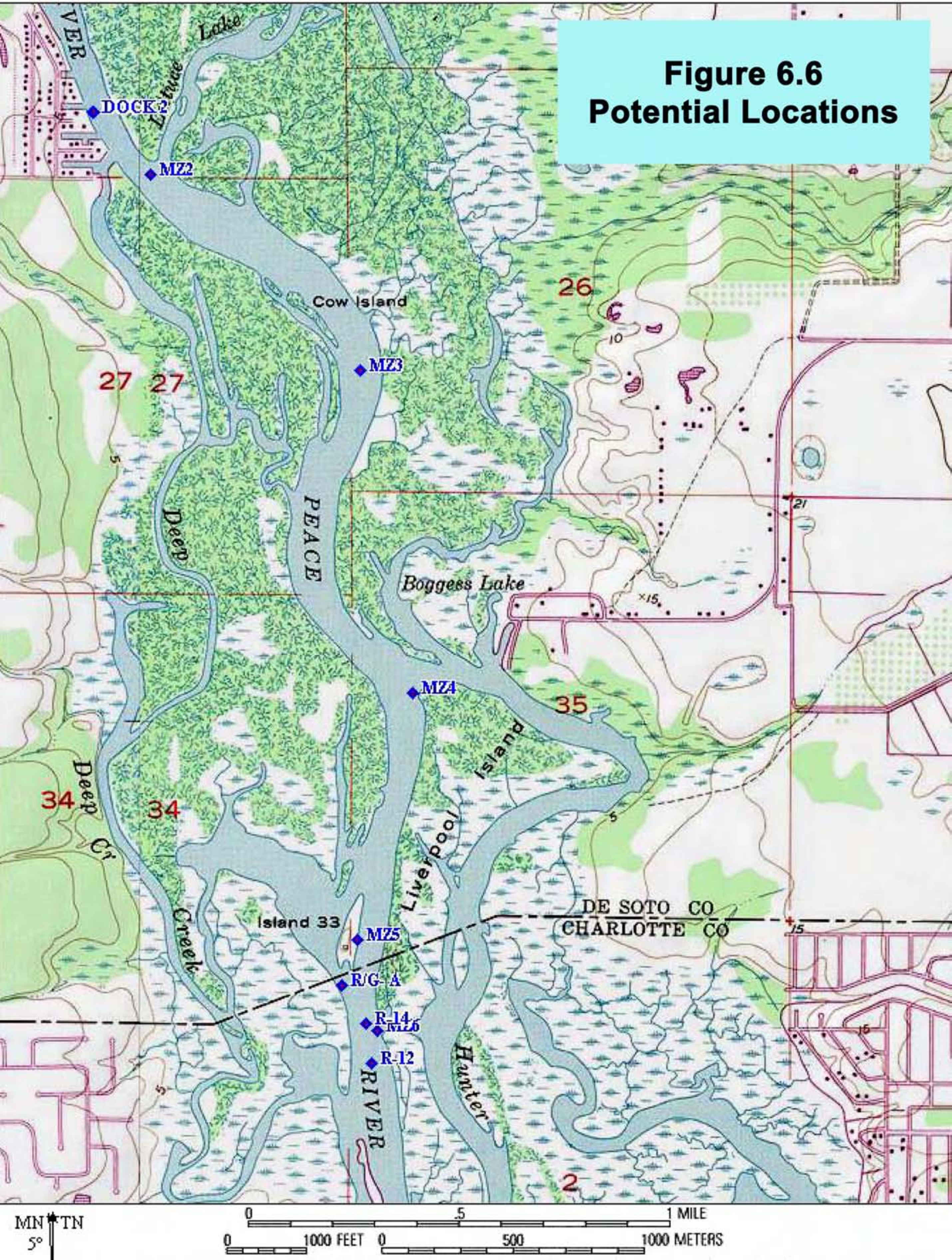


Figure 6.4 Recorder bottom conductivity at river kilometer 26.7 versus flow

Figure 6.6 Potential Locations



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

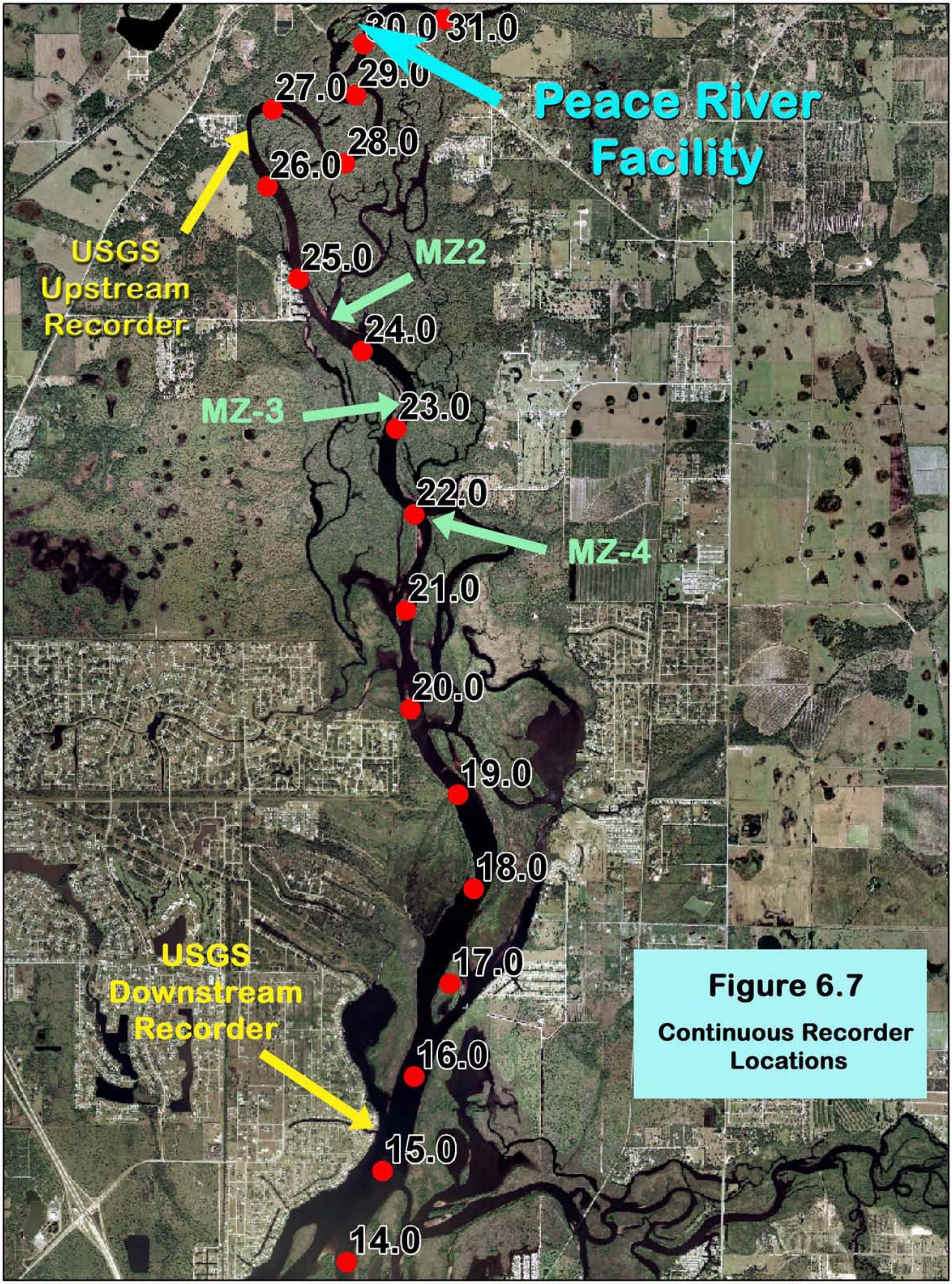


Figure 6.7

Continuous Recorder Locations

Figure 6.8

Diagram of Attachement to Existing Manatee Speed Zone Sign

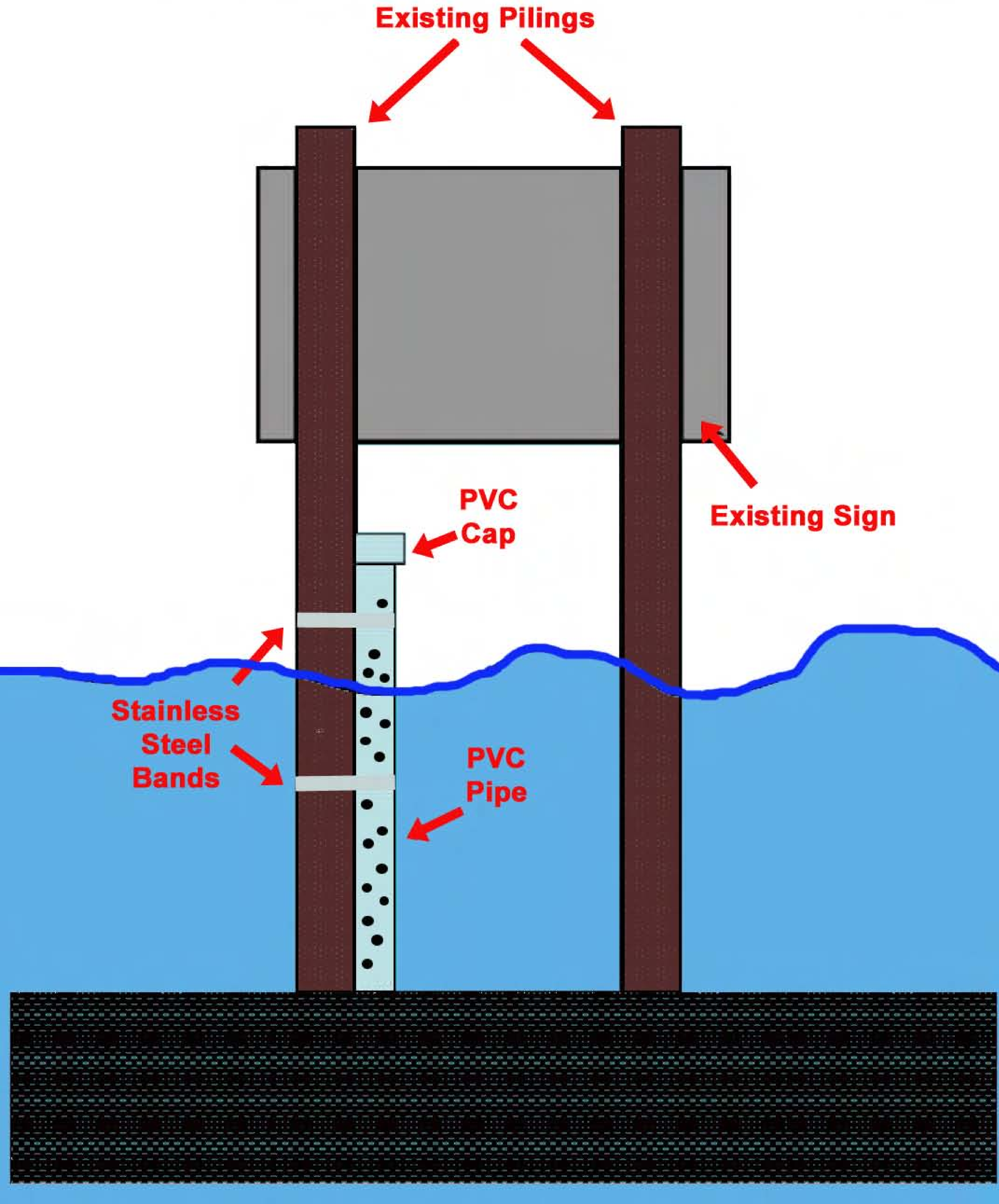


Figure 6.9

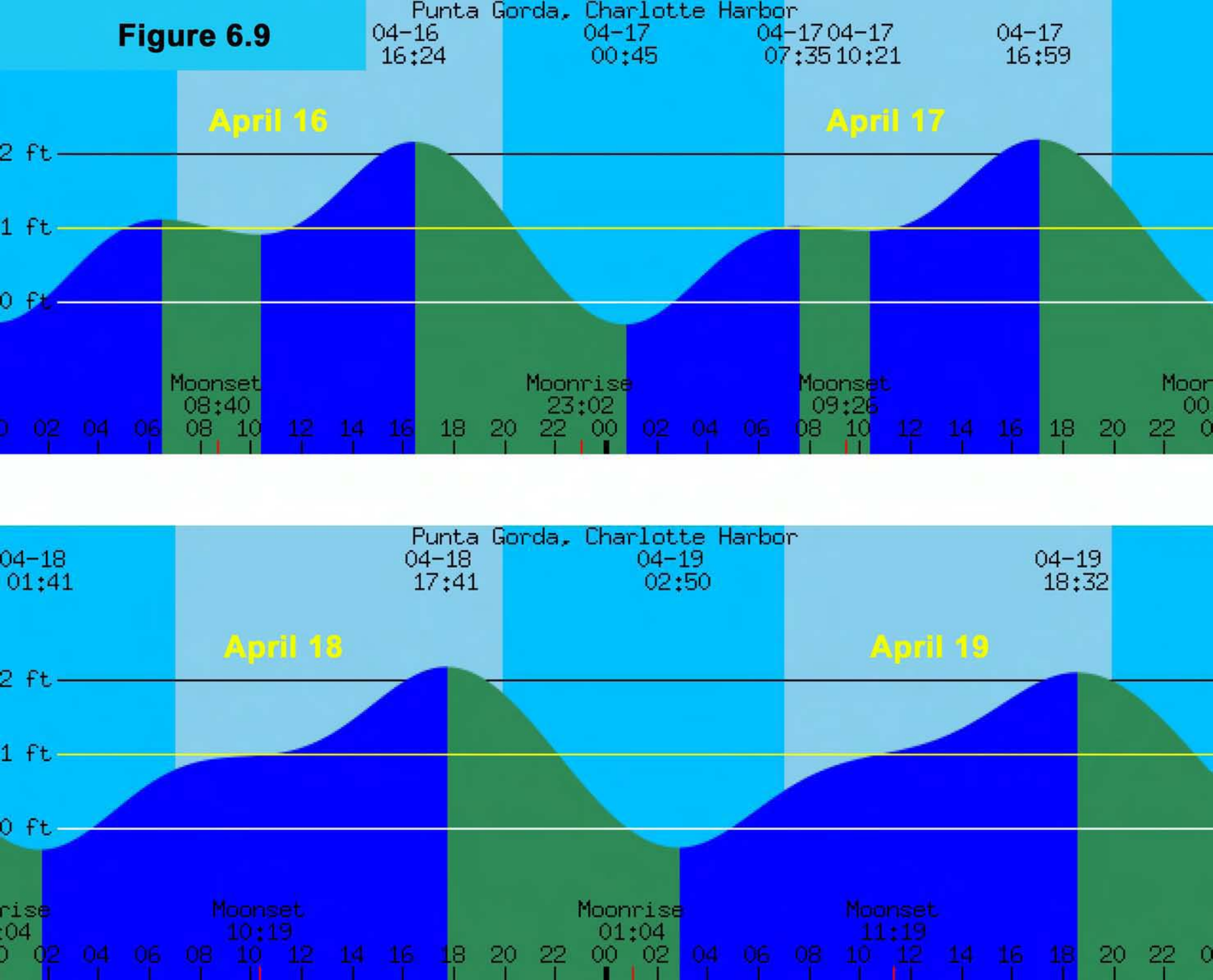

Punta Gorda, Charlotte Harbor
04-16 16:24
04-17 00:45
04-17 07:35
04-17 10:21
04-17 16:59
April 16
April 17
2 ft
1 ft
0 ft
Moonset 08:40
Moonrise 23:02
Moonset 09:26
02 04 06 08 10 12 14 16 18 20 22 00 02 04 06 08 10 12 14 16 18 20 22
Punta Gorda, Charlotte Harbor
04-18 01:41
04-18 17:41
04-19 02:50
04-19 18:32
April 18
April 19
2 ft
1 ft
0 ft
Moonset 10:19
Moonrise 01:04
Moonset 11:19
02 04 06 08 10 12 14 16 18 20 22 00 02 04 06 08 10 12 14 16 18 20 22

Figure 7.1

Conceptual Mode Of Impact Of Surface Water Withdrawals

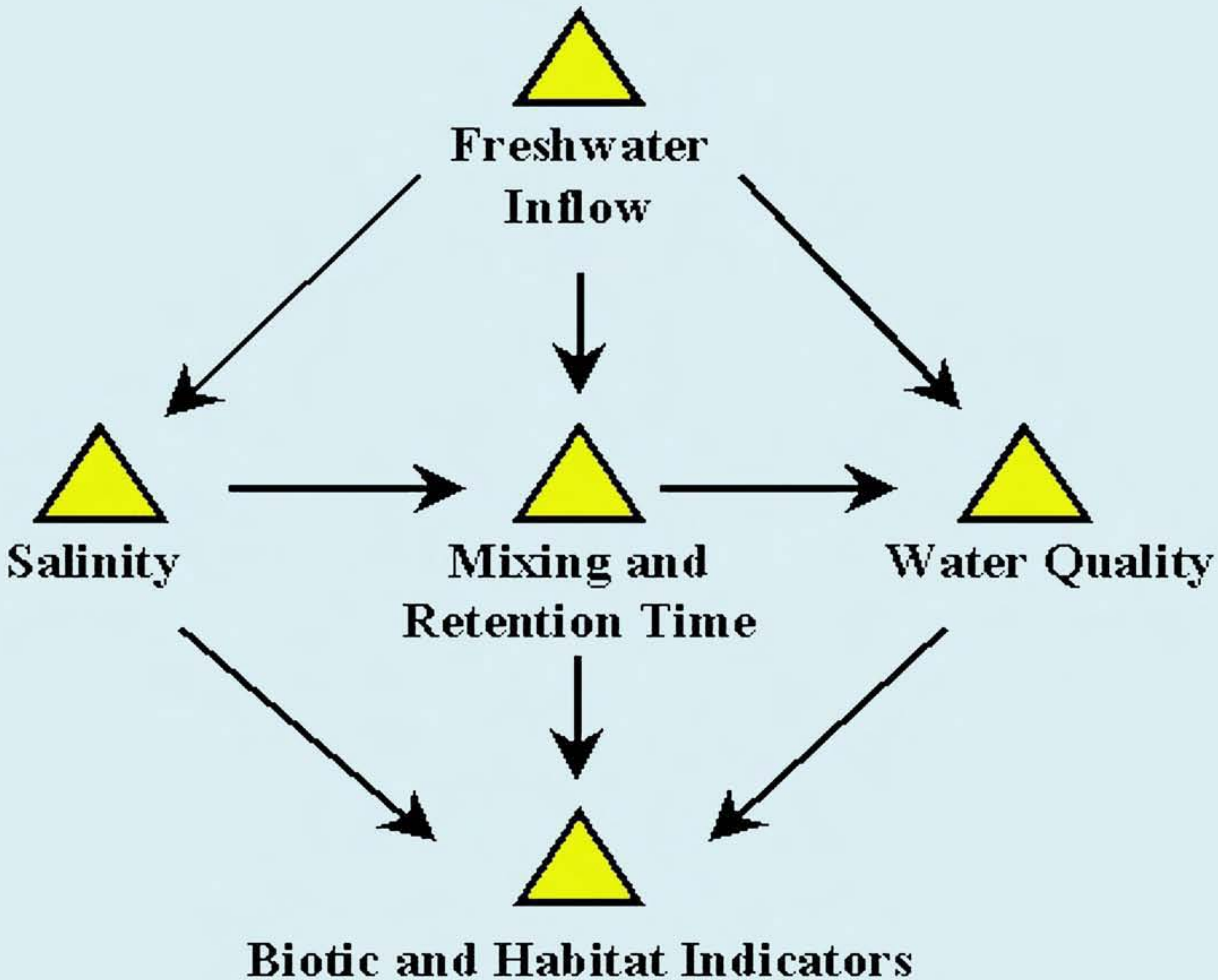
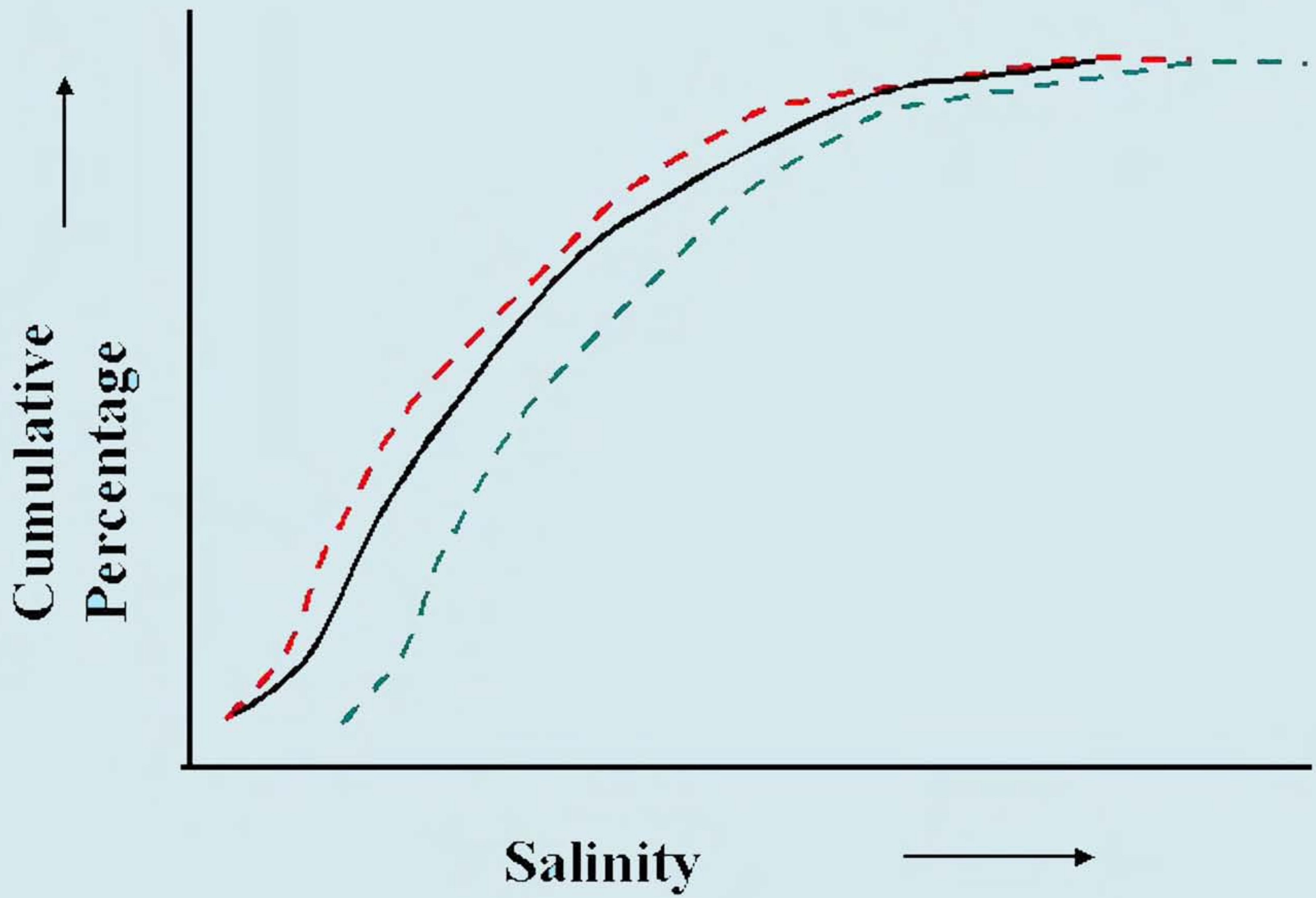


Figure 7.2

Conceptual Illustration Of A Salinity Target Range



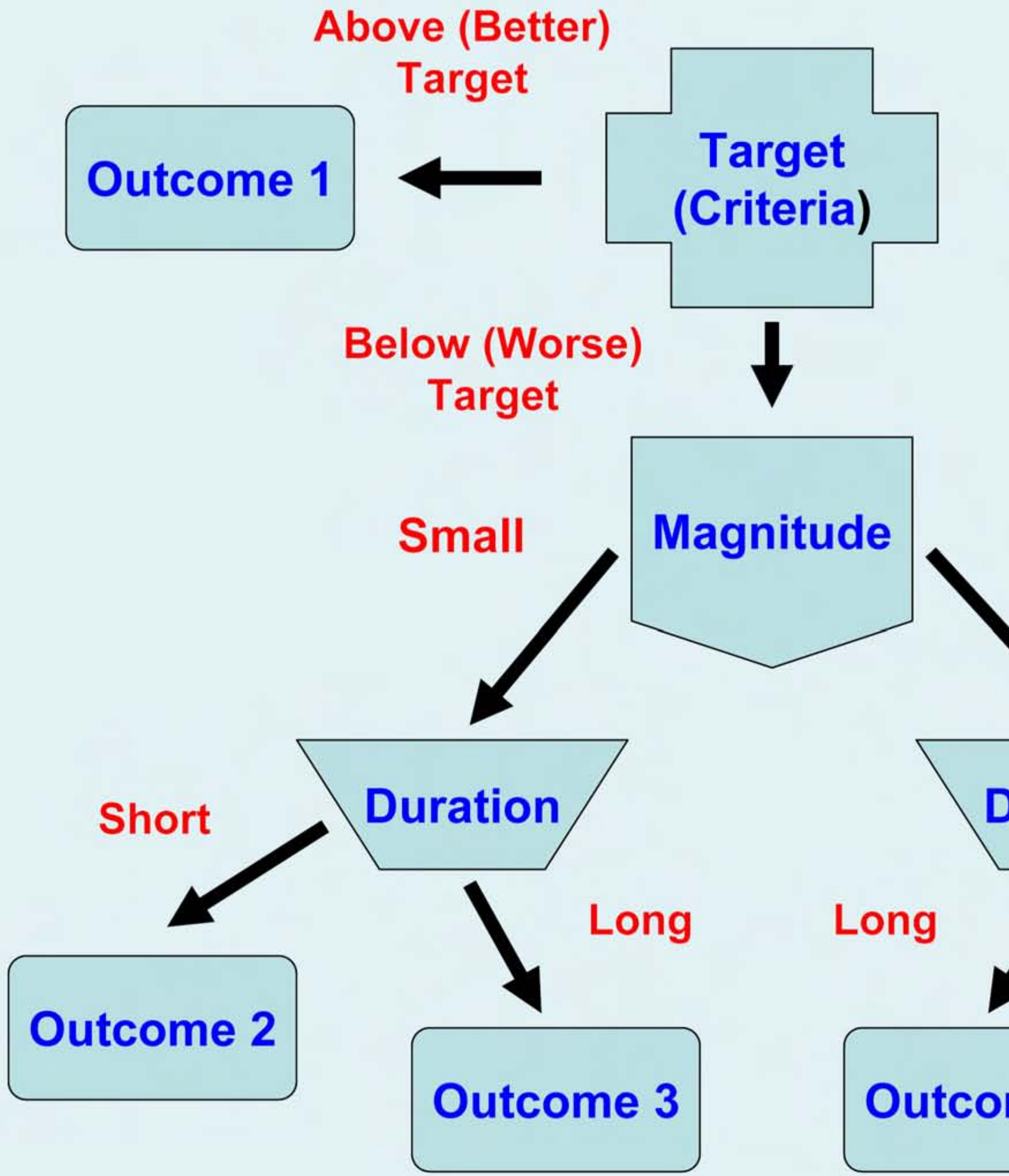
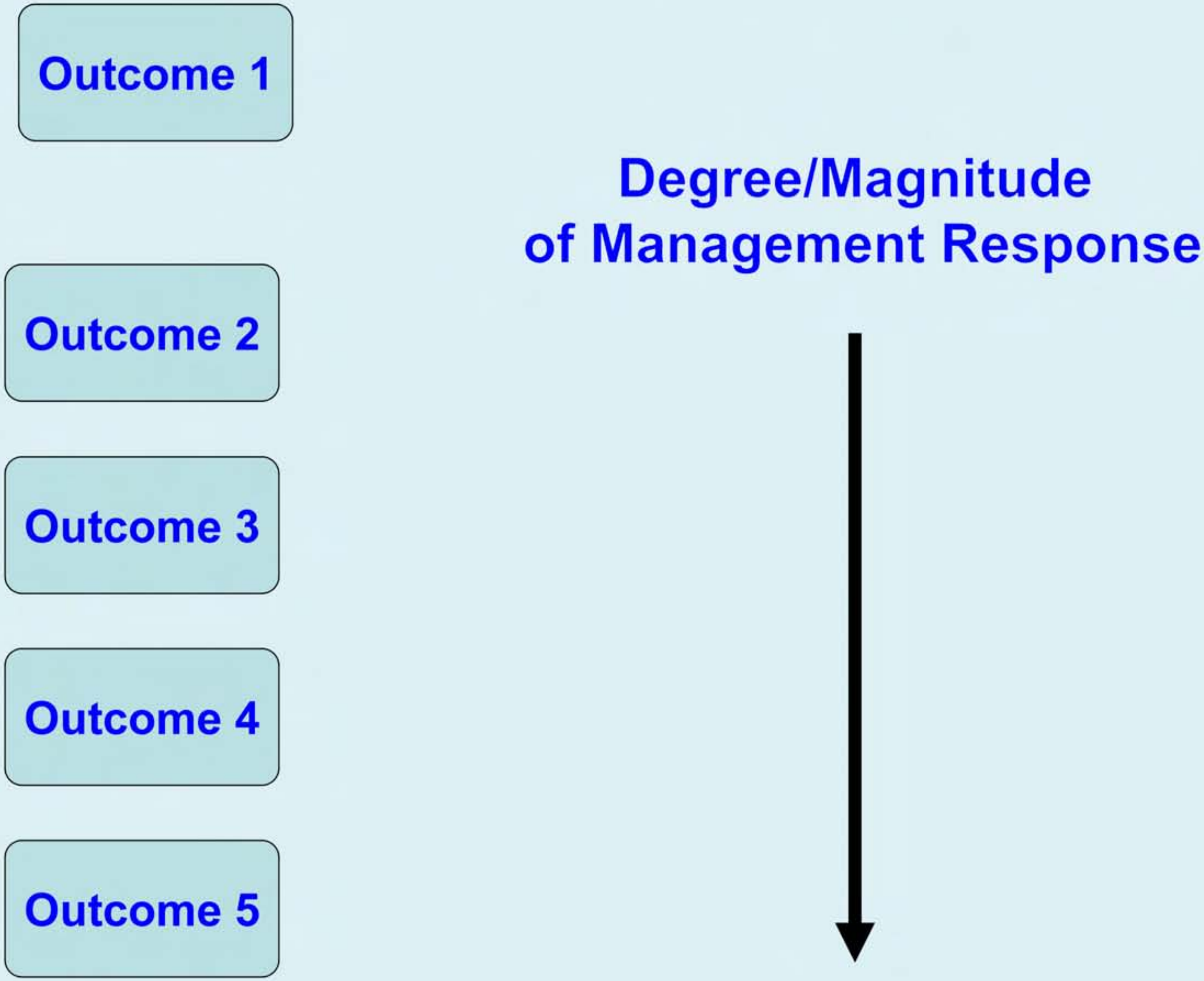
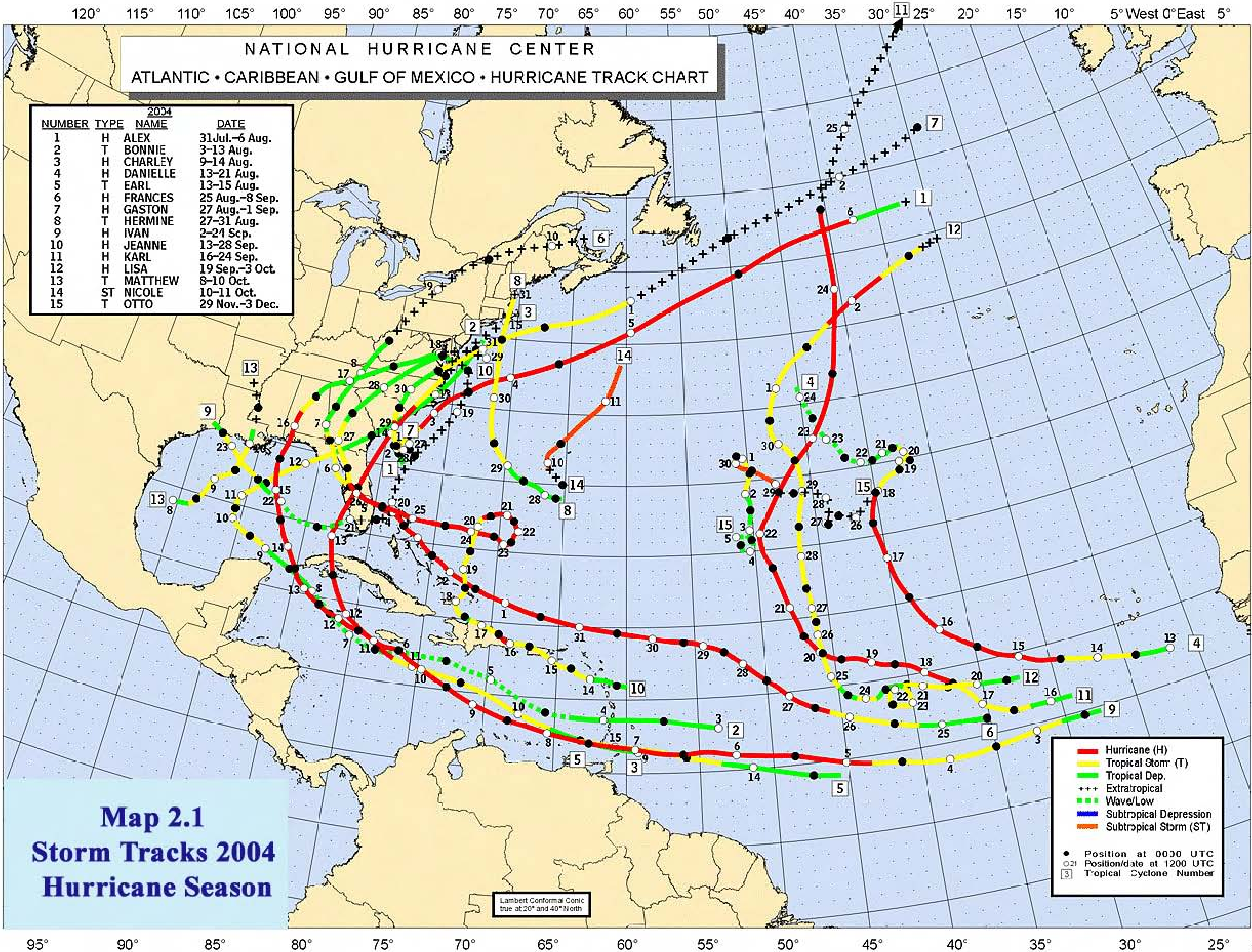


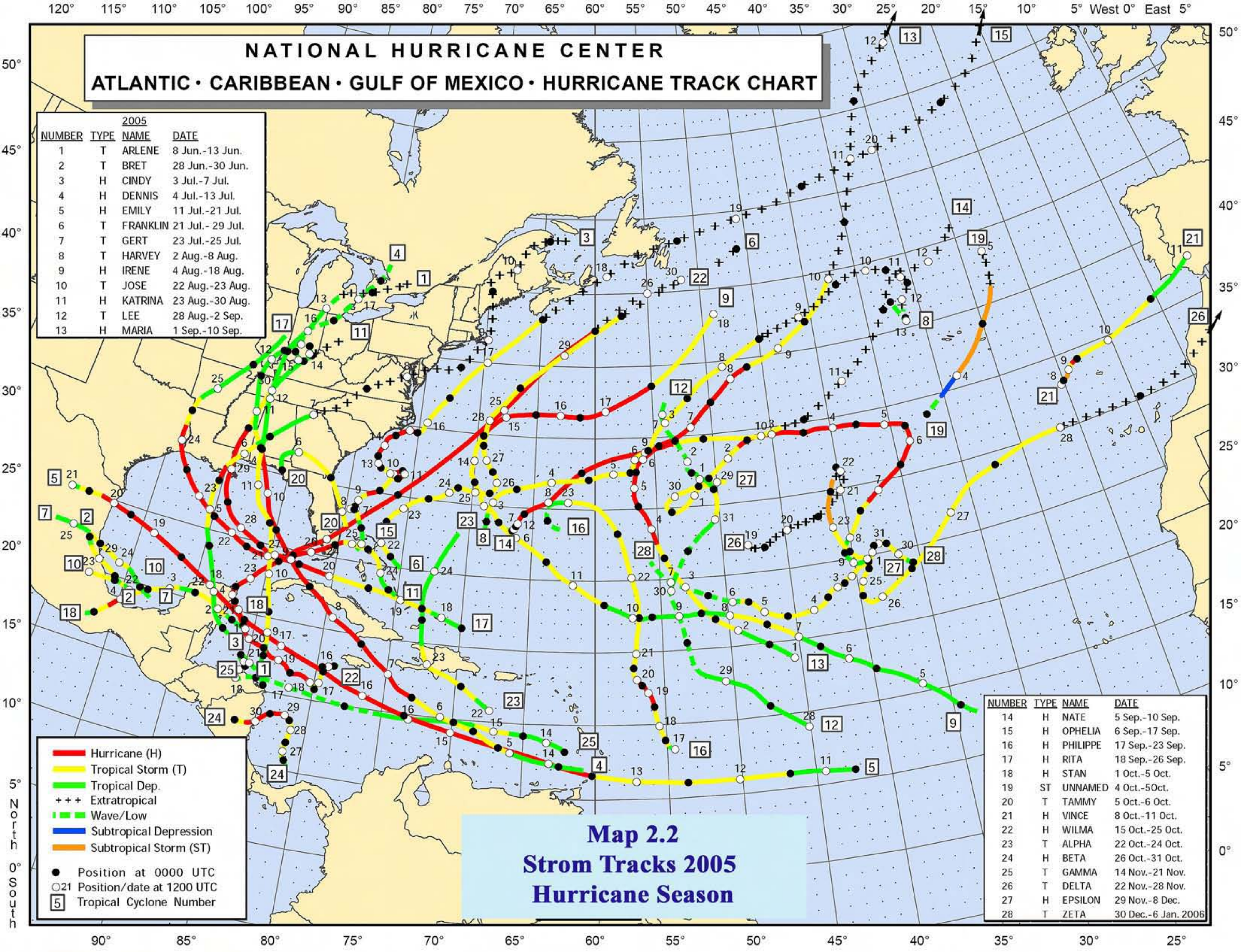
Figure 7.3
Conceptual Decision Tree for Evaluating Changes

Figure 7.4
Relationship of Change to Response





Map 2.1
Storm Tracks 2004
Hurricane Season



Map 2.2
Strom Tracks 2005
Hurricane Season

Photo 6.1

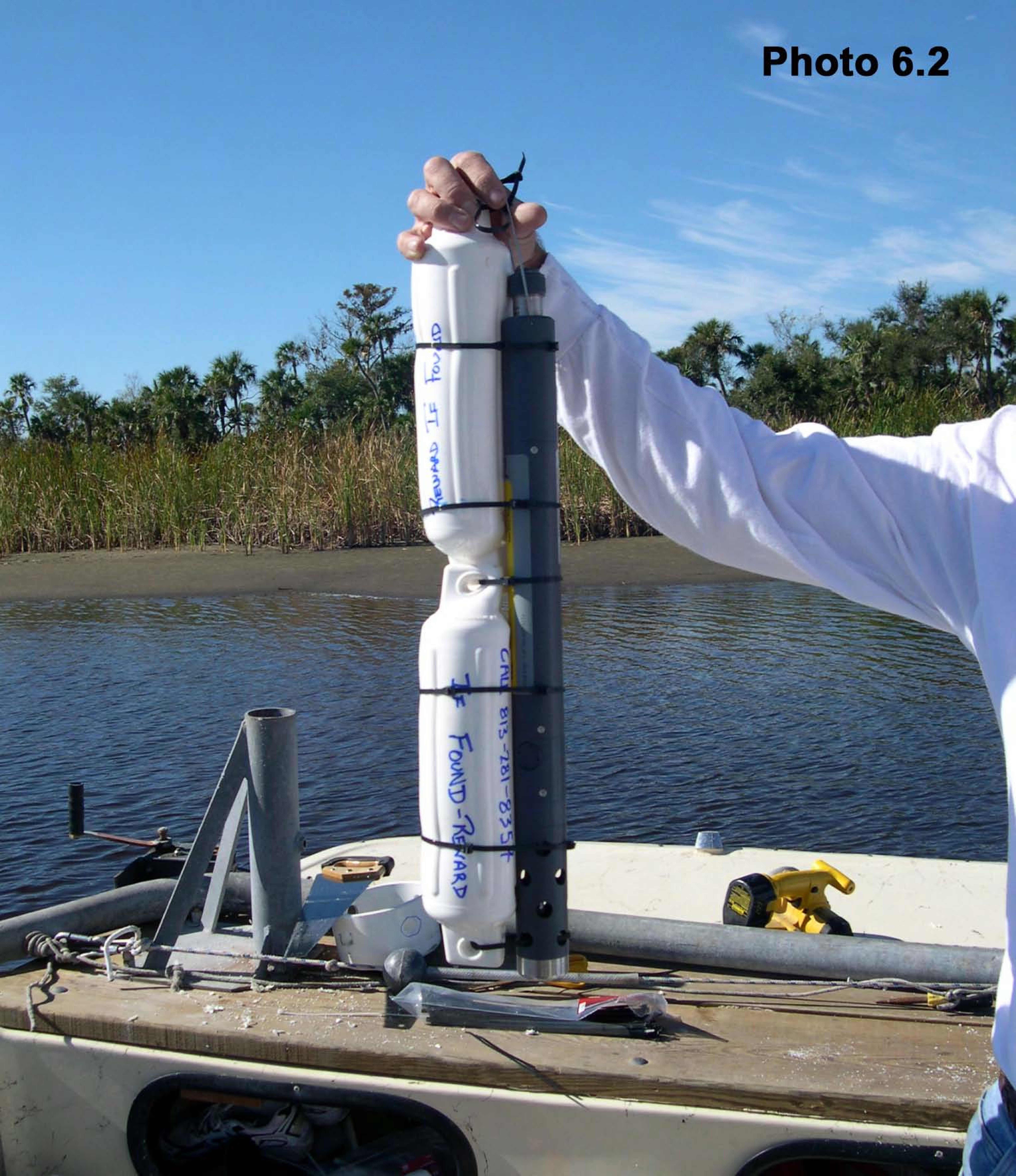


Photo 6.2

Photo 6.3

Photo 6.4

Data Set Name WORK.FLWD05

Observations	27304		
Member Type	DATA	Variables	17
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Created	Saturday, July 01, 2006 06:15:22 PM	Observation Length	136
Last Modified	Saturday, July 01, 2006 06:15:22 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	12288
Number of Data Set Pages	304
First Data Page	1
Max Obs per Page	90
Obs in First Data Page	67
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat	Label
2	ARCADIA	Num	8	BEST12.	F12.	Peace River at Arcadia (cfs)
11	BARTOW	Num	8	BEST12.	F12.	Peace at Bartow flow (cfs)
16	BIGS	Num	8	BEST12.	F12.	Big Slough at North Port flow (cfs)
10	DATE	Num	8	MMDDYY8.	DATE9.	DATE
8	DAY	Num	8			
12	FTMEADE	Num	8	BEST12.	F12.	Peace at Ft Meade flow (cfs)
1	HORSE	Num	8	BEST12.	F12.	Horse Flow (cfs)
3	JOSHUA	Num	8	BEST12.	F12.	Joshua Flow (cfs)
7	MONTH	Num	8			
15	MYAKKA	Num	8	BEST12.	F12.	Myakka near Sarasota flow (cfs)
14	PRAIRIE	Num	8	BEST12.	F12.	Prairie Creek flow (cfs)
17	Rainfall	Num	8	BEST12.	F12.	Rainfall at Facility (inches)
9	SASDATE	Num	8			
4	SHELL	Num	8	BEST12.	F12.	Shell Flow (cfs)
5	WITH	Num	8	8.2	F12.	Withdrawal (cfs)
6	YEAR	Num	8			
13	ZOLFO	Num	8	BEST12.	F12.	Peace at Zolfo flow (cfs)

Data Set Name WORK.CMOV8305

Observations	1158		
Member Type	DATA	Variables	55
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:23 PM	Observation Length	440
Last Modified	Saturday, July 01, 2006 06:15:23 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

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Number of Data Set Pages	32
First Data Page	1
Max Obs per Page	37
Obs in First Data Page	20
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
47	ALK	Num	8		Alkalinity (mg/l)
24	CF1	Num	8	8.1	Chlorophyll a >20 um Fraction (mg/m3)
25	CF2	Num	8	8.1	Chlorophyll a 20><5 um Fraction (mg/m3)
26	CF3	Num	8	8.1	Chlorophyll a 5> um Fraction (mg/m3)
27	CF4	Num	8	8.1	% Chlorophyll a >20 um Size Fraction
28	CF5	Num	8	8.1	% Chlorophyll a 20><5 um Size Fraction
29	CF6	Num	8	8.1	% Chlorophyll a 5> um Size Fraction
15	CHLA	Num	8	8.1	Chlorophyll-a (ug/l)
54	CHLB	Num	8		Chlorophyll b (mg/m3)
55	CHLC	Num	8		Chlorophyll c (mg/m3)
44	CL	Num	8	8.1	Chloride (mg/l)
7	COLOR	Num	8	8.	Color (CPU)
45	DATE	Num	8	DATE8.	Date
5	DAY	Num	8	8.	Day
4	DIS	Num	8	8.1	Distance (km)
42	DOC	Num	8	8.2	Dissolved Organic Carbon (mg/l)
50	DOP	Num	8		Dissolved Orthophosphate (mg/L)
14	EXC	Num	8	8.2	Light Extinction Coefficient
18	F1	Num	8	8.2	Uptake >20 um Fraction (mg Carbon/m3/E)
19	F2	Num	8	8.2	Uptake 20><5 um Fract. (mg Carbon/m3/E)
20	F3	Num	8	8.2	Uptake 5> um Fraction (mg Carbon/m3/E)
21	F4	Num	8	8.1	% Carbon Uptake >20 um Size Fraction
22	F5	Num	8	8.1	% Carbon Uptake 20><5 um Size Fraction
23	F6	Num	8	8.1	% Carbon Uptake 5> um Size Fraction
32	IOC	Num	8	8.2	Inorganic Carbon (mg/l)
43	IRON	Num	8	8.2	Iron (mg/l)
6	LIGHT	Num	8	8.1	Light Same Day (Einsteins)

Data Set Name WORK.CMOV8305 (continued)

2	MONTH	Num	8	8.	Month
9	N23	Num	8	8.3	Nitrite/Nitrate (mg/l)
8	NH34	Num	8	8.3	Ammonia/Ammonium (mg/l)
11	NP	Num	8	8.1	Available N/P Ratio
33	NPA	Num	8	8.1	Available N/P Atomic Ratio
35	ONIT	Num	8	8.2	TKN - NH4 (mg/l)
10	OP	Num	8	8.3	Orthophosphorus (mg/l)
37	OPD01	Num	8	8.2	Depth 1% of Surface Light Remains (m)
38	OPD10	Num	8	8.2	Depth 10% of Surface Light Remains (m)
39	OPD50	Num	8	8.2	Depth 50% of Surface Light Remains (m)
17	P2	Num	8	8.2	Carbon Uptake (mg Carbon/m3/hr)
16	P3	Num	8	8.2	Carbon Uptake (mg Carbon/m3/E)
46	SASDATE	Num	8		SAS Date
13	SI	Num	8	8.2	Silica (mg/l)
51	SOURCE	Char	3		
3	STATION	Num	8	8.	Sample Location
30	TKN	Num	8	8.2	Total Kjeldahl Nitrogen (mg/l)
36	TN	Num	8	8.2	TKN + N23 (mg/l)
12	TNTP	Num	8	8.1	Total N/P Ratio
34	TNTPA	Num	8	8.1	Total N/P Atomic Ratio
41	TOC	Num	8	8.2	Total Organic Carbon (mg/l)
31	TP	Num	8	8.3	Total Phosphorus (mg/l)
48	TSS	Num	8		Total Suspended Solids (mg/l)
40	TURB	Num	8	8.2	Turbidity
52	TYPE	Char	6		
49	VSS	Num	8		Volatile Suspended Solids (mg/L)
1	YEAR	Num	8	8.	Year
53	time	Num	8	TIME5.	

Data Set Name WORK.HYMOV05

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Member Type	DATA	Variables	17
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Created	Saturday, July 01, 2006 06:15:23 PM	Observation Length	136
Last Modified	Saturday, July 01, 2006 06:15:23 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

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Number of Data Set Pages	80
First Data Page	1
Max Obs per Page	90
Obs in First Data Page	69
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
7	COND	Num	8	8.1	Conductivity
12	DATE	Num	8	DATE7.	DayMonthYear
3	DAY	Num	8	4.	Day
4	DEPTH	Num	8	4.1	Sample Depth (m)
13	DIS	Num	8	8.1	Distance (km)
6	DO	Num	8	8.1	Dissolved Oxygen (mg/l)
2	MONTH	Num	8	8.	Month
9	ORP	Num	8	5.	Oxidation Reduction Potential
8	PH	Num	8	8.1	pH
10	SAL	Num	8	8.1	Salinity (ppt)
11	SASDATE	Num	8	6.	SAS Date
14	SOURCE	Char	4		Data Source
16	STATION	Num	8	6.	
5	TEMP	Num	8	8.1	Temperature (C)
15	TYPE	Char	6		Moving or Fixed
1	YEAR	Num	8	8.	Year
17	time	Num	8	TIME5.	

Data Set Name WORK.HYFIX05

Observations	13772		
Member Type	DATA	Variables	16
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Created	Saturday, July 01, 2006 06:15:23 PM	Observation Length	128
Last Modified	Saturday, July 01, 2006 06:15:23 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	12288
Number of Data Set Pages	146
First Data Page	1
Max Obs per Page	95
Obs in First Data Page	74
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
12	COND	Num	8	8.	Specific Conductance (us/cm)
6	DATE	Num	8	DATE7.	Date
10	DAY	Num	8		Day
5	DEPTH	Num	8	8.1	Sampling Depth (m)
4	DIS	Num	8		River Kilometer of Site Location
13	DO	Num	8	8.2	Dissolved Oxygen (mg/L)
9	MONTH	Num	8	8.	Month
14	PH	Num	8	8.2	pH Water Whole Field (std.units)
16	SAL	Num	8	8.1	Salinity (ppt)
3	SASDATE	Num	8		SAS Date
1	SOURCE	Char	4		Collected By
15	STATION	Num	8	6.	
11	TEMP	Num	8	8.1	Temperature (C)
7	TIME	Num	8	TIME5.	Time
2	TYPE	Char	5		Moving or Fixed
8	YEAR	Num	8	8.	Year

Data Set Name WORK.CFIX9605

Observations	1129		
Member Type	DATA	Variables	40
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:23 PM	Observation Length	312
Last Modified	Saturday, July 01, 2006 06:15:23 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	16384
Number of Data Set Pages	23
First Data Page	1
Max Obs per Page	52
Obs in First Data Page	34
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
23	ALK	Num	8		Alkalinity Lab (mg/L as CACO3)
33	CF1	Num	8		> 20 um Size Fraction
34	CF2	Num	8		20> <5 um Size Fraction
35	CF3	Num	8		> 5 um Size Fraction
32	CHLA	Num	8	8.2	Chlorophyll a (ug/L)
39	CHLB	Num	8	8.2	Chlorophyll b (mg/m3)
40	CHLC	Num	8	8.2	Chlorophyll c (mg/m3)
19	CL	Num	8		Chloride Dissolved (mg/l as Cl)
11	COLOR	Num	8		Color (Platinum-cobalt units)
1	DATE	Num	8	DATE7.	Date
4	DAY	Num	8		Day
9	DEP	Char	3	$3.	Surface or Bottom Sample
6	DIS	Num	8		Distance from Mouth of River
17	DOC	Num	8		Carbon, Organic dissolved (mg/l as C)
25	DOP	Num	8		Dissolved Orthophosphate (mg/L)
18	IOC	Num	8		Carbon, Inorganic Total (mg/l as C)
36	IRON	Num	8		Iron (mg/L)
3	MONTH	Num	8		Month
15	N23	Num	8		Nitrogen, NO2+NO3 Total (mg/l as N)
37	NH34	Num	8		Ammonia/Ammonium (mg/l)
26	NP	Num	8	8.1	Ration of Availiable Nitriogen to Phosphorus
28	NPA	Num	8	8.1	Atomic Ration of Availiable Nitriogen to Phosphorus
30	ONIT	Num	8		Organic Nitrogen (mg/L)
22	OP	Num	8		Phosphorus Ortho Total (mg/l as P)
5	SASDATE	Num	8		SAS Date
20	SI	Num	8		Silica, Dissolved (mg/l as SIO2)

Data Set Name WORK.CFIX9605 (continued)

7	SOURCE	Char	4		Collected By
24	STATION	Num	8		Station Number
14	TKN	Num	8		Nitrogen, Total Kjeldahl (mg/l as N)
31	TN	Num	8		Total Nitrogen (mg/L)
27	TNTP	Num	8	8.1	Ration of Total Nitriogen to Phosphorus
29	TNTPA	Num	8	8.1	Atomic Ration of Total Nitriogen to Phosphorus
16	TOC	Num	8		Carbon, Organic Total (mg/l as C)
21	TP	Num	8		Phosphorus, Phosphorus Total (mg/l as P)
13	TSS	Num	8		Residue Volatile, suspended (mg/l)
10	TURB	Num	8		Turbidity (NTU)
8	TYPE	Char	5		Moving or Fixed
12	VSS	Num	8		Residue Total at 105 degC susp (mg/l)
2	YEAR	Num	8		Year
38	time	Num	8	TIME5.	

Data Set Name WORK.EFIX9605

Observations	1233		
Member Type	DATA	Variables	13
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:23 PM	Observation Length	96
Last Modified	Saturday, July 01, 2006 06:15:23 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	8192
Number of Data Set Pages	15
First Data Page	1
Max Obs per Page	84
Obs in First Data Page	60
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
9	DATE	Num	8	DATE8.	Sampling Date
2	DAY	Num	8		Day
12	DIS	Num	8		River Kilometer
5	EXC	Num	8		Extinction Coefficient
1	MONTH	Num	8		Month
6	OPD01	Num	8		1% Light Depth
7	OPD10	Num	8		10% Light Depth
8	OPD50	Num	8		50% Light Depth
10	SASDATE	Num	8		
13	SOURCE	Char	3		
4	STATION	Num	8		EQL Station #
11	TYPE	Char	5		
3	YEAR	Num	8		Year

Data Set Name WORK.HH05

Observations	309783		
Member Type	DATA	Variables	15
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:23 PM	Observation Length	112
Last Modified	Saturday, July 01, 2006 06:15:23 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	12288
Number of Data Set Pages	2843
First Data Page	1
Max Obs per Page	109
Obs in First Data Page	85
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
6	CONDBOT	Num	8		Bottom Conductance (uS/cm @25C)
5	CONDSURF	Num	8		Surface Conductance (uS/cm @25C)
2	DATE	Num	8	DATE7.	Date
11	DAY	Num	8		Day
15	DIS	Num	8		Distance from Mouth of River
1	GAGE	Char	8		USGS Gage Number
4	GHEIGHT	Num	8		Gage Height (feet)
10	MONTH	Num	8		Month
12	SASDATE	Num	8		SAS Date
13	SOURCE	Char	4		Collected By
8	TEMPBOT	Num	8		Bottom Temperature (degrees C)
7	TEMPSURF	Num	8		Surface Temperature (degrees C)
3	TIME	Num	8	TIME5.	Time
14	TYPE	Char	4		Moving, Fixed or Gage
9	YEAR	Num	8		Year

Data Set Name WORK.PRH05

Observations	272614		
Member Type	DATA	Variables	15
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:26 PM	Observation Length	112
Last Modified	Saturday, July 01, 2006 06:15:26 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	12288
Number of Data Set Pages	2502
First Data Page	1
Max Obs per Page	109
Obs in First Data Page	85
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
6	CONDBOT	Num	8		Bottom Conductance (uS/cm @25C)
5	CONDSURF	Num	8		Surface Conductance (uS/cm @25C)
2	DATE	Num	8	DATE7.	Date
11	DAY	Num	8		Day
15	DIS	Num	8		Distance from Mouth of River
1	GAGE	Char	8		USGS Gage Number
4	GHEIGHT	Num	8		Gage Height (feet)
10	MONTH	Num	8		Month
12	SASDATE	Num	8		SAS Date
13	SOURCE	Char	4		Collected By
8	TEMPBOT	Num	8		Bottom Temperature (degrees C)
7	TEMPSURF	Num	8		Surface Temperature (degrees C)
3	TIME	Num	8	TIME5.	Time
14	TYPE	Char	4		Moving, Fixed or Gage
9	YEAR	Num	8		Year

Data Set Name WORK.CHALL_2

Observations	3546		
Member Type	DATA	Variables	37
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:28 PM	Observation Length	296
Last Modified	Saturday, July 01, 2006 06:15:28 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	16384
Number of Data Set Pages	65
First Data Page	1
Max Obs per Page	55
Obs in First Data Page	38
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
24	ALK	Num	8	6.1	Alkalinity-CaCO3 (mg/l)
26	CA	Num	8	6.1	Calcium Hardness (mg/l)
13	CHLA	Num	8	7.1	Chlorophyll a (ug/l)
14	CL	Num	8	7.1	Chloride (mg/l)
17	COLOR	Num	8	5.	Color (CPU)
3	D	Num	8		Day
23	DAY	Num	8		Day
18	DEPTH	Num	8		
37	DO	Num	8		Dissolved Oxygen (mg/l)
19	DOC	Num	8		Dissolved Organic Carbon (mg/l)
31	F	Num	8	6.2	Fluroide (mg/l)
32	FC	Num	8	5.	Fecal Coliform Bacteria (c/100 ml)
20	FE	Num	8		Iron (mg/l)
33	FS	Num	8	5.	Fecal Strep. Bacteria (c/100 ml)
25	HARD	Num	8	5.	Hardness-CaCO3 (mg/l)
11	IOC	Num	8	7.1	Inorganic Carbon (mg/l)
2	M	Num	8		Month
27	MG	Num	8	6.1	Magnesium Hardness (mg/l)
22	MONTH	Num	8		Month
4	N23	Num	8	6.3	Nitrite/Nitrate (mg/l)
5	NH3	Num	8	6.3	Ammonia/Ammonium (mg/l)
8	OP	Num	8	6.3	Orthophosphorus (mg/l)
30	PH	Num	8		
15	SASDATE	Num	8		SAS Date
9	SI	Num	8	6.2	Silica (mg/l)
28	SO4	Num	8	6.1	Sulfate (mg/l)

Data Set Name WORK.CHALL_2 (continued)

16	STATION	Num	8		Station Number
34	TC	Num	8	5.	Total Coliform Bacteria (c/100 ml)
36	TCOL	Num	8		Total Coliform Bacteria (c/100 ml)
29	TDS	Num	8	5.	Total Dissolved Solids (mg/l)
35	TEMP	Num	8		
6	TKN	Num	8	6.2	Total Kjeldahl Nitrogen (mg/l)
10	TOC	Num	8	7.1	Total Organic Carbon (mg/l)
7	TP	Num	8	6.2	Total Phosphorus (mg/l)
12	TURB	Num	8	4.1	turbidity (NTU)
1	Y	Num	8		Year
21	YEAR	Num	8		Year

Data Set Name WORK.HYDROALL

Observations	22515		
Member Type	DATA	Variables	13
Engine	V9	Indexes	0
Created	Saturday, July 01, 2006 06:15:28 PM	Observation Length	104
Last Modified	Saturday, July 01, 2006 06:15:28 PM	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information

Data Set Page Size	12288
Number of Data Set Pages	193
First Data Page	1
Max Obs per Page	117
Obs in First Data Page	94
Number of Data Set Repairs	0
Release Created	9.0101M3
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Label
7	COND	Num	8	Conductivity (mmho)
3	DAY	Num	8	Day
5	DEPTH	Num	8	Depth (meters)
6	DO	Num	8	Dissolved Oxygen (mg/l)
2	MONTH	Num	8	Month
9	ORP	Num	8	Oxidation Reduction Potential
8	PH	Num	8	pH
10	SAL	Num	8	Salinity o/oo
12	SASDATE	Num	8	SAS Date
11	SAT	Num	8	Percent Oxygen Saturation
4	STATION	Num	8	Station Number
13	TEMP	Num	8	Temperature (C)
1	YEAR	Num	8	Year