A Department of Ecology Report

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Chehalis Best Management Practices Evaluation Project-- 1995 Temperature Monitoring Data

Abstract

This report describes the 1995 water temperature monitoring results for three sites in the Chehalis River basin where best management practices (BMPs) have been installed: North Fork Lincoln Creek (Lewis County); Mill Creek (Lewis County); and a tributary to Mohney Creek (Mason County). Results for two of the BMP areas showed significant temperature differences between the upstream (control) site and the downstream (treatment) site. The third BMP area showed little temperature difference between the control and treatment sites. The merit of continuing to monitor this site should be discussed with the U.S. Fish & Wildlife Service. Results are also presented for long-term temperature monitoring sites, including a site on the mainstem Chehalis River upstream of the Newaukum River and for the mouths of four tributaries to the Chehalis River: Black River, Lincoln Creek, Newaukum River, and the South Fork Chehalis River. All of the long-term temperature monitoring sites showed temperature violations, with three out of the five sites exceeding temperatures of 25°C, which is near the lethal limit for salmonids. Recommendations for continued monitoring are provided.

Introduction

This report presents the results for 1995 water temperature monitoring done as part of the Chehalis Best Management Practices Evaluation Project funded by the U.S. Fish & Wildlife Service's (USFWS) Chehalis Fisheries Restoration Program (CFRP). Three sites in the Chehalis River basin were monitored where BMPs have been installed: North Fork Lincoln Creek in Lewis County; Mill Creek in Lewis County; and a tributary to Mohney Creek located in Mason County (Figure 1). The purpose of the monitoring is to document surface water temperature change associated with shade tree restoration of riparian areas. Replanting of the stream corridor for shading occurred at all sites during 1994 and early 1995. The BMPs will not be fully effective for six to ten years after initial replanting. Monitoring for 1995 provides baseline data for comparison to post-BMP data.

Water temperature monitoring results are also presented for a site on the mainstem Chehalis River upstream of the Newaukum River and for the mouths of four tributaries to the Chehalis River: Black River; Lincoln Creek; Newaukum River; and the South Fork Chehalis River (Figure 1). The purpose of this monitoring is to document long-term trends in water temperature.

Water Quality Standards for temperature in the areas monitored (Class A waters) are as follows:

Temperature shall not exceed 18.0°C, due to human activities. When natural conditions exceed these temperatures, no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3°C. In addition, incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8°C.

by Debby Sargeant
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Methods

The monitoring period was from July through September, during the warmer months of the year. Hourly water temperature data were collected for each site using a StowAway™ water temperature probe and data logger (provided by USFWS), hereafter referred to collectively as a thermograph. Sampling was conducted as described by the Quality Assurance Project Plan (QAPP) (Sargeant, 1995).

Thermographs were calibrated prior to deployment, and again at the conclusion of the study. As a field check on the instruments, water temperatures were taken using a hand held thermometer at all thermograph sites at the time of deployment and data retrieval. Thermographs and thermometer readings were within ± 0.2°C during all calibration checks.

Tabular results can be obtained by contacting the Environmental Investigations and Laboratory Services Program at the Department of Ecology at (360) 407-6696.

Results

North Fork Lincoln Creek

The BMP site is state owned land that was formerly leased for agricultural purposes. In early 1995 this site received treatment for erosion control and riparian restoration. Banks along the creek were stabilized using willow plantings and tree-revetments. For 1,200 feet along the south side of the creek a 10 to 80 foot buffer was re-planted with willow, red-osier dogwood, douglas fir, and cedar (Edwards, 1996).

On August 24, 1995, the riparian canopy at the BMP site was evaluated using a spherical densiometer and photo points at 25-meter intervals. The average densiometer (shading) reading for the North Lincoln BMP site was 23%, and the range was from 0 to 60%.

The Forest Practices Board Manual defines minimum canopy cover (shade) requirements after timber harvest in the riparian management zone so that adequate shading is left along streams. At an elevation of 190 feet, a percent canopy cover average of approximately 80% or more is considered acceptable to meet Class A temperature standards (DNR, 1995).

Flow discharge measurements were obtained on August 24, 1995, at the upstream and downstream sites. Flow discharge at both sites was 0.6 cfs, indicating no major ground or surface water inputs between the upstream and downstream sites.

Three thermographs were placed on the North Fork of Lincoln Creek. Two thermographs were installed at the downstream edge of the BMP site. Riparian corridor vegetation at the BMP site is almost exclusively reed canary grass. The upstream thermograph was placed one mile upstream of the BMP site the riparian zone was well shaded with mature conifer and deciduous trees. One of the downstream thermographs, located near the south bank, was not functioning during most of the monitoring period. The triggering mechanism was not activated properly, fortunately the mid-stream thermograph functioned throughout the monitoring period and provided the necessary data for the downstream site. The upstream thermograph was not functioning from August 20 through August 24, 1995, due to battery failure. Air temperature data recorders were installed at the upstream and downstream sites.

Figures 2a and 2b present water temperature for the upstream and downstream site from June 30 through September 21, 1995. The graphs show the downstream site had higher daytime temperatures and more variation in temperature over a 24-hour period than the upstream site. Notched boxplots of maximum daily temperature for each two week period (Figure 3) show the downstream and upstream sites had significantly different medians for five out of the six monitoring periods. Figure 4 illustrates how to interpret a notched boxplot.

The highest water temperatures occurred between July 14 and August 10, 1995. The downstream water temperature station exceeded the Water Quality Standards criterion of 18.0°C 15 days during the sampling period, with a maximum temperature of 21.1°C on July 19, 1995. The upstream water temperature exceeded 18.0°C twice (on August 18 and 19) during the sampling period with a temperature of 18.1°C.

Figures 5 and 6 present graphs of air and water temperature for the downstream and upstream sites. Note the wider daily range of air temperature at the downstream station, and the upstream correspondence of air temperature to water temperature changes. The downstream site receives more solar radiation than the upstream site due to the lack of riparian shading while site is well shaded, which explains the differences in air and water temperatures between the sites.

Mill Creek

The BMP site is on privately owned land that is used for pasture. In early 1995 this site received treatment for riparian restoration, including ash, cedar, and willow plantings, and livestock exclusion with 2000 feet of fencing (Edwards, 1996).

On August 18, 1995, the riparian canopy at the BMP site was evaluated using a spherical densiometer and photo points at 25 meter intervals. The average densiometer reading for the Mill Creek BMP site was 20%, and the range was from 0 to 54%. The Forest Practices Board Manual defines minimum canopy cover (shade) requirements after timber harvest in the riparian management zone so that adequate shading is left along streams. At an elevation of 220 feet, a percent canopy cover average of approximately 80 % or more is considered acceptable to meet Class A temperature standards (DNR, 1995).

Flow discharge measurements were obtained on August 18, 1995 at the upstream and downstream sites. Flow discharge at both sites was 0.6 cfs, indicating no major ground or surface water inputs between the upstream and downstream sites.

Three thermographs were placed in Mill Creek on June 29, 1995. Two thermographs were installed downstream of the BMP site, one in mid-channel and one near the west bank. One thermograph was installed one mile upstream of the BMP site, the riparian zone was mostly deciduous trees and younger conifers. This thermograph ceased functioning on August 18, 1995 because of battery failure. Air temperature data recorders were installed at the upstream and downstream sites.

Figure 7 presents water temperature for the upstream and downstream sites from June 29 through August 24, 1995. The graphs show the downstream sites had slightly higher temperatures during the day than the upstream site. There is also a time lag in temperature seen between the upstream and downstream sites. Figure 8 is a boxplot of maximum daily water temperatures for each two week monitoring period. The boxplots show that generally the downstream bank thermograph had the highest temperatures and the upstream site had the lowest temperatures. However, the median maximum temperatures were not significantly different between the three sites. The lack of a distinct temperature difference between the upstream and downstream sites could be due to a lack of riparian canopy upstream or may be caused by a small pond located 0.8 mile upstream of the upstream site (warming in the pond may obscure downstream variations in temperature due to shading).

The highest water temperatures occurred between July 19 and July 21, 1995. Temperatures at the downstream bank site exceeded 18.0°C during 27 days during the monitoring period, with a maximum of 21.6°C. At the downstream mid-channel site temperatures exceeded 18.0°C during 24 days of the monitoring period, with a maximum temperature of 20.8°C. At the upstream site temperatures exceeded 18.0°C during 19 days of the monitoring period, with a maximum temperature of 20.9°C. All sites exceeded the water quality standard for temperature.

Figure 9 presents graphs of air and water temperature for the downstream and upstream sites. The air temperature at the upstream site tended to be lower and had less variability than the downstream site. The downstream site receives more solar radiation than the upstream site due to the lack of riparian shading while the upstream site is well shaded, which could explain the differences in air and water temperatures seen between the sites.

Mohney Creek Tributary

The BMP site is on privately owned lands used for agricultural purposes, mostly grazing. In early 1995 the site received treatment for riparian restoration and livestock exclusion. Approximately 3000 feet of fencing were installed and the riparian area was replanted with native vegetation (Barnes, 1996).

Two thermographs were deployed, one at the downstream edge of the BMP site and one 0.25 mile upstream. The riparian corridor upstream of the downstream thermograph provides little streamside shading. The riparian corridor in the vicinity of the upstream thermograph is well shaded by conifer and deciduous trees. The thermographs were placed late in the season. No densiometer, flow, or air temperature measurements were taken at this site.

Figure 10 presents water temperature for the upstream and downstream sites from August 18 through September 28, 1995. The graphs show the downstream site had higher temperatures during the day and more diel variation (24 hour period) in temperature than the upstream site. Boxplots of maximum daily temperature for each two week period show the downstream and upstream sites have significantly different medians (Figure 11).

During the sampling period the maximum upstream water temperature was 14.2°C on September 15, 1995. Water temperature at the downstream station exceeded the water quality standard of 18.0°C 11 days during the sampling period, with a maximum temperature of 19.2°C on September 2, 4, and 15, 1995. While air temperatures and densiometer readings were not obtained, field observations noted major differences in riparian cover between the upstream and downstream sites. The downstream site receives more solar radiation than the upstream site due to the lack of riparian shading, while the upstream site is well shaded. This probably accounts for the differences in water temperature between the sites.

Long Term Trend Monitoring

Water temperature monitoring results for the five long-term stations are presented in Figures 12 - 16. Monitoring occurred from June 15 through September 15, 1995.

Black River

The results for the Black River are graphed in Figure 12. The thermograph was located near the left bank of the mouth of the Black River at the Howanut Road bridge. The water temperature exceeded 18.0°C during 54 of the 93 days monitored. A maximum temperature of 23.6°C was reached on July 20, 1995.

Lincoln Creek

The results for Lincoln Creek are graphed in Figure 13. The thermograph was located near the mouth of Lincoln Creek under the farthest downstream Lincoln Creek Road bridge. The water temperature exceeded 18.0°C during 25 of the 93 days monitored. A maximum temperature of 21.2°C was reached on July 20, 1995.

Newaukum River

The results for the Newaukum River are graphed in Figure 14. The thermograph was located at the mouth of the Newaukum River. The water temperature exceeded 18.0°C during 83 of the 93 days monitored. A maximum temperature of 27.2°C was reached on July 19, 1995.

Chehalis River upstream of the Newaukum River

The results for the upper mainstem Chehalis River are graphed in Figure 15. The thermograph was located on the left bank of the Chehalis 0.01 mile upstream of the mouth of the Newaukum River. The water temperature exceeded 18.0°C during 82 of the 93 days monitored. A maximum temperature of 25.8°C was reached on July 20, 1995.

South Fork Chehalis River

The results for the South Fork Chehalis River are graphed in Figure 16. The thermograph was located 0.7 mile above the mouth at the tanker intake off of the Curtis-Boistfort Road. The water temperature exceeded 18.0°C during 79 of the 93 days monitored. A maximum temperature of 26.5°C was reached on July 19, 1995.

Conclusions

- ☐ At the North Lincoln Creek BMP monitoring area, the downstream BMP site had higher daytime temperatures and more variation over a 24 hour period than the upstream site. The downstream site exceeded temperature standards seven times more often than the upstream site.

- ☐ While the upstream Mill Creek BMP monitoring site had only slightly lower water temperatures than the downstream sites, all sites exceeded temperature standards on numerous occasions.

- ☐ For the BMP sites on the tributary to Mohney Creek, the downstream site had higher temperatures and more variation over a 24 hour period than the upstream site. Though monitoring did not occur during the warmest part of the summer, the downstream site exceeded temperature standards on 11 out of 42 days, while the upstream site did not exceed temperature standards during that period.

- ☐ At all of the long term trend monitoring sites the temperature standard was exceeded. Temperatures on the Newaukum, South Fork Chehalis, and the mainstem Chehalis exceeded 25°C, which is near the lethal limit for salmonids (Welch, 1980). (The lethal limit is the temperature at which 50% of the test fish survive for 96 hours. If the temperature fluctuates daily, slightly higher lethal limits can be tolerated for short periods if the temperature is lowered below that level for longer periods.) At best, these temperatures result in severe stress on over-summering juvenile or migrating adult salmon that may be present at this time of year.

Recommendations

- ☐ Continue BMP monitoring at North Lincoln Creek and Mohney Creek tributary sites. Take canopy closure measurements at the upstream station at both sites for comparison to downstream canopy closure measurements.

- ☐ At Mill Creek little difference in temperature was noted between upstream and downstream sites, and continued monitoring of this site may not be worthwhile. The merit of monitoring at this site should be reviewed with USFWS. One alternative may be to install more temperature control BMPs upstream of the upstream temperature station.

- ☐ Continue summer monitoring of long term trend sites.

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Barnes, J., 1996. "CFRP Project Status, Mason Conservation District." Memorandum to Mike Kelly (USFWS), dated February 1, 1996. Mason Conservation District, Shelton, WA.

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Welch, E.B., 1980. Ecological Effects of Waste Water. Cambridge University Press, New York, NY.

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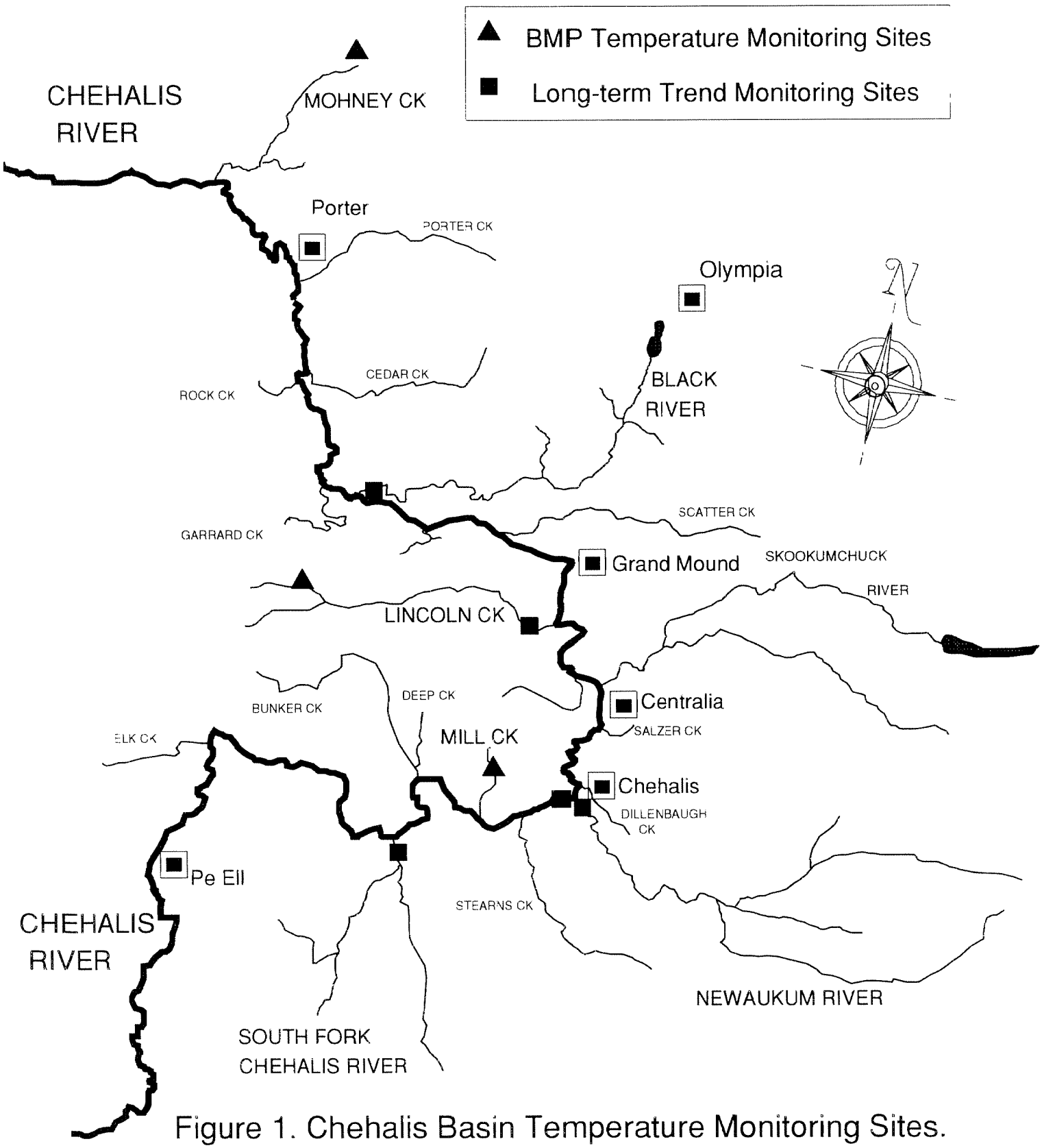


Figure 1. Chehalis Basin Temperature Monitoring Sites.

Figure 2a: Water Temperature in N.F. Lincoln Creek.

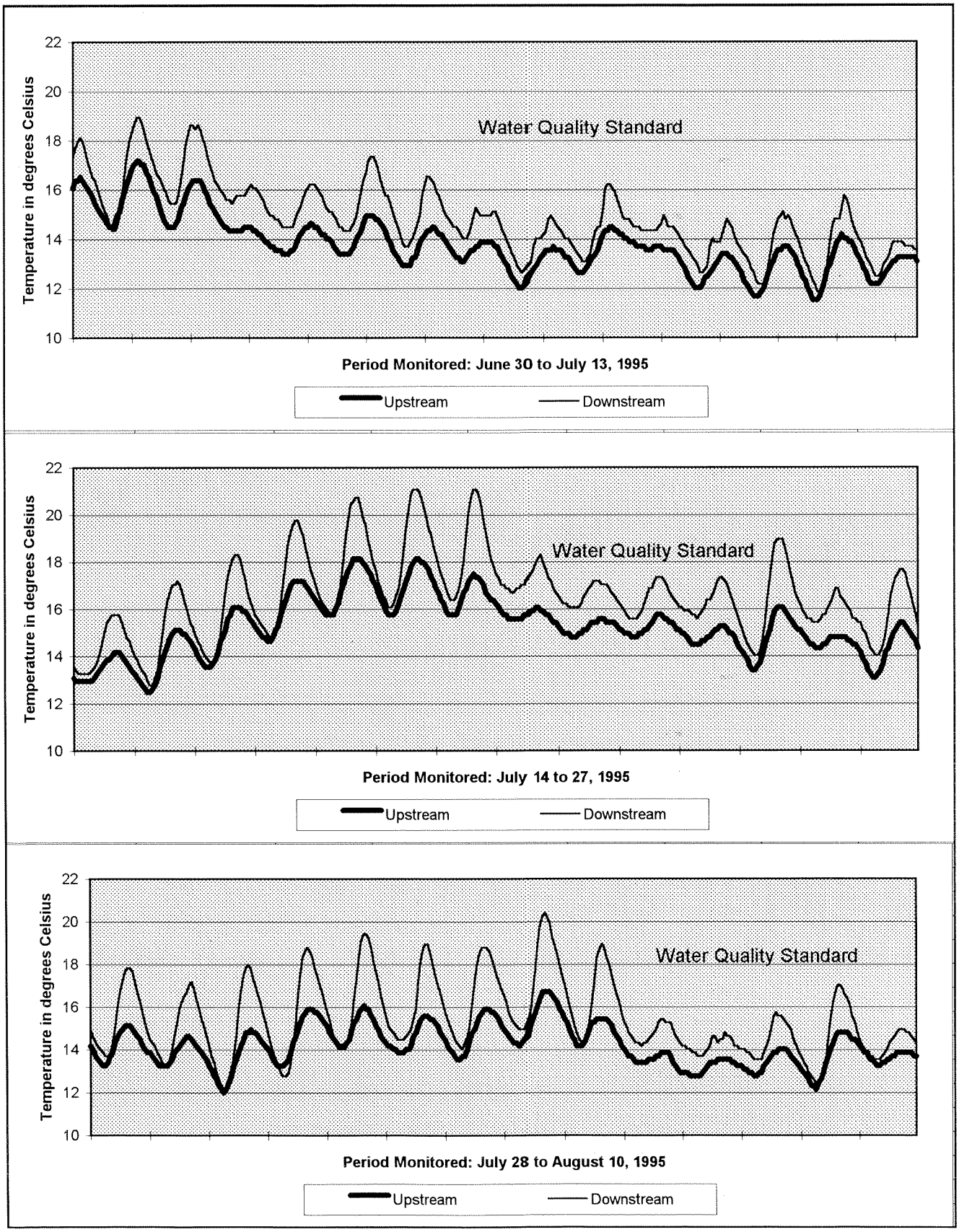
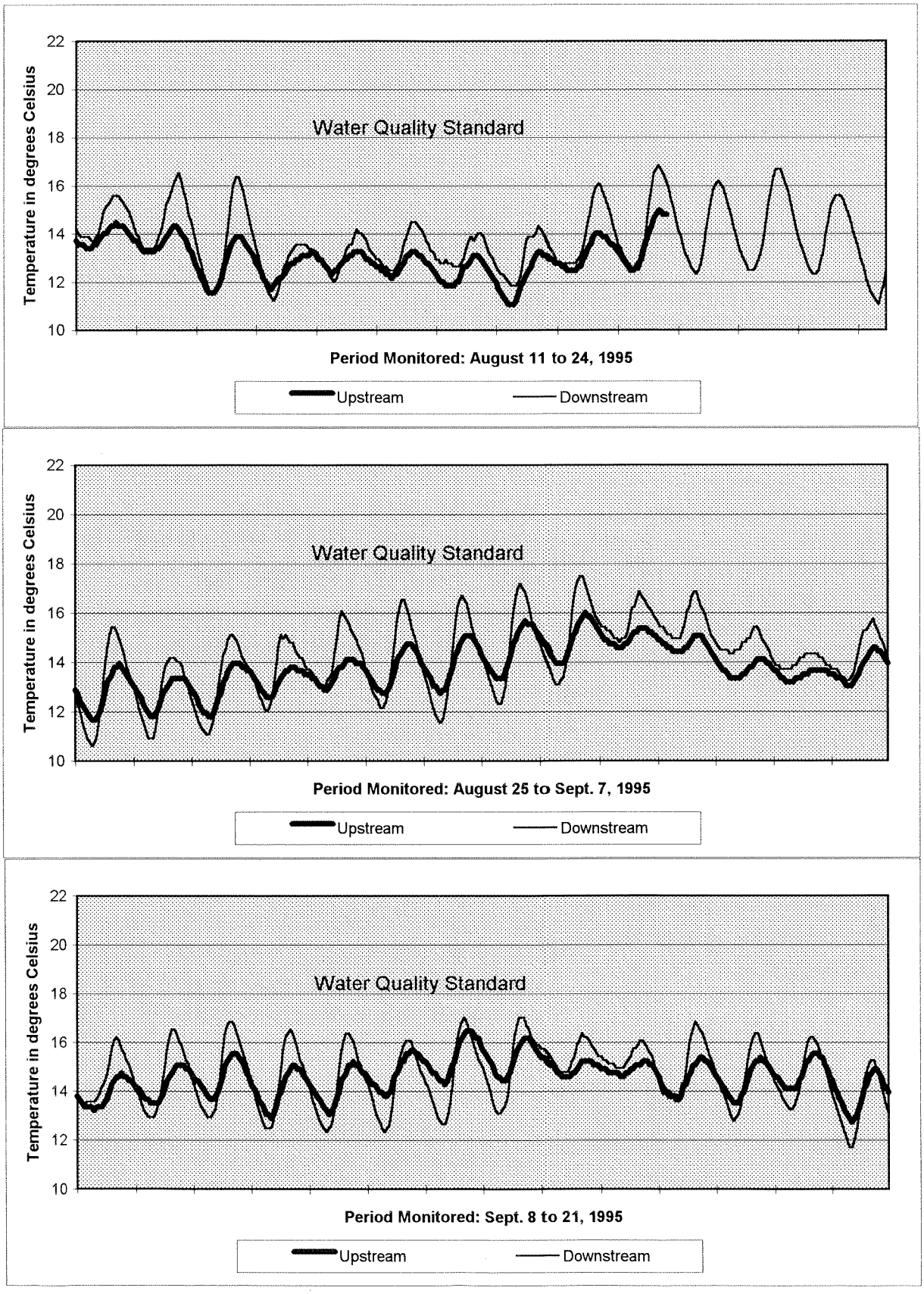


Figure 2b: Water Temperature in N.F. Lincoln Creek.



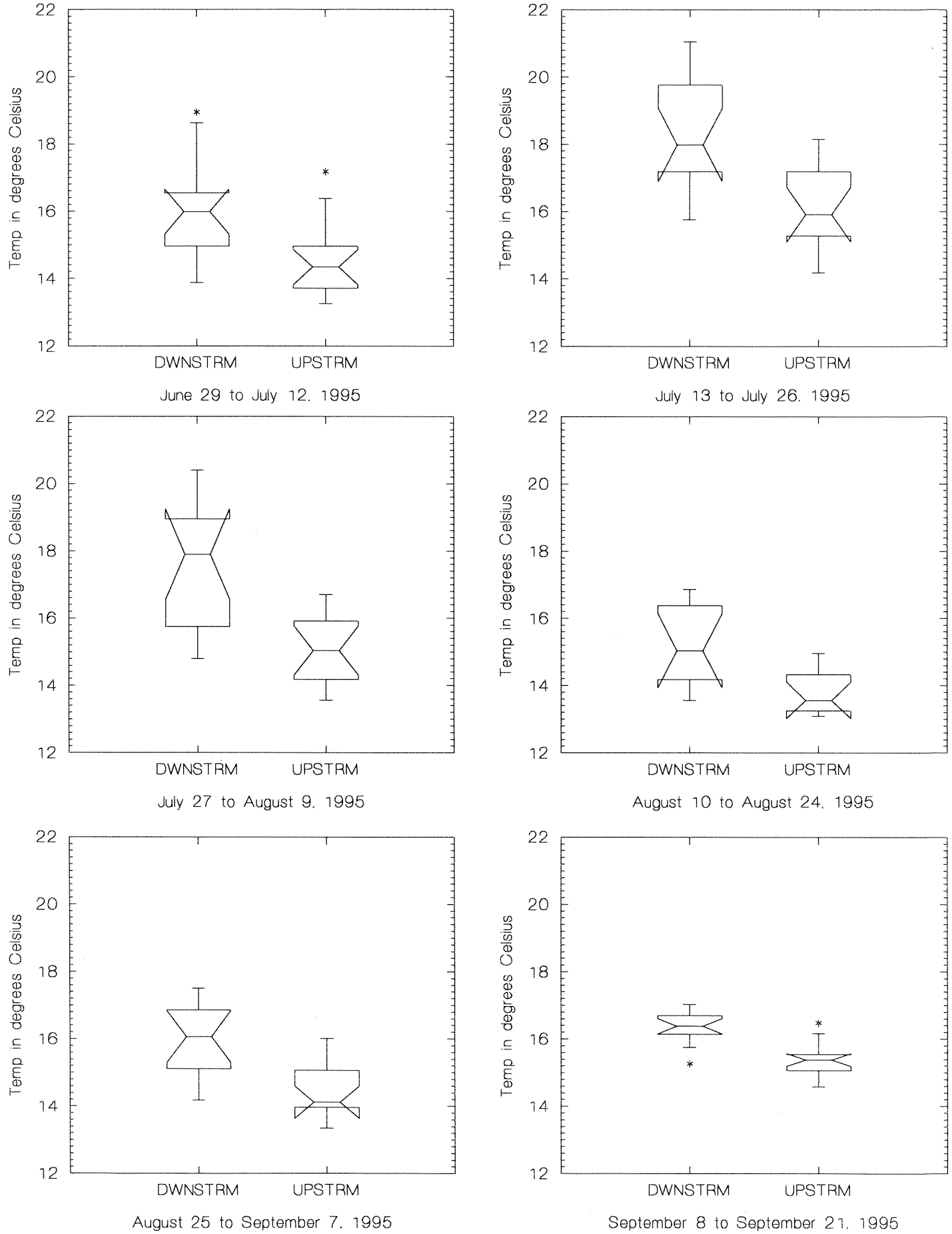


Figure 3 Comparison of Maximum Daily Water Temperature at N.F. Lincoln Creek Sites.

Figure 4. Example of Notched Boxplots.

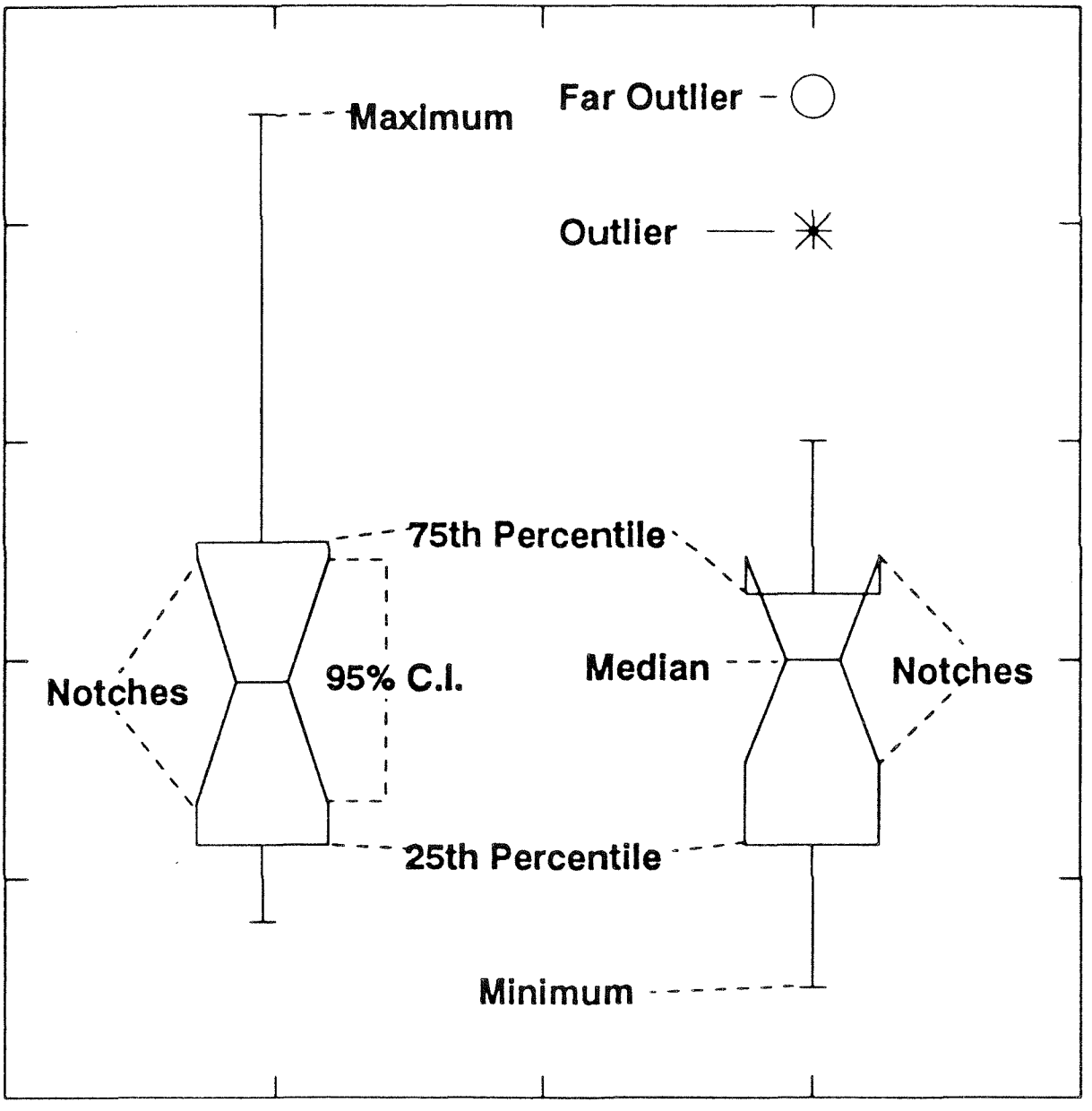


Figure 5: Air and Water Temperature in N.F. Lincoln Creek.

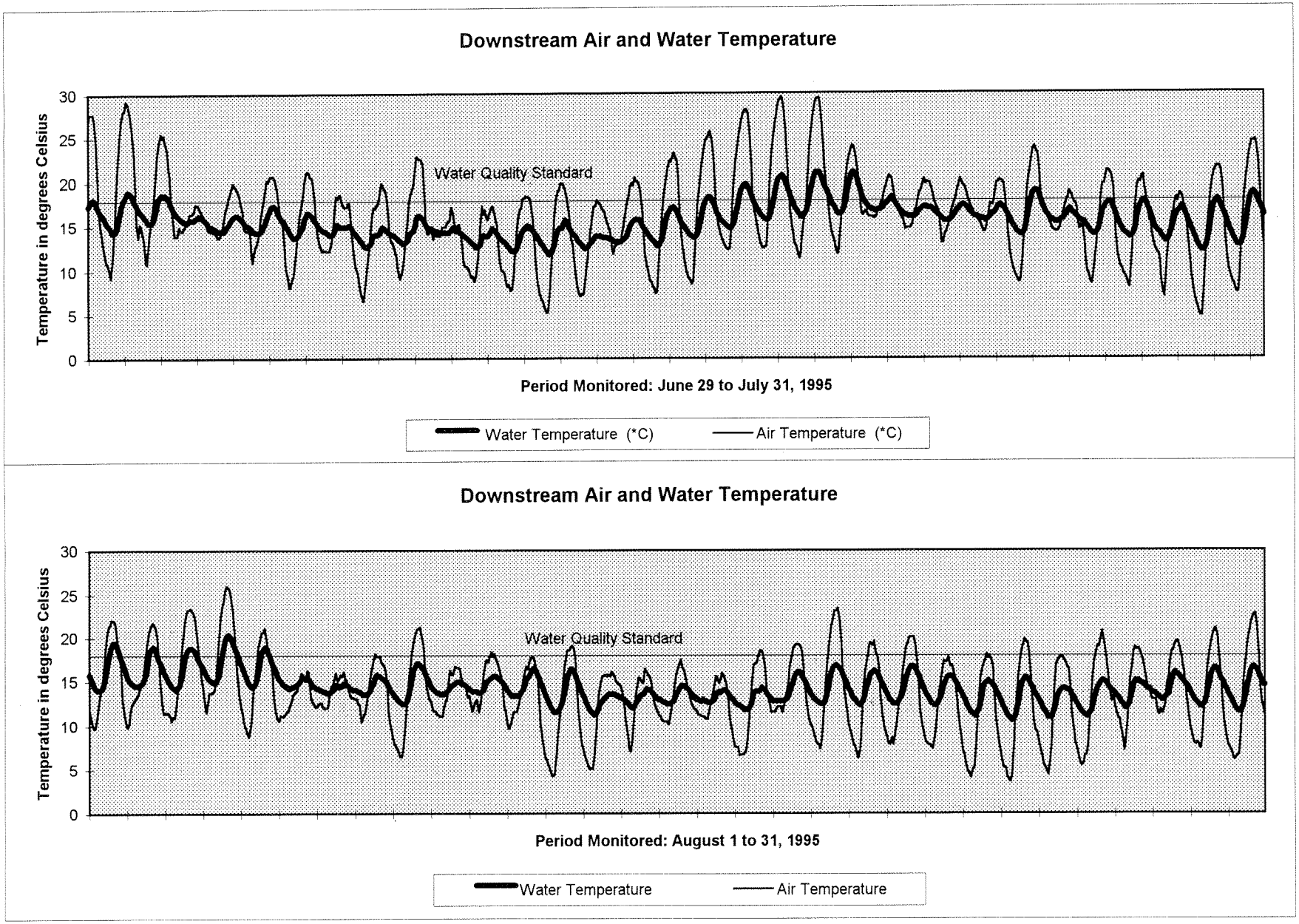


Figure 6: Air and Water Temperature in N.F. Lincoln Creek.

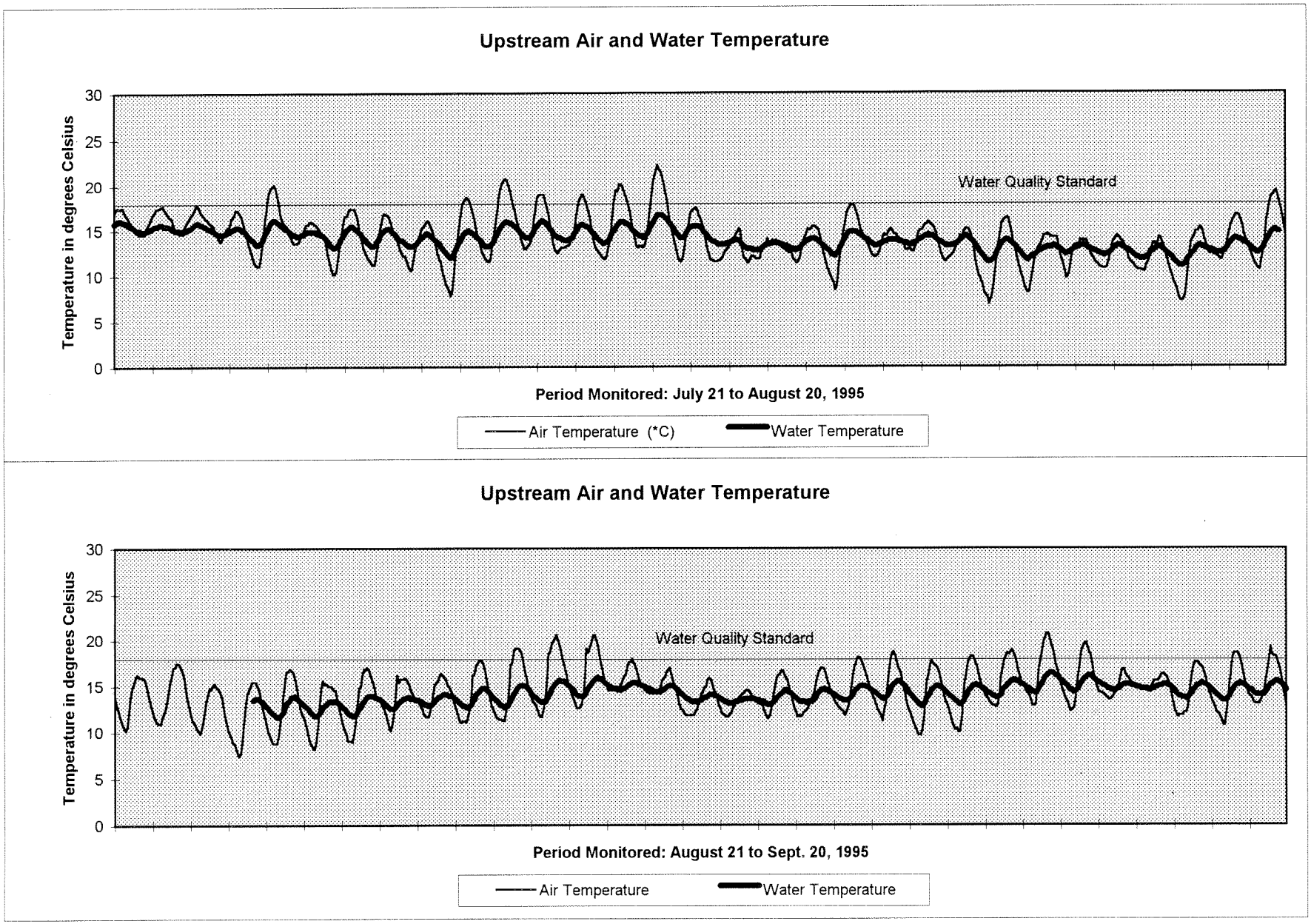
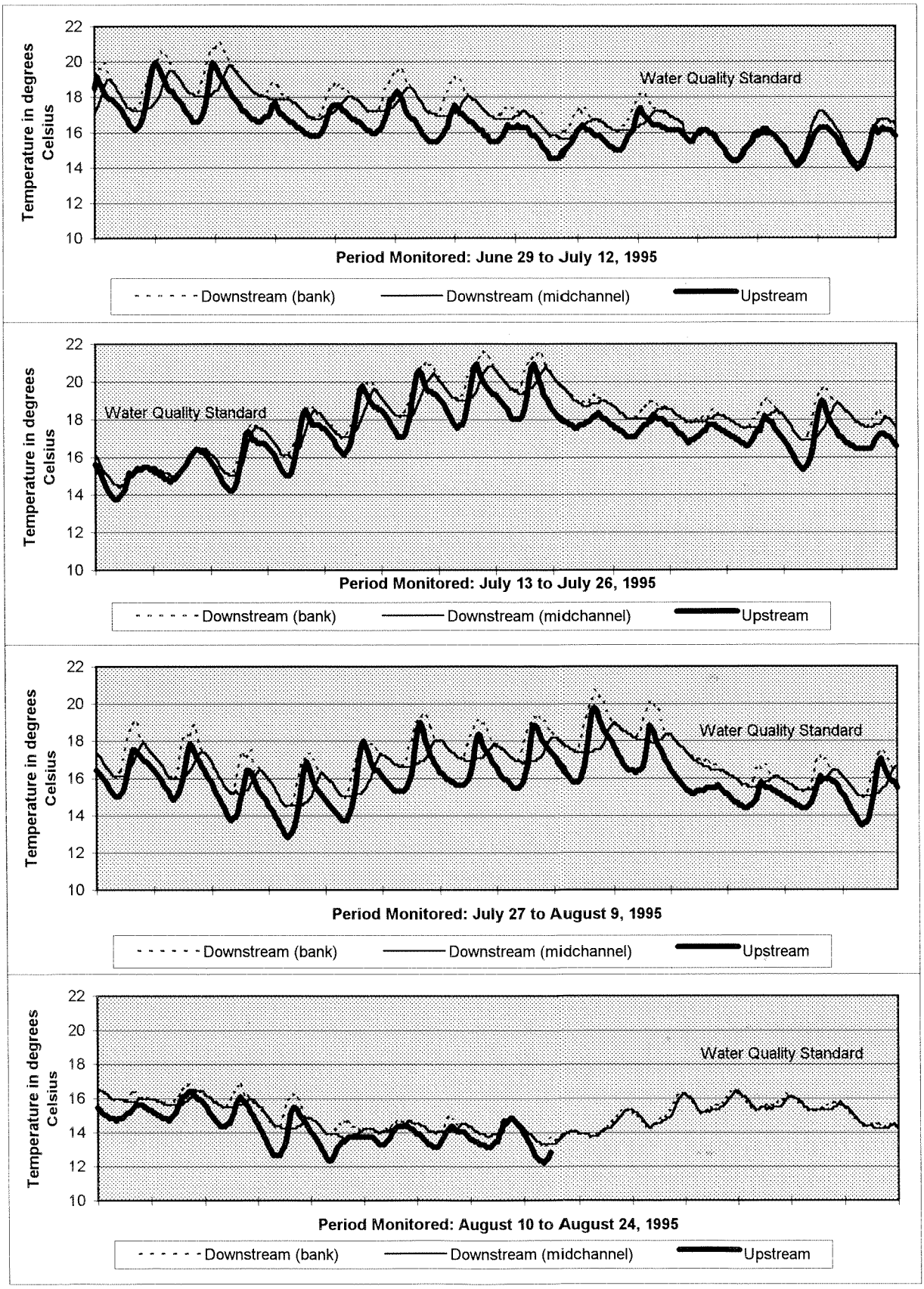


Figure 7: Water Temperature in Mill Creek.



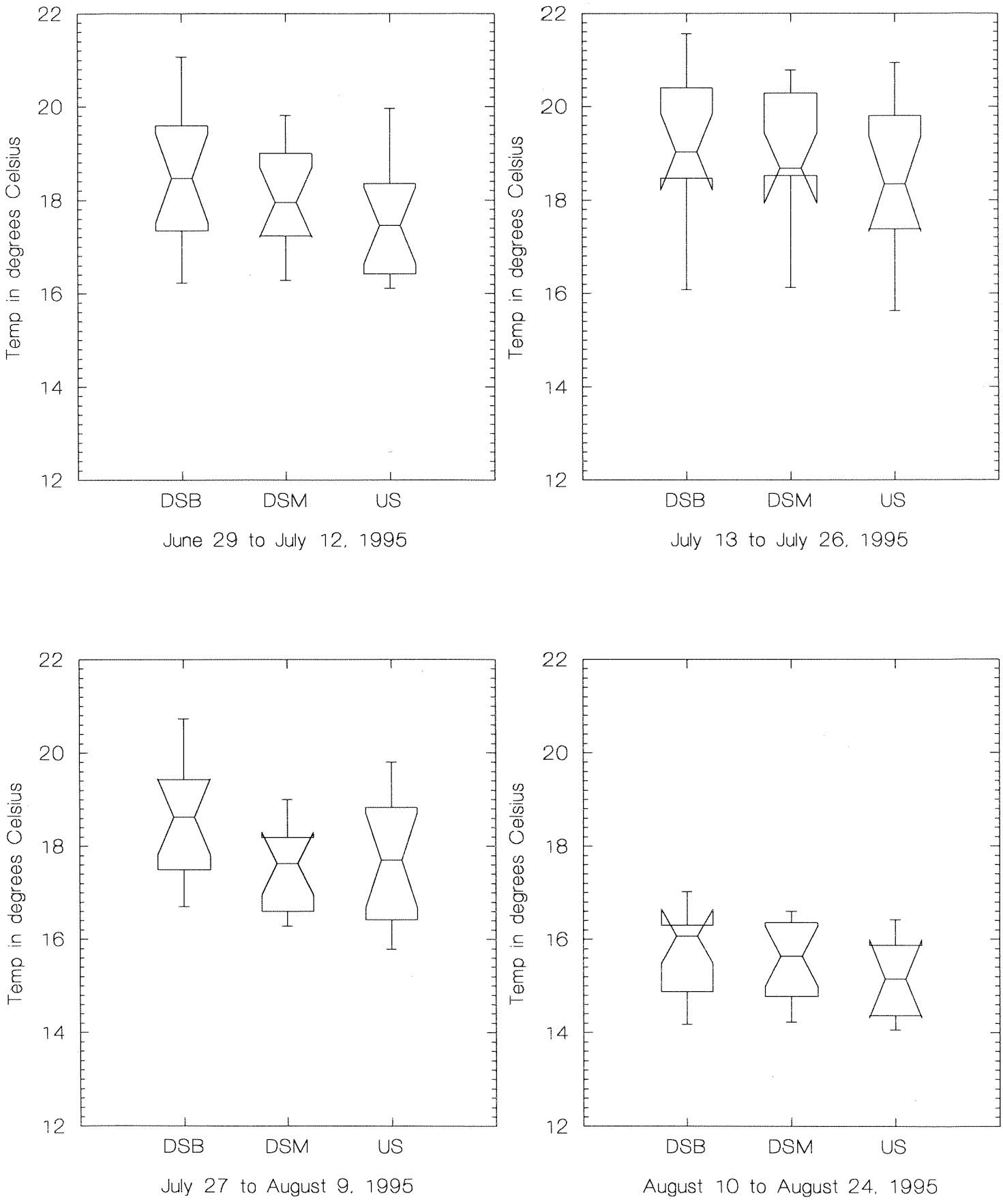


Figure 8: Comparison of Maximum Daily Water Temperature at the Mill Creek Sites.

Figure 9: Air and Water Temperatures at Mill Creek.

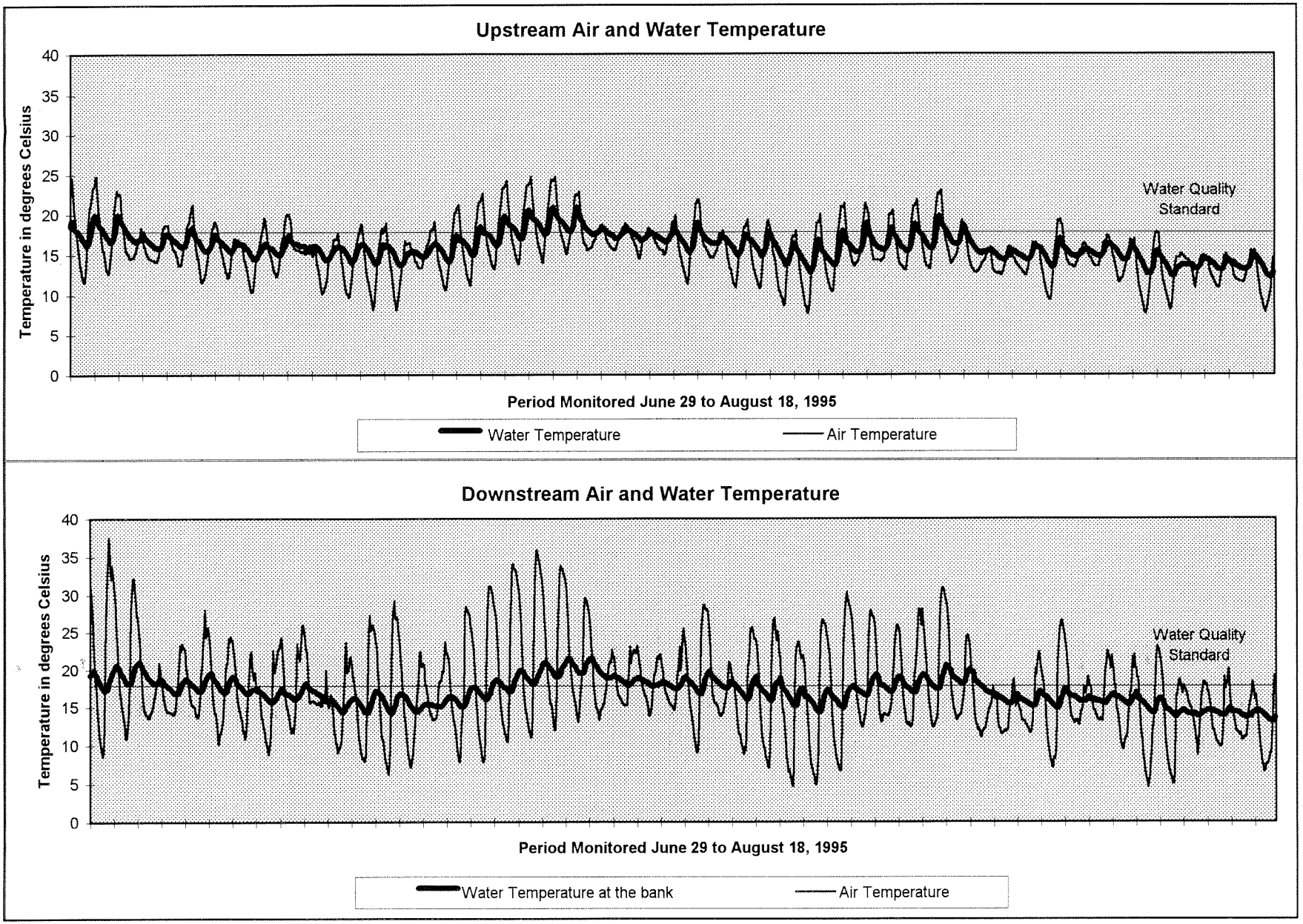
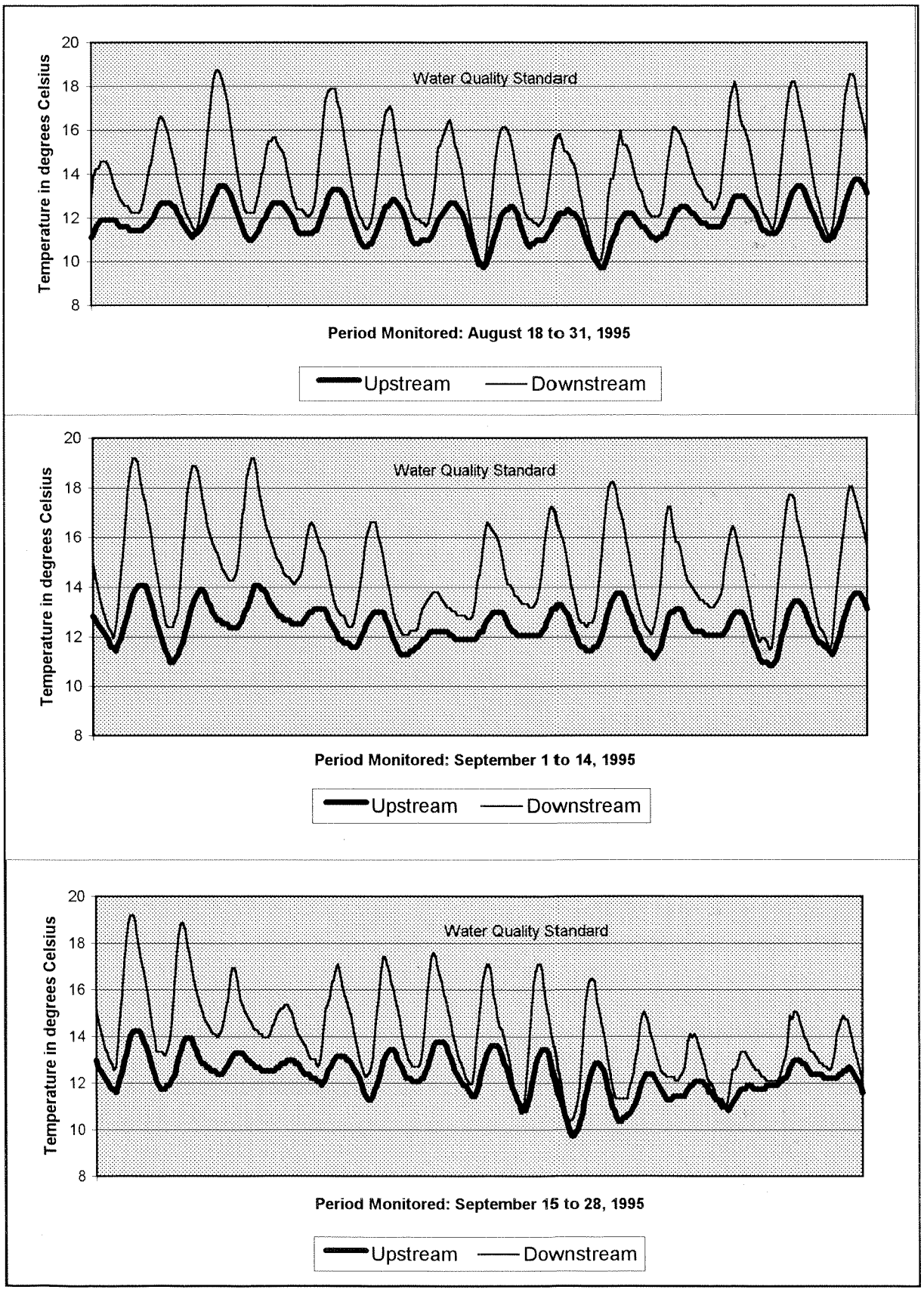


Figure 10: Water Temperatures for a Tributary to Mohney Creek.



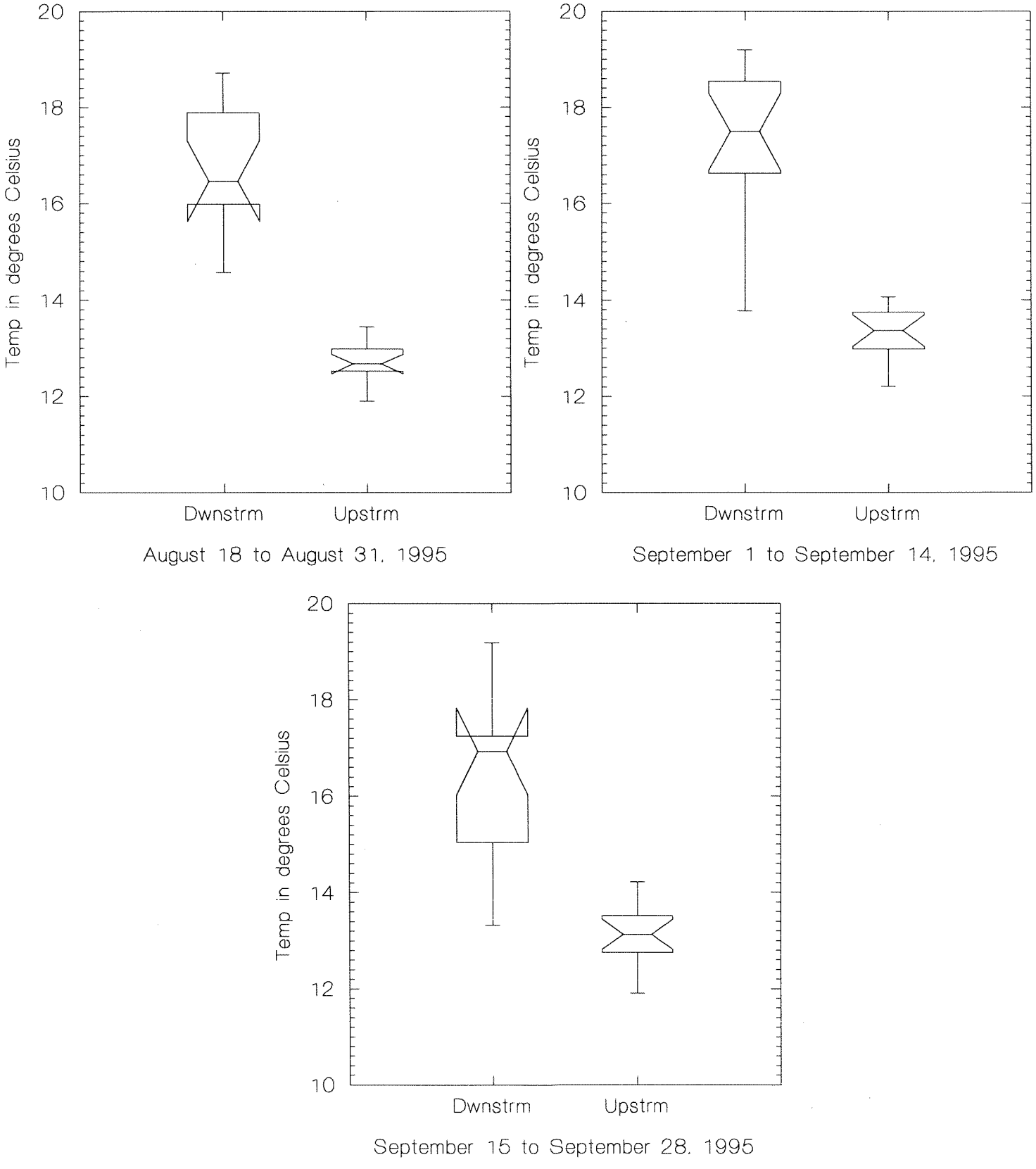


Figure 11 Comparison of Maximum Daily Water Temperature at the Mohney Creek Tributary Sites.

Figure 12: Water Temperature for the Black River at Howanut Rd.

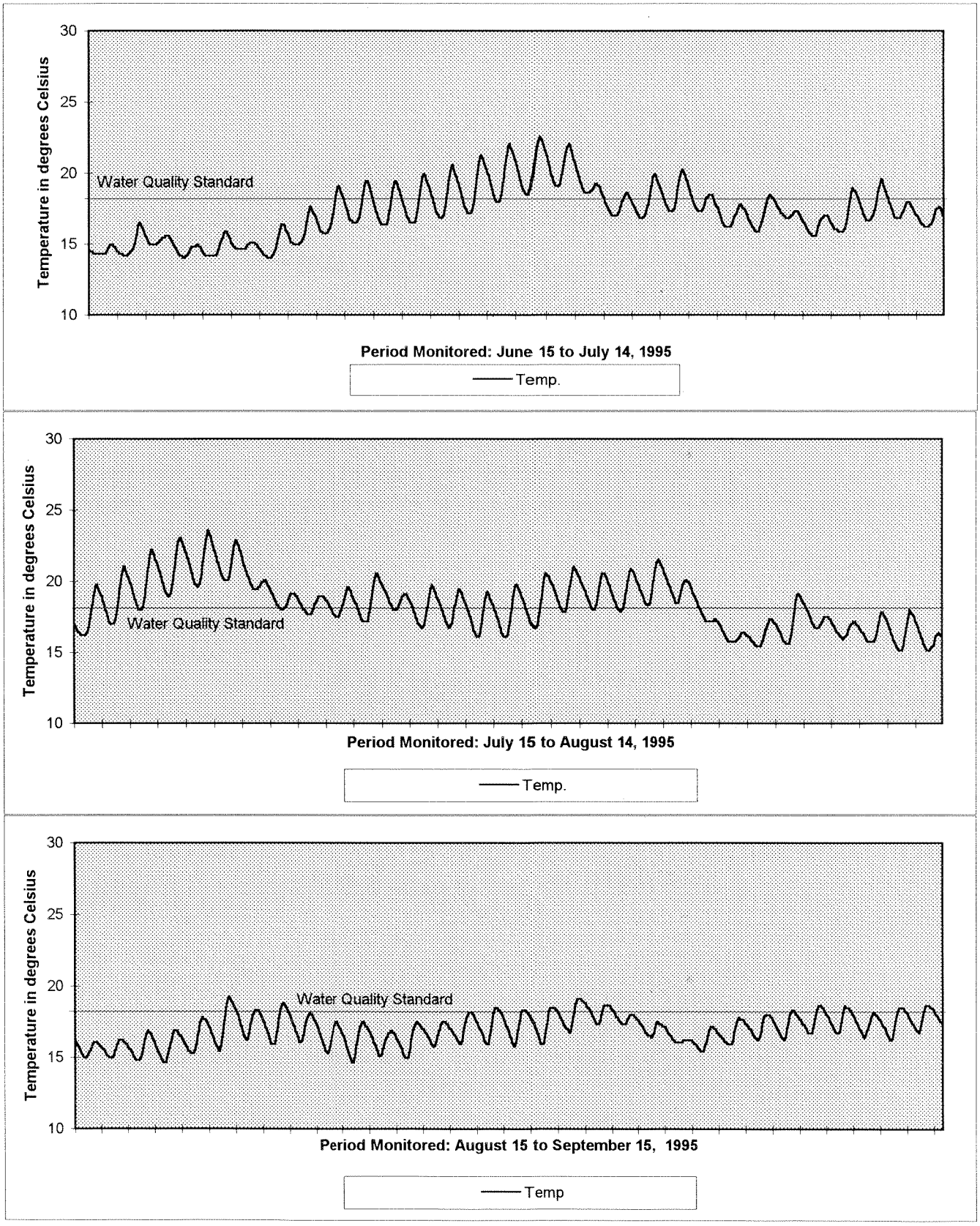


Figure 13: Water Temperature near the mouth of Lincoln Creek

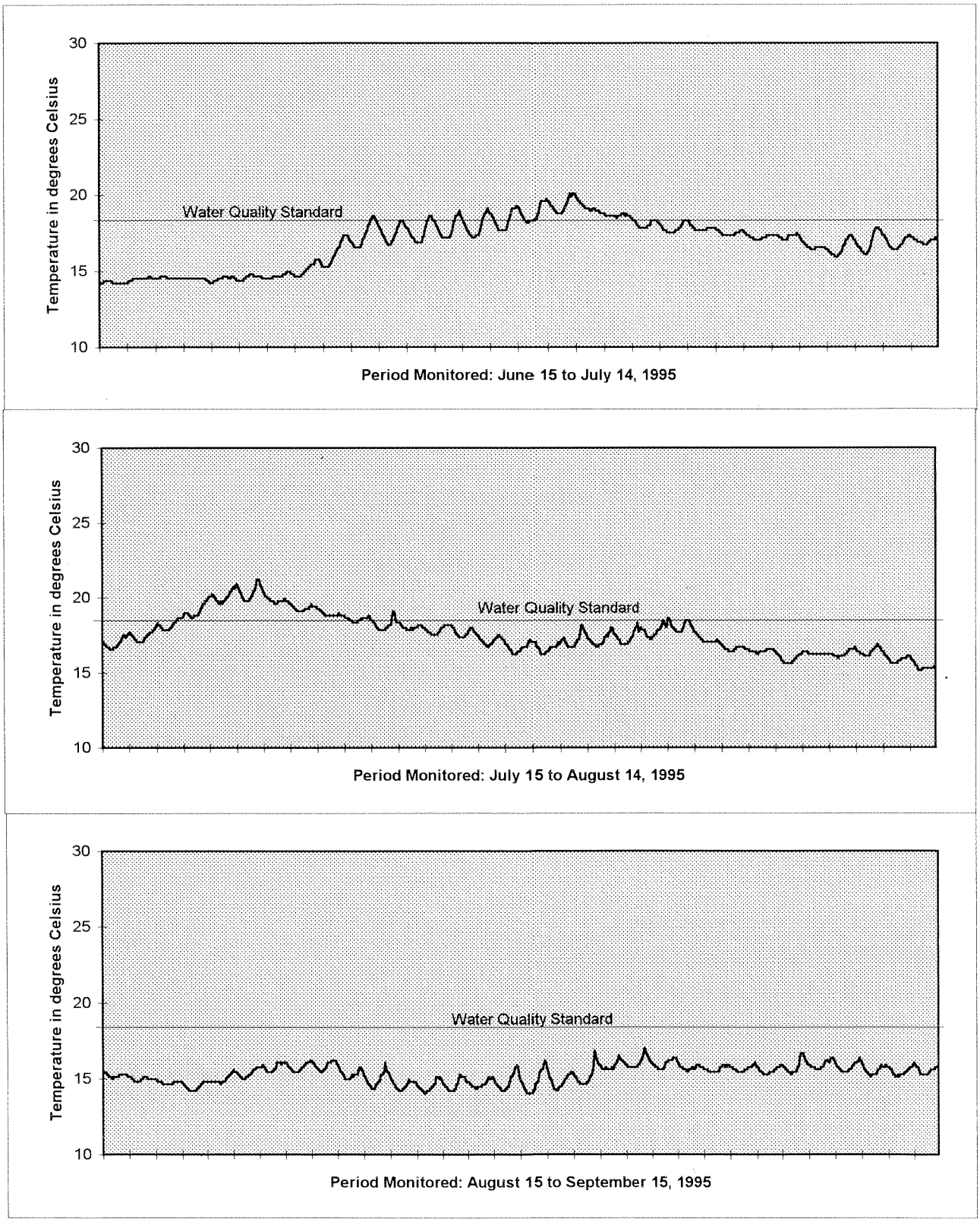


Figure 14: Water Temperature at the mouth of the Newaukum River

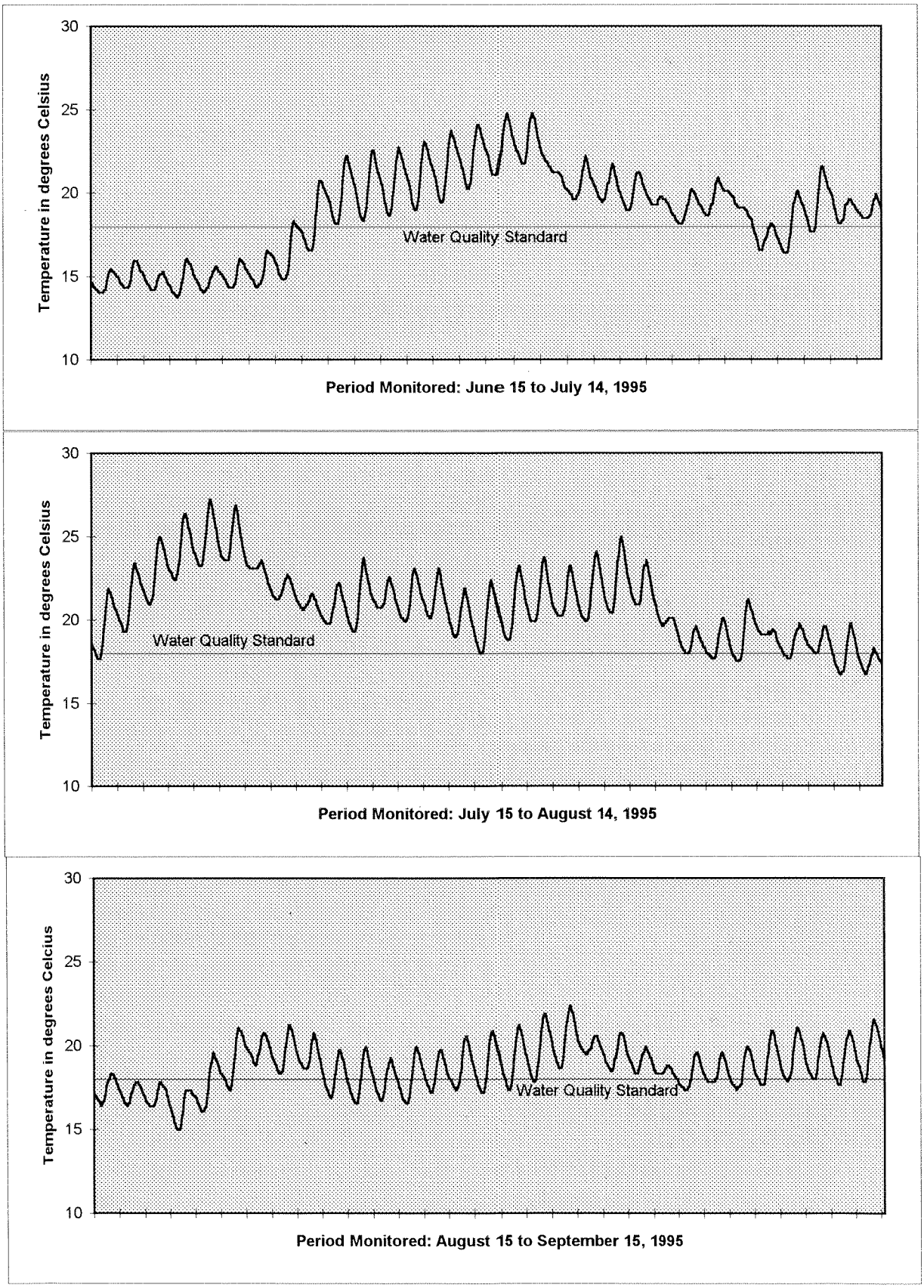


Figure 15: Water Temperature on the Chehalis River, upstream of Newaukum River.

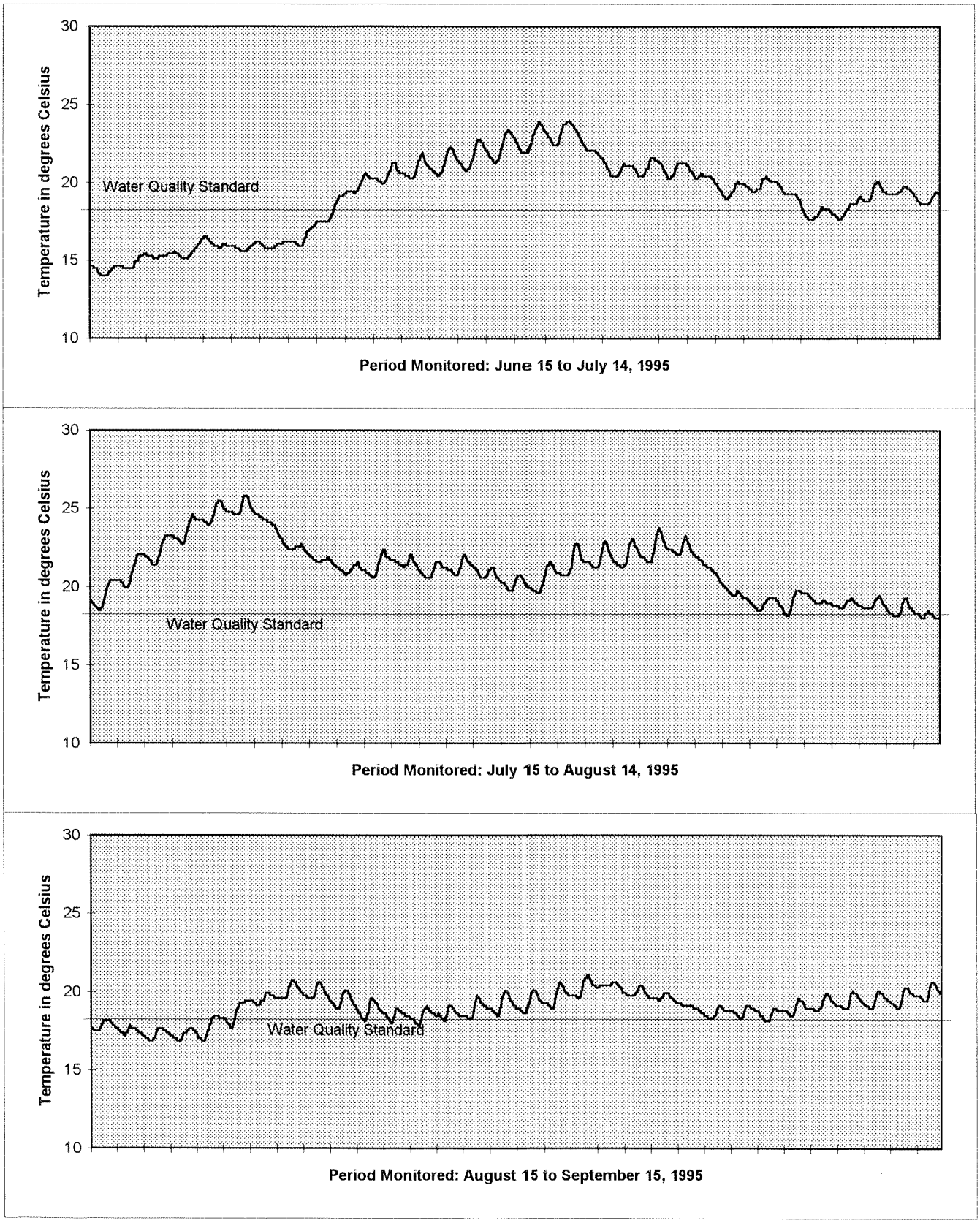


Figure 16: Water Temperature at the mouth of the South Fork of the Chehalis River