FINAL PROJECT REPORT

WATER QUALITY IMPROVEMENT IN THE COW CREEK WATERSHED

JANUARY 1, 2004 – MARCH 31, 2006

COW CREEK WATERSHED
No. 18020118 (Upper Cow-Battle)

WATER QUALITY PLANNING AND NONPOINT SOURCE POLLUTION CONTROL PROGRAM

PROJECT COST $67,160

Funding for this project has been provided in full or in part through an Agreement with the state Water Resources Control Board(SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and polices of the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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Problem Statement

Water quality is one of the primary problems identified in the Cow Creek Watershed Assessment published in November 2001. The Cow Creek watershed is No. 18020118 (Upper Cow-Battle), located in Central Shasta County. The water quality problems in Cow Creek have three major components: fecal coliform, high temperatures, and channel scouring, which together significantly contribute to water quality, flow problems and degraded habitat for threatened spring run Chinook salmon. This project will survey the five main tributaries in the watershed to create baseline data, identify the sources of fecal coliform contamination, verify where extreme water temperature variations occur in the watershed and why, determine where removal of excessive non-native species or revegetating the riparian areas may improve water flow and water temperatures, and identify potential spawning areas to be rehabilitated for Chinook salmon habitat. The results of the survey will support the implementation of restoration activities in the Cow Creek Watershed.

Project Goals

The goals of the project were to: identify the source(s) of fecal coliform in the Cow Creek watershed and develop options to remedy the problem(s); monitor water temperature in various locations to determine the capacity within the watershed to lower elevated temperatures to improve anadromous fish habitat; support an ongoing monitoring program to implement adaptive management. In addition, the project would: facilitate and improve collaboration among government agencies and the Cow Creek Watershed Management Group; conduct a monitoring program based on sound science that would include a wide-range of participants in the decision-making process for watershed health enhancement; and disseminate information throughout the watershed (including local, regional, and state groups). The resulting implementation plan includes a priority list of projects with estimated costs and a list of potential funding sources.

Project Description

Water Quality Improvement in the Cow Creek watershed was under the SWRCB Water Quality Planning and Nonpoint Source Pollution Control Programs. The following is a Schedule of Completed Deliverables and Submission dates.

TASK	SUB-TASK	DELIVERABLE	SUBMISSION DATE
1	**PROJECT ADMINISTRATION**		
	1.2	Monthly Progress Reports	**4-10-04 to 4-10-06**
	1.5	Contract Summary Form	**4-10-04**
	1.6	Subcontractor Documentation	**6-10-04**
	1.7	Expenditure/invoice projections	**4-10-04**

			12-10-04
			6-10-05
			12-19-05
	1.8	Project Survey form	**4-10-06**
2	**CEQA/NEPA DOCUMENTATION AND PERMITS**		
	2.1	CEQA/NEPA Documentation	**7-10-04**
	2.2	Permits	**No additional permits**
3	**QUALITY ASSURANCE PROJECT PLAN**		
	3.1	QAPP	**6-30-04**
4	**ADJOINING LANDOWNER NOTIFICATION**		
	4.1	Landowner notification documentation	**5-31-02**
5	**TECHNICAL ADVISORY COMMITTEE**		
	5.1	List of Technical Advisory Committee members	**4-10-04**
	5.2	Roles and Responsibilities Summary	**4-10-04**
	5.3	Public meetings, agendas, minutes and Sign-in Sheets	
		1	**3-22-04**
		2	**3-26-04**
		3	**5-11-04**
		4	**5-28-04**
		5	**11-18-04**
		6	**6-23-05**
		7	**12-20-05**
		8	**3-7-06**
		9	**4-4-06**
6	**FECAL COLIFORM TESTING**		
	6.1	Draft coliform monitoring plan	**6-10-04**
	6.2	Final coliform monitoring plan	**6-10-04**
	6.3	Landowner Agreements	**7-10-04**
		TAC approved summary report of fecal coliform monitoring	**4-10-06**
7	**TEMPERATURE TESTING**		
	7.1	Draft temperature monitoring plan	**6-10-04**
	7.2	Final temperature monitoring plan	**6-10-04**
	7.3	Landowner agreements	**7-10-04**
	7.6	TAC approved monitoring report of temperature monitoring	**4-10-06**
8	**SUGGESTED IMPLEMENTATION PLAN AND CHECKLIST**		
	8.1	Fecal Coliform Implementation Plan and Checklist	**4-10-06**
	8.2	Excessive Temperature Implementation Plan and Checklist	**4-10-06**
9	**DRAFT AND FINAL REPORTS**		

	9.2	Draft Project Report	**1-5-06**
	9.3	Final Project Report	**4-10-06**

Project Methodology

Temperature and *E. coli* concentration were measured at twenty stream reaches in the Cow Creek Basin over a 17-month period from June 2004 – November 2005. Two specific objectives of the monitoring study were: (1) continue a multiple-year temperature monitoring program that will develop a temperature baseline that will identify reaches unsuitable or limiting for survival and/or propagation of fish (with emphasis on cold water salmonids); and (2) identify reaches where *E. coli* concentrations exceed established standards and criteria for protection of water contact and recreation.

Temperature Monitoring -
Continuous temperature monitoring devices were placed and maintained throughout the Cow Creek Watershed at 20 sites. Sites were stratified to include high elevation (2,000ft – 4000ft), mid-elevation (1000ft – 2000ft), and low-elevation (500ft - 1000ft) along the lengths of each tributary (North Cow; Oak Run; Clover; Old Cow; and South Cow) and at the main stem of Cow Creek. Multiple temperature probes were established at each site for accurate temperature measurement (data resolution <+/- 0.5º C) and to identify potential elevated temperature sources with upstream-downstream comparisons.

E. coli Monitoring -
Water grab samples were collected for evaluation of *E. coli* presence and abundance throughout the Cow Creek Watershed including at 22 sites. Sites used were the same general locations as the temperature monitoring probes, but included multiple samples upstream and downstream of tributary or runoff inputs. *E. coli* grab samples were collected twice monthly.

Sampling Locations -
Sampling locations were selected to isolate each sub-watershed within the Cow Creek Basin, and to stratify each sub-basin into elevation classes. Stream sites are ultimately selected because of access by public road and private landowner agreement.

Table 1. Study Locations for temperature and / or E. coli measurements.

Site Name	Site Code	N	W
Main stem Cow Crk at USGS Guage	001	40º 30.291	122º 13.968
Main stem Cow Crk	002	40º 32.755	122º 14.089
Old Cow / Little Cow Confluence at Hwy 44	201	40º 33.352	122º 13.847
Old Cow / South Cow Crk at Old Hwy 44	203	40º 32.727	122º 10.524
Lower South Cow Crk near South Cow Creek Rd.	103	40º 33.062	122º 4.730

Middle South Cow Crk at PG&E diversion dam	105	40º 35.528	122º 58.908
Upper South Cow Crk at Ponderosa Way	107	40º 36.407	121º 51.309
Middle Old Cow Crk near Whitmore Rd.	205	40º 37.722	121º 57.770
Glendenning Creek off Ponderosa Way	206	-	-
Upper Old Cow Crk at Kilarc Power Plant	207	40º 40.704	121º 52.349
Lower Clover Crk near Old Hwy 44	303	40º 33.289	121º 11.163
Lower / Mid Clover Crk near Whitmore Rd.	304	40º 34.163	121º 8.650
Upper Clover Crk at Ponderosa Way	307	40º 42.113	121º 55.118
Lower Oak Run Crk at Old Hwy 44	403	40º 34.011	122º 11.513
Lower / Mid Oak Run Crk at Oak Run Rd.	404	40º 39.361	122º 4.490
Middle Oak Run Crk A at Fern Rd.	405	40º 41.445	122º 2.545
Middle Oak Run Crk B town of Oak Run	406	40º 42.127	122º 1.592
Upper Oak Run Crk at Ponderosa Way	407	40º 42.826	121º 56.709
Lower Little Cow Crk at Swede Creek Rd.	503	40º 35.474	122º 13.602
Middle Little Cow Crk near Ingot	505	40º 43.891	122º 4.511
Upper Little Cow Crk at Buzzards Roost Rd.	507	40º 44.941	121º 56.629
Upper Cedar Crk near Hwy 299	508	40º 47.122	121º 57.238

Temperature -
Temperature monitoring probes were maintained at 20 sites in the Cow Creek watershed from May 2004 – October 2005. At each site two Onset StowAway TidbiT sensors were anchored to boulders of sufficient size or natural substrates to maintain the TidbiTs during moderate flows, and remain completely submerged at low stream flow. TidbiTs were sometimes moved within the stream reach throughout the study to prevent exposure to air or high velocity flood flows. TidbiTs temperature loggers were programmed to multi-sample the temperature every 30 seconds, and average 120 measurements per hour. Although all sensors were checked throughout the study, data is reported from only one sensor at each site.

E. coli -
Grab samples were collected twice-monthly at 22 sites in the Cow Creek watershed from May 2004 – October 2005 (38 sampling events). Water samples were collected in Idexx Laboratories, Inc. sterile 100mL plastic sample bottles, held on ice for < 12 hours, and incubated with Idexx Laboratories, Inc. Colilert-18 test in a sterile Quantitray2000 estimator. After >20 hours of incubation at 34ºC the samples were quantified in the laboratory under ultraviolet light for fluorescence, indicating E. coli presence. The Quantitray2000 technique calculates a MPN (most probable number) of E. coli cells in a 100mL of water sample. All water samples were collected in running water habitat (riffle, run or flowing pool) at the thalweg if possible, from under the water surface.

Project Results

Precipitation and Stream Flow

Precipitation and stream flow conditions have a large effect on water temperature and microbial activity in lotic waters. Over the period of this study chinook salmon were first observed in lower tributaries (Site 201 and 203) the second week of October in 2004 and 2005; generally following the first significant precipitation event of the season. These spawning adults are most likely fall-run chinook. Water temperature noticeably lowers after precipitation events. Some streams show peak microbial activity as flows decrease leaving isolated pools (e.g., Site 303). The precipitation record of daily rainfall data (an average of the CDF station at Diddy Wells and the diversion dam at South Cow Creek) over the study period identifies storms that contribute to abrupt stream water temperature change and runoff (Figure 1A). The resulting stream flow at the Main Stem Cow Creek gauge is recorded by USGS and shows the response to rainfall events (Figure 1B). Based on historical records the May 2004 – October 2005 period was “typical”, yielding slightly greater than average precipitation and peak streamflows.

Temperature

Stream water temperature fluctuated daily and throughout the season at all 21 sites measured (Figures 2). Daily temperatures ranged as much as 10ºC in the downstream reaches (e.g., 103 and 503), and a few upstream tributaries (see 507 and 508). Seasonal temperatures differed by as much as 30ºC at sites 304 and 503, and a little as 10ºC in the upper elevations tributaries. Although only higher elevation sites maintained cold water habitat year round, lower elevation sites had suitable temperature during the fall spawning period in mid October. Adult chinook salmon did not migrate into the Main Stem of Cow Creek until the first heavy precipitation events in October. In general, cold water habitat persisted in the Main Stem of Cow Creek until approximately the first week of June.

E. coli

Concentrations of *E. coli* varied greatly across the Cow Creek Basin and throughout the study period (Figure 3). Over half of the samples collected at sites 103, 403, and 405 exceeded the 235 MPN single sample safe public contact threshold proposed by the California State Water Resources Control Board 2002 Amendment to the Basin Plan for the Sacramento River and its watersheds. Other sites regularly exceeded this threshold or had one or more samples that exceeded the measurement capacity of the technique used. High *E. coli* concentrations at all sites were generally associated with storm runoff events following periods of no rain. However, sites that regularly exceeded the safe public contact threshold listed above also did so during the May – September dry seasons (Figure 4).

Public Outreach

For the project, the RCD worked with landowners and stakeholders in the Cow Creek Watershed Management Group. This project ensured continued involvement by continuing communication through the quarterly newsletter, public service announcements, periodic news articles and community meetings. Representatives of the community were also invited to participate on the project's Technical Advisory Committee. To conduct the project landowners were contacted and asked for permission to allow access for sensor placement and water sampling and the results of these studies will be presented to the Cow Creek Watershed Management Group following the projects completion.

Conclusions

There were several challenges to completing the project. The first one being the fact that Cow Creek is an uncontrolled stream system that has flows that can range from approximately 10 cfs during the summer to over 10000 cfs during storm events which made it difficult to maintain sensors in some locations. In order to maintain the effectiveness of temperature sensors, future efforts to monitor water temperature in the watershed need to take in account the rapidly changing conditions of flow in the watershed. Additional methodology needs to be developed so that sensors remain intact and data is gathered continuously. Even with the sensor loss, temperature data was generated for over 50% of the study period.

Another challenge and great success was landowner participation in the study. Most sensors and sampling were from located on private property. Landowners were willing to sign an entry permit for the study even though water quality is a debated topic in the watershed. This success would not have been possible without the help of the proactive efforts of the Cow Creek Watershed Management Group. Additional support was provided by Dr. Cajun James of Sierra Pacific Industries who provided the use of laboratory space and equipment for temperature and *E. coli* measurements.

This type of participation directly supported the CALFED Water Quality Program priority of supporting community-based watershed efforts to reduce non-point sources of contaminants and the data gathered also supports the CALFED Watershed Program Plan Primary Objective of providing good water quality for all beneficial uses. This project supported SWRCB/RWQCB Priorities in documenting existing baseline water quality in Cow Creek and establishing a framework to evaluate long-term water quality trends.

The State Water Resources Control Board and the Regional Water Quality Control Board have adopted a Water Quality Control Plan (Basin Plan) per California Water Code (Section 13240). The Basin Plan is a regionally specific plan that identifies the "beneficial uses" of water bodies and sets numeric criteria

to protect the beneficial uses identified. The beneficial uses identified for Cow Creek include: “Municipal and domestic supply, irrigation, stock watering, power generation, contact recreation, canoeing and rafting, non-contact recreation and aesthetic, cold water habitat, spawning habitat for cold and warm water fisheries, migration for anadromous fisheries, wildlife habitat and navigation.” E coli Data gathered in this project was measured using criteria for listed in the basin plan for recreational contact.

TAC participation was vital in interpreting the results of the temperature and E coli data. An example of this is the efforts of the Department of Fish and Game in providing guidance on temperature thresholds for anadromous fish. Overall, TAC representatives made sure that conclusions based on the data were based on the scientific results and not the assumptions of existing conditions in the watershed.

Overall, the project met the goals of establishing water quality baseline conditions in the watershed while fostering watershed based management efforts. As the project data is used to help manage water quality in the watershed, additional monitoring will need to be implemented in order to track changes in the conditions of the watershed and measure the effectiveness of this project.

APPENDIX A

INSERT FINAL REPORT APPENDIX

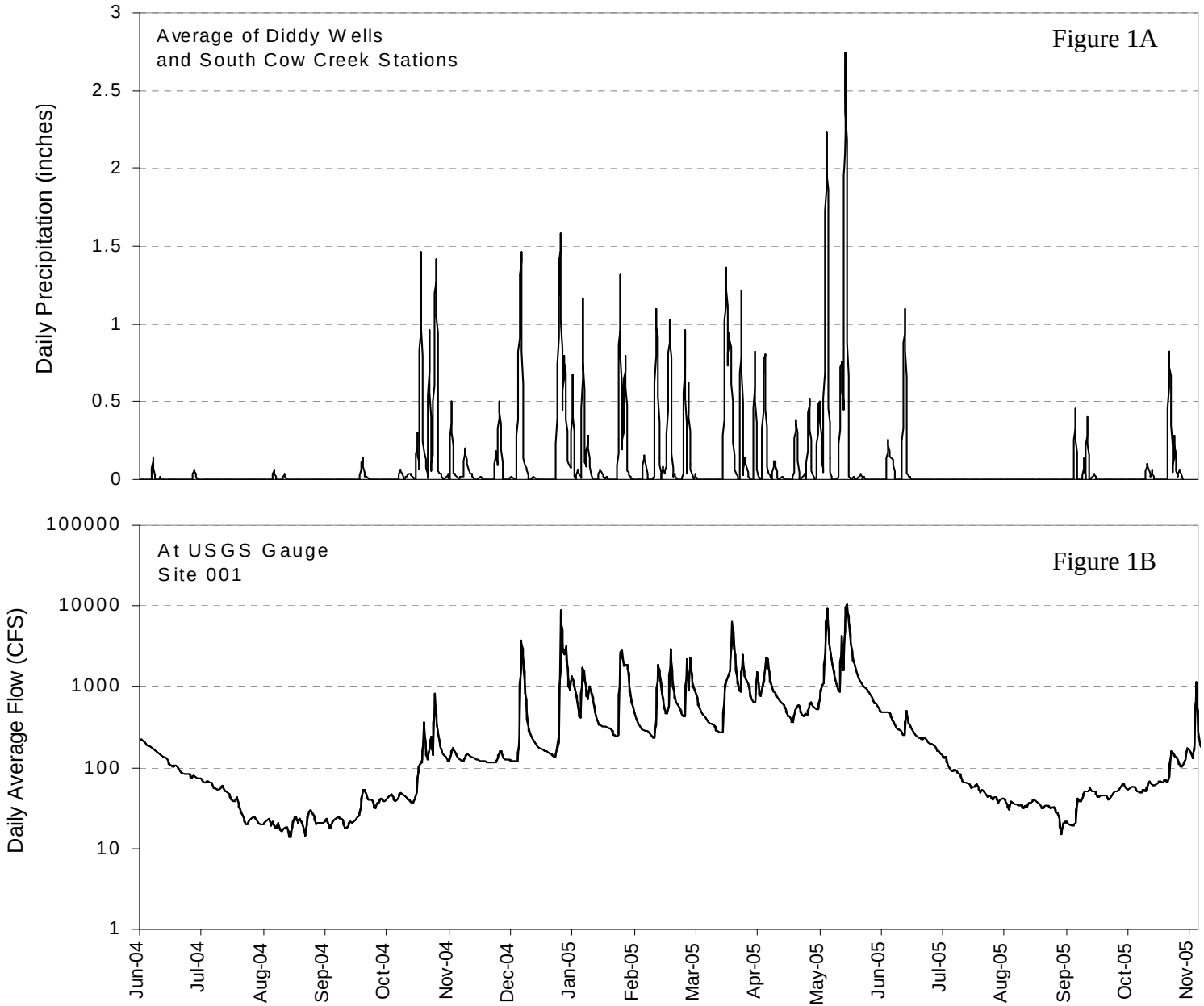

Figure 1A and 1B. Average of daily rainfall at Diddy Wells (CDF) and South Cow Creek (BR) weather stations and daily average stream flow at Main Stem of Cow Creek in Palo Cedro (Site 001, USGS).

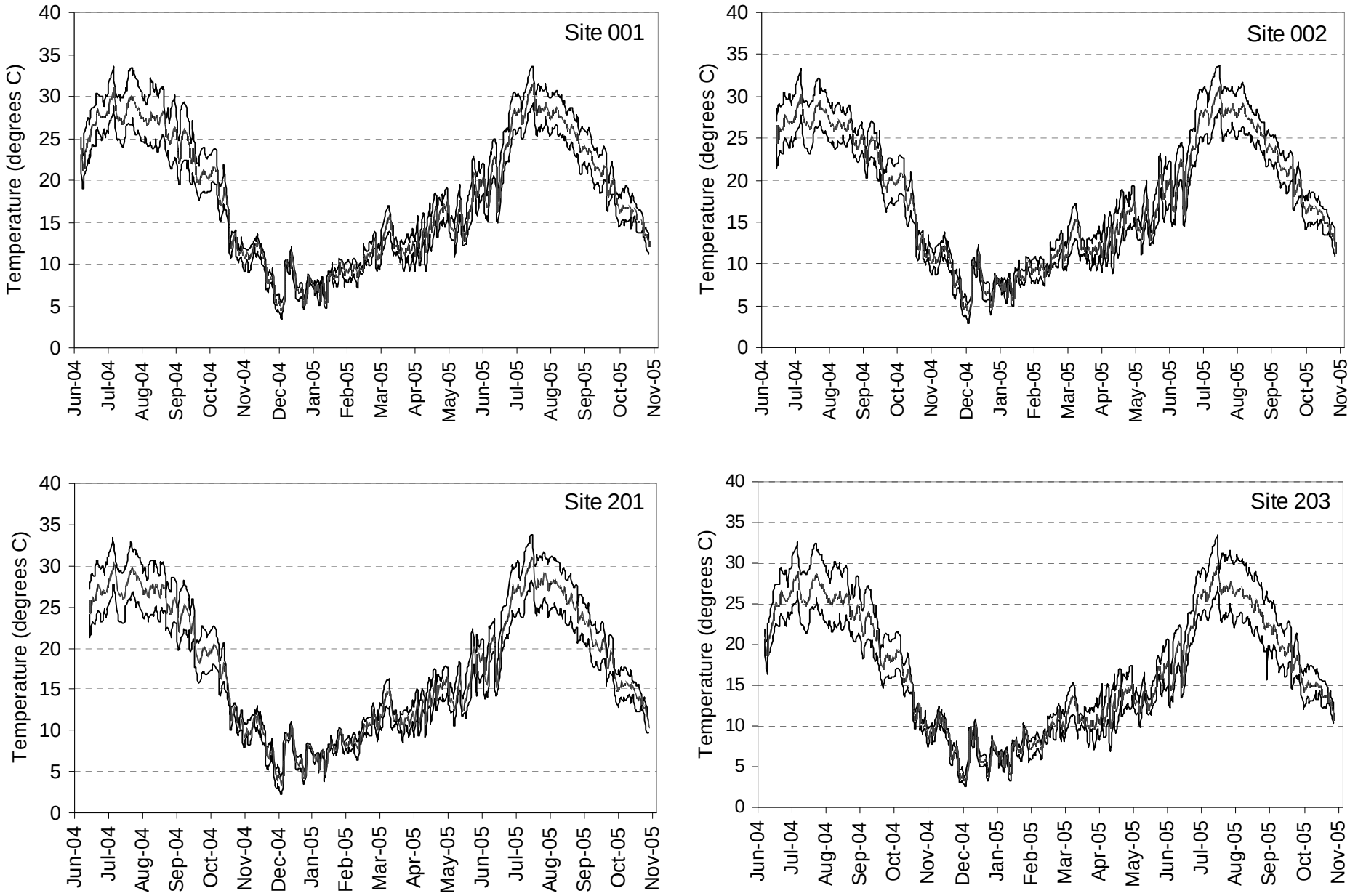

Figure 2. Daily maximum, minimum, and average water temperatures (degrees C) for lower reaches of Cow Creek and Old Cow Creek.

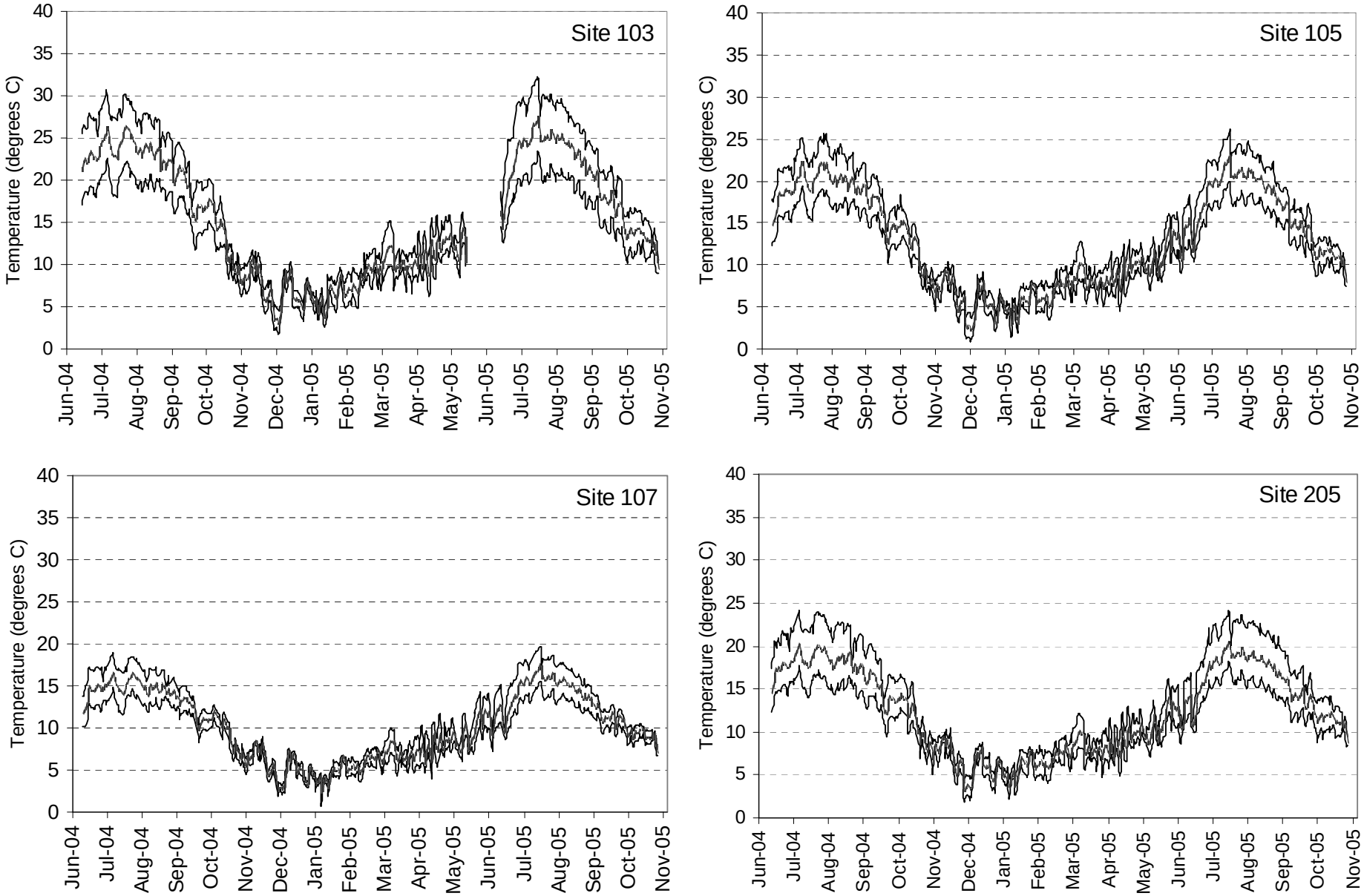

Figure 3. Daily maximum, minimum, and average water temperatures (degrees C) for Middle reaches of Old Cow and South Cow Creek.

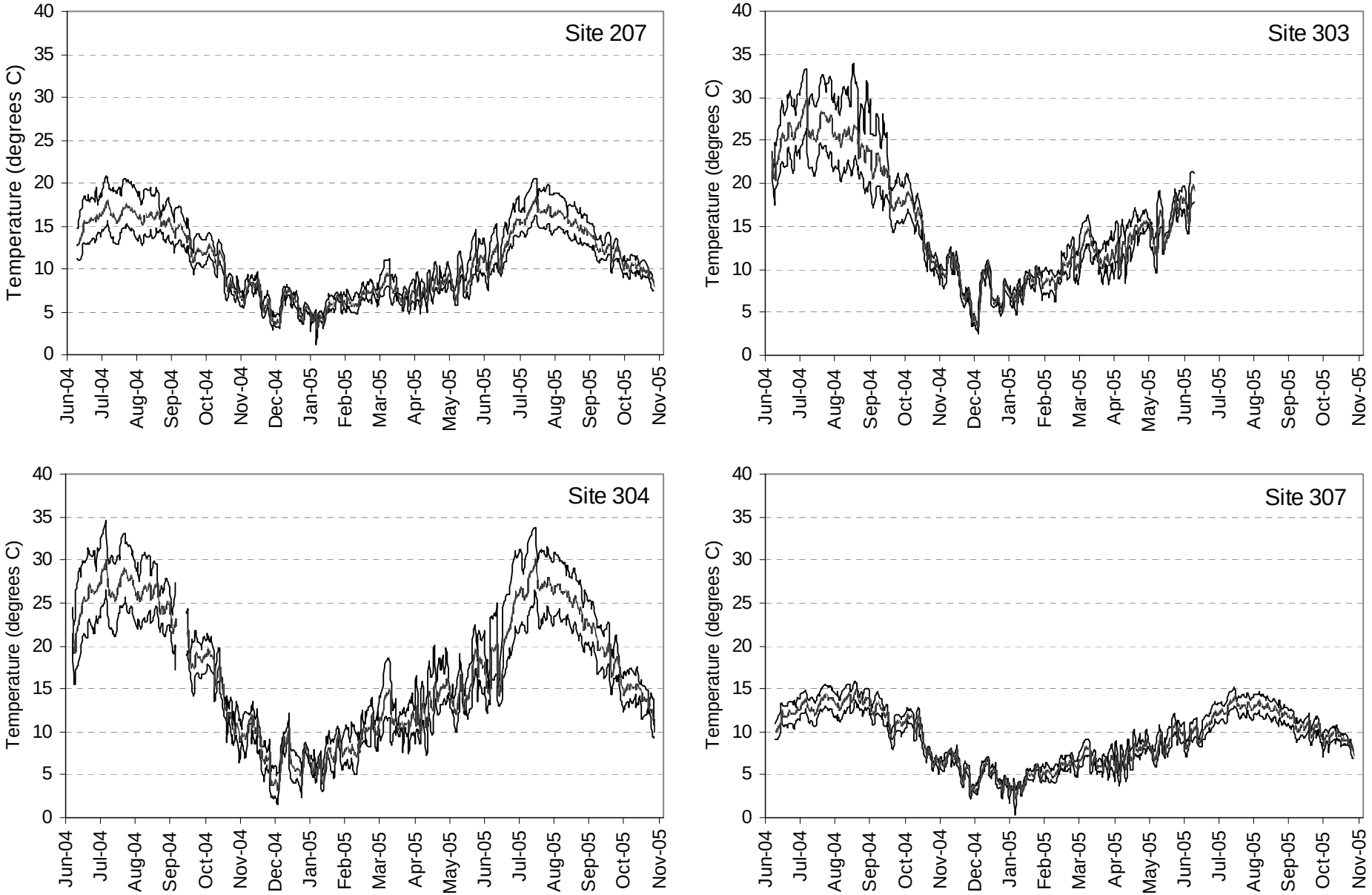

Figure 4. Daily maximum, minimum, and average water temperatures (degrees C) for upper reaches of Old Cow Creek and Clover Creek. Site 303 sensors were not recovered (possibly removed by beavers) for June – October 2005 data.

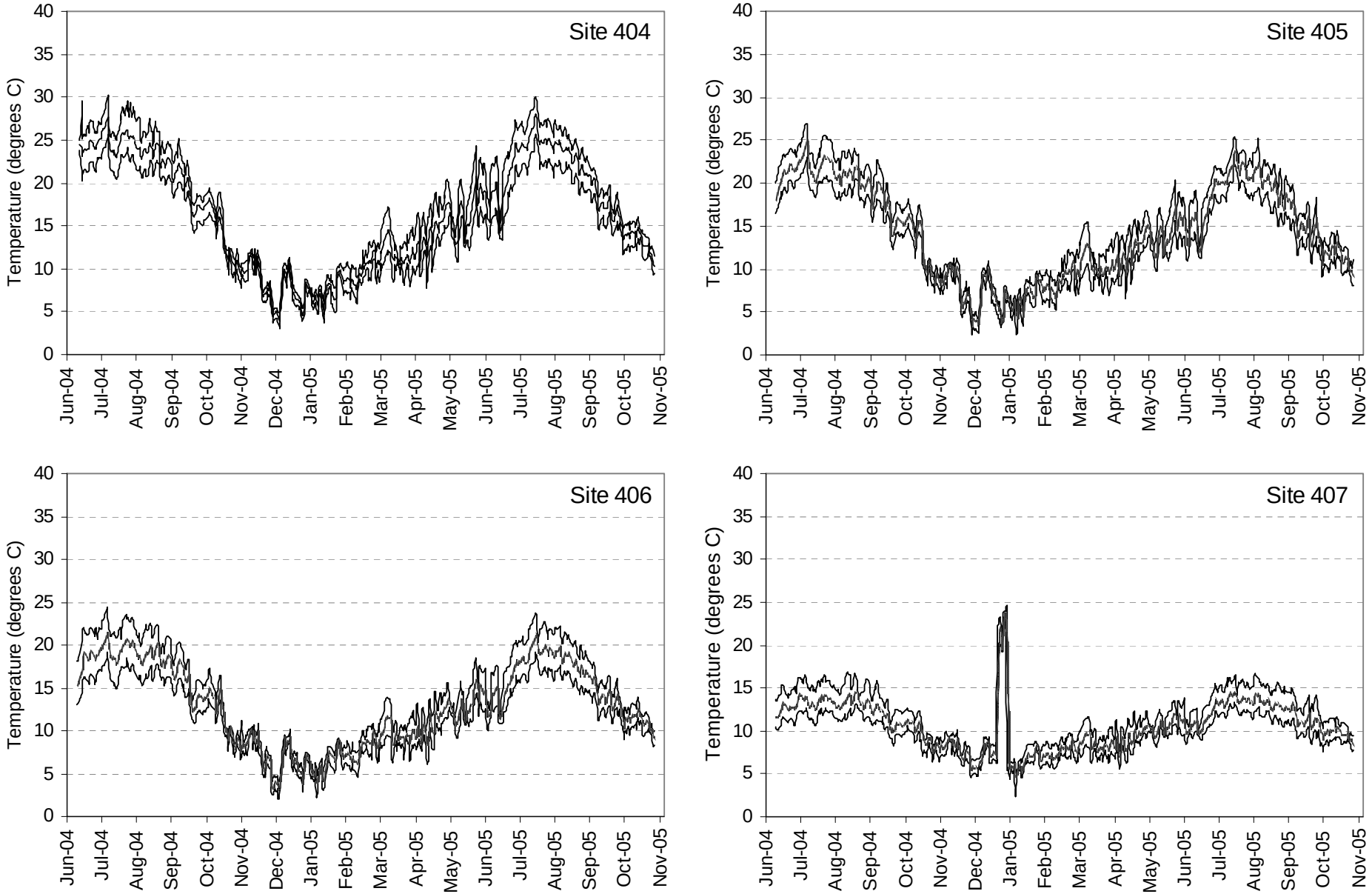

Figure 5. Daily maximum, minimum, and average water temperatures (degrees C) for reaches of Oak Run Creek.

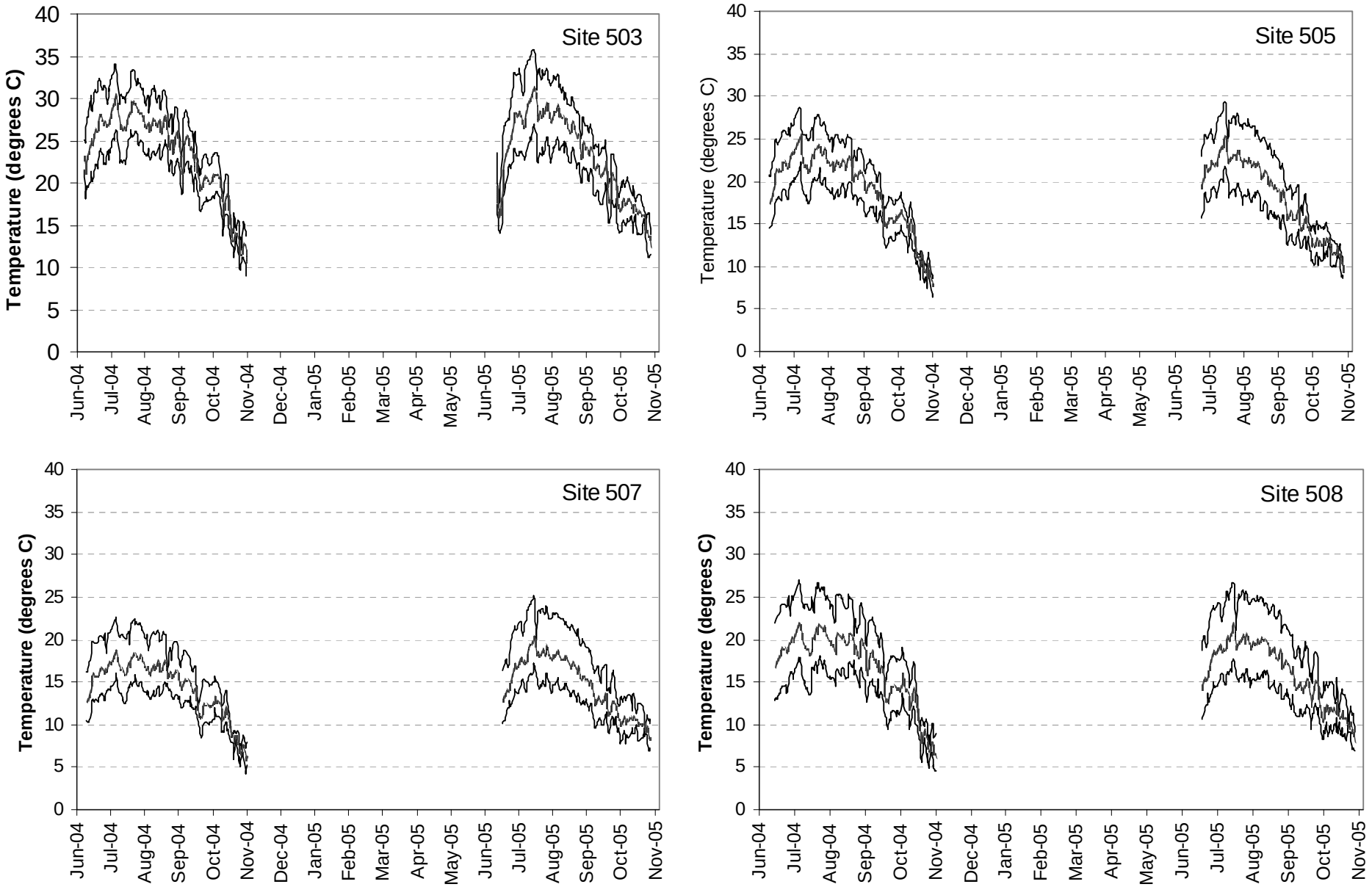

Figure 6. Daily maximum, minimum, and average water temperatures (degrees C) for Little Cow Creek and tributary Cedar Creek. Data gaps between November 2004 and June 2005 were caused by missing sensors from a significant scouring flood in May 2005. These sensors were never recovered. Site 505 sensor was replaced farther upstream.

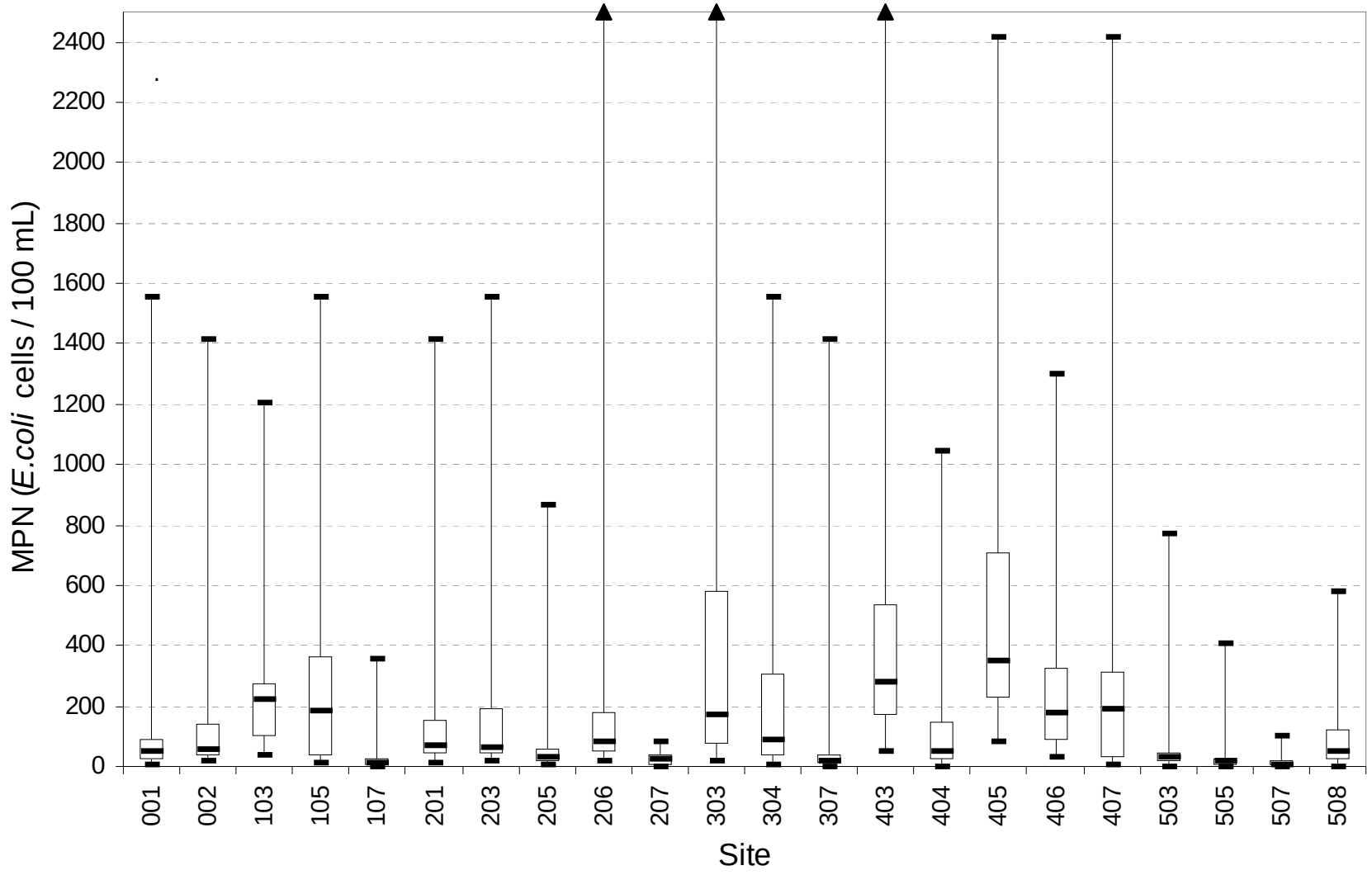

Figure 7. Box and whisker plots (line = median; box = 25%-75% quartile range; whiskers = maximum and minimum values) for *E. coli* concentrations at 22 sites in the Cow Creek Basin. Arrows at the maximum values of Sites 206, 303, and 403 exceeded the measuring ability of the methods used on one or more occasions.

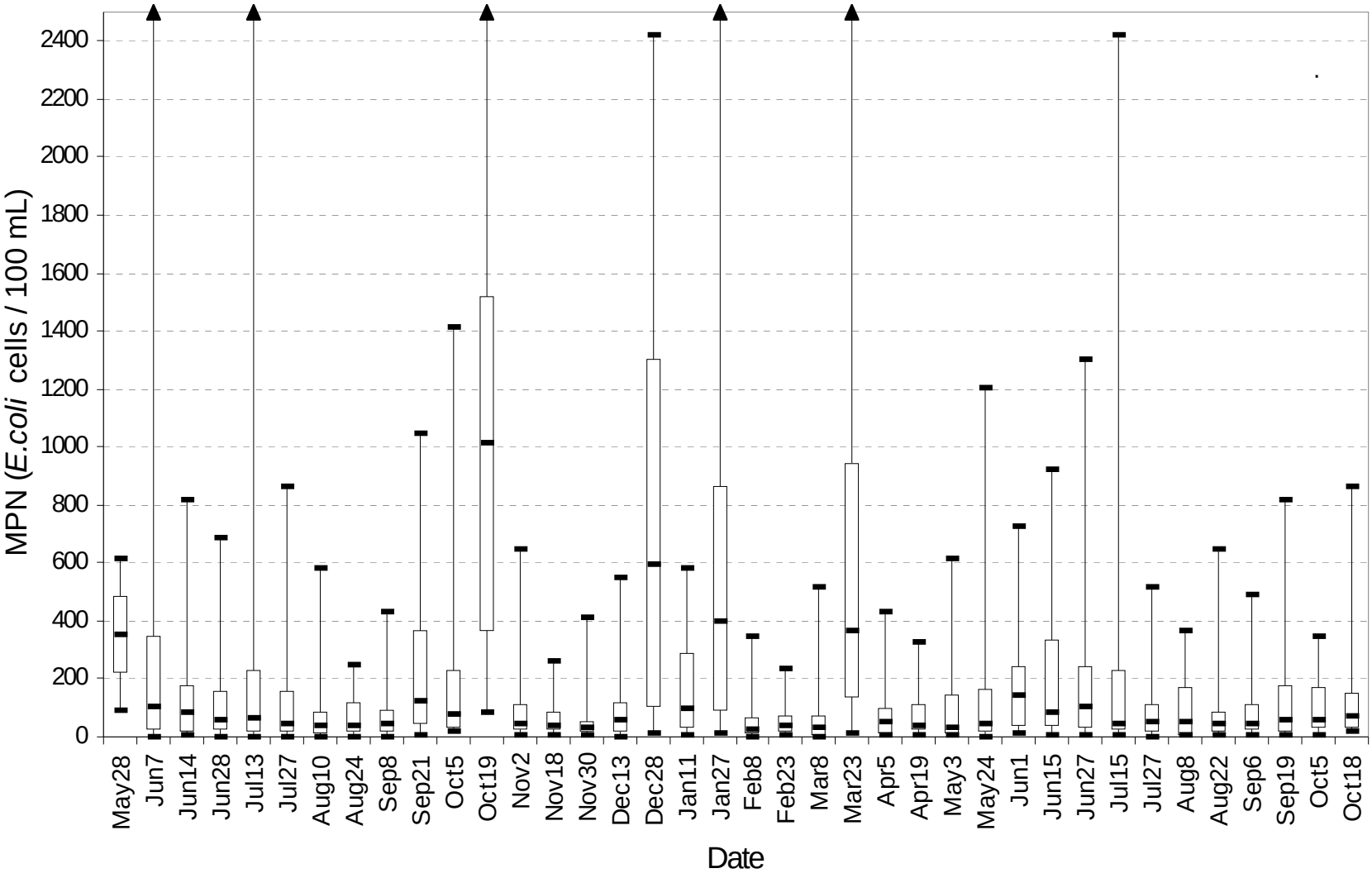

Figure 8. Box and whisker plots (line = median; box = 25%-75% quartile range; whiskers = maximum and minimum values) for *E. coli* concentrations in the Cow Creek Basin throughout the study period. Arrows at the maximum values exceeded the measuring ability of the methods used at one or more locations.