

NICOLA RIVER WATERSHED STREAM TEMPERATURES, JULY-OCTOBER 2006

Prepared for:

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Table of Contents

List of Figures	ii
List of Tables	iii
Introduction.....	1
Methods.....	2
Results.....	2
Nicola River	2
Coldwater River	3
Spius Creek	3
Other Sites.....	3
DFO 2005 data.....	3
Discussion.....	4
Acknowledgements.....	5
References.....	6

List of Tables

Table 1. Nicola watershed 2006 temperature sites. 8

List of Figures

Figure 1. Map of Nicola River watershed showing temperature recording sites. Coldwater River site at which temperature recorder malfunctioned is not shown..... 10

Figure 2. Water level (m) and discharge (m³/s) of the Nicola River above Nicola Lake, July – October, 2006..... 11

Figure 3. Temperature in the Nicola River above Nicola Lake with upper temperature limits (coloured solid lines) and optimum rearing temperature ranges (dotted lines) shown for coho (CO) and Chinook (CH) salmon. Temperature recorder out of water from mid August to early September. 12

Figure 4. Temperature in the Nicola River above Nicola Lake with upper temperature limits (coloured solid lines) and optimum rearing temperature ranges (dotted lines) shown for rainbow trout (RB) and bull trout (BT). Temperature recorder out of water from mid August to early September. 12

Figure 5. Temperature in the Nicola River below Nicola Lake. Symbols and notations as in figure 3..... 13

Figure 6. Temperature in the Nicola River below Nicola Lake. Symbols and notations as in figure 4..... 13

Figure 7. Temperature in the Coldwater River (at Kingsvale Bridge). Symbols and notations as in figure 3..... 14

Figure 8. Temperature in the Coldwater River (at Kingsvale Bridge). Symbols and notations as in figure 4..... 14

Figure 9. Temperature in upper Spius Creek (below Maka Creek confluence). Symbols and notations as in figure 3..... 15

Figure 10. Temperature in upper Spius Creek (below Maka Ck confluence). Symbols and notations as in figure 4..... 15

Figure 11. Temperature in lower Spius Creek (just above confluence with Nicola River). Symbols and notations as in figure 3..... 16

Figure 12. Temperature in lower Spius Creek (just above confluence with Nicola River). Symbols and notations as in figure 4..... 16

Figure 13. Temperature in Maka Creek. Symbols and notations as in figure 3..... 17

Figure 14. Temperature in Maka Creek. Symbols and notations as in figure 4..... 17

Figure 15. Temperature in Prospect Creek. Symbols and notations as in figure 3..... 18

Figure 16. Temperature in Prospect Creek. Symbols and notations as in figure 4..... 18

Figure 17. Temperature in Spahomin Creek. Symbols and notations as in figure 3..... 19

Figure 18. Temperature in Spahomin Creek. Symbols and notations as in figure 4..... 19

Figure 19. Temperature in Quilchena Creek. Symbols and notations as in figure 3..... 20

Figure 20. Temperature in Quilchena Creek. Symbols and notations as in figure 4..... 20

Figure 21. Temperature in Guichon Creek. Symbols and notations as in figure 3..... 21

Figure 22. Temperature in Guichon Creek. Symbols and notations as in figure 4..... 21

Figure 23. Temperature in Nuaitch Creek. Symbols and notations as in figure 3..... 22

Figure 24. Temperature in Nuaitch Creek. Symbols and notations as in figure 4..... 22

Figure 25. Temperature in Shakan Creek. Symbols and notations as in figure 3..... 23

Figure 26. Temperature in Shakan Creek. Symbols and notations as in figure 4..... 23

Figure 27. Temperature in Skuhun Creek. Symbols and notations as in figure 3. 24

Figure 28. Temperature in Skuhun Creek. Symbols and notations as in figure 4. 24

Figure 29. Daily maximum stream temperatures from five sites on the Nicola mainstem River (between the Coldwater River confluence and downstream of Skuhun Creek), late July to mid November, 2005. Upper temperature limits (red solid lines) are shown for coho (CO), Chinook (CH), rainbow trout (RB) and bull trout (BT). 25

Introduction

The Nicola River, a tributary of the Thompson River, is a sixth order stream, 189 km long, draining an area of 7,227 km² in the interior of southern British Columbia (Figure 1). Important tributaries to the Nicola for salmonids include the Coldwater River and Spius, Quilchena, Clapperton and Guichon creeks (Walthers and Nener 1998). Historically, the Nicola River was a significant important contributor to interior Fraser River salmonid stocks, particularly early run Chinook and coho salmon and steelhead. Currently, salmonid escapement to the Nicola system is much lower than it was historically, and higher levels are considered essential for survival of these stocks. Excessive exploitation rates, habitat alteration, disruption and destruction from various human activities in the watershed, as well as effects of climate change appear to be contributing to the decline of these fish stocks (DFO 2005).

In spite of the importance of the Nicola River, it remains one of the most threatened in the province, mainly due to impacts from forestry, agriculture, irrigation and urban developments. Forestry is the major land use in the area, with harvesting operations and associated road building activities often causing increased levels of suspended sediments in streams from erosion of roads and cutbanks, landslides and soil disturbances (Rood and Hamilton 1995, DFO 1998). Other sources of impacts to flow and water quality in streams include agricultural developments, water diversion, alteration/loss of riparian habitat, linear and urban influences, pipeline construction, and mining activities (Rood and Hamilton 1995, Kosakoski and Hamilton 1982, DFO 1998). There has been considerable loss of riparian vegetation along the Nicola River, which has reduced stream shading and resulted in warmer stream temperatures during summer. Additional thermal stresses are imposed due to flows being reduced by water withdrawals for irrigation and other land uses, resulting in greater daily temperature variations (Walthers and Nener 1997). Also, frequent destabilization of stream banks has resulted in wider channels and shallower waters being more susceptible to warming during summer. Increases in water temperature, if too great, can adversely affect growth, distribution, behaviour, disease resistance, production and ultimately survival of salmonids. Studies by Walthers and Nener (1997) suggest that salmonid production in both the Nicola and Coldwater rivers are constrained by relatively high water temperatures, with the distribution of fish influenced by local variations in water temperatures as fish tend to seek cooler areas with groundwater inflows, shade, and other features. Within the Nicola system, Rood and Hamilton (1995) regarded the mainstem Nicola, the Coldwater River and other important salmonid tributaries as sensitive areas for salmonids due to high water demands, extreme low and high flows, and excessive logging activity.

Very little temperature data are available for drainages of importance for salmonids in the southern interior of British Columbia. The primary objective of this study was to collect temperature data at various sites within the Nicola watershed from July through October and assess the suitability of these environments for salmonids with respect to species temperature preferences and tolerances.

Methods

In July 2006, temperature recorders were installed at 14 sites in the Nicola River watershed (Figure 1; Table 1). These included two sites in each of the Nicola River mainstem, Coldwater River and Spius Creek, and one site in each of Maka, Prospect, Spahomin, Quilchena, Guichon, Nuaitch, Shakan and Skuhun creeks. Unfortunately, the recorder in the Coldwater River lower site malfunctioned, so very limited data are available for this site (not shown). At each of the other 13 sites, temperature was recorded from the second week in July to the second week in October, 2006, with the recorders briefly removed for downloading on 6 September.

Each of the temperature recorders was either secured to a large wooden structure or secured in the thalweg of the channel, taking into consideration likely summer low flow levels when determining placement in the channel. Stream temperature was recorded every hour at all sites. UTM coordinates were noted at deployment, with site photos taken at the beginning and during the download visit.

Sites were checked at various times during the period of summer low flows to ensure that the recorders were in water. At the upper site in the Nicola mainstem the recorder was out of the water during mid-season downloading due to exceptionally low flows. Discharge data from the site indicates extreme low flows began mid August (Figure 2). No other sites were dry throughout the recording period.

The temperature data were retrieved from the recorders and graphed for comparison with optimal rearing ranges and upper temperature limits for juveniles of Chinook and coho salmon, rainbow trout and bull trout. Optimal temperature ranges for rearing are considered to be 10-15.5 °C for Chinook salmon, 9-16 °C for coho salmon, 6-14 °C for bull trout and 16-18°C for rainbow trout; upper temperature limits are 22 °C for Chinook salmon, 24 °C for coho salmon, 15 °C for bull trout and 24 °C for rainbow trout (Oliver and Fidler 2001).

Results

Nicola River

Daily temperature variation in the Nicola River above the lake during summer was considerable (>5 °C at extremes), whereas below the lake daily variability was minimal (about 2 °C), although temperatures were quite warm (usually well above 16 °C in July and August). The maximum temperature recorded was slightly higher above the lake (27.6 °C) than below the lake (25.7 °C), whereas the monthly averages were slightly warmer below the lake in all months. Summer temperatures above and below the lake generally exceeded the thermal preferences and tolerances of bull trout, and to quite an extent of other salmonids (Figure 3 -6; Table 1).

Coldwater River

The summer thermal regime in the Coldwater is similar to that of the Nicola above the lake, with daily variation in temperature being pronounced (>5 °C at extremes) and maximum and average temperatures not being greatly dissimilar between these two sites. To mid September, daytime temperatures in the Coldwater were frequently above the thermal limit for bull trout, but generally within the limits for other salmonids (although summer temperatures did occasionally exceed the upper tolerance limits of all species) (Figure 7 -8; Table 1).

Spius Creek

In general, daily temperature variability in Spius Creek is considerable, although more pronounced in the lower site (>5 °C at extremes) due to higher daytime temperatures. The summer thermal regime of Spius resembles that of the Coldwater with their monthly maximums and averages being similar. As in the Coldwater, until mid September, daytime temperatures in Spius frequently exceeded the upper limit for bull trout, and to some extent for Chinook, coho and rainbow trout (Figure 9 -12; Table 1).

Other Sites

Among the other eight sites for which temperature data are presented (Figure 13 -28; Table 1), Maka Creek had the coolest thermal regime during summer, exceeding 15 °C for no more than 10 days in the latter half of July, reaching a maximum 16.9 °C. The average temperature for July and August was 12.7 °C and 10.7 °C, respectively. The range in daily temperature was less than 5 °C throughout the recording period, and for much of the time was within the range preferred by bull trout, Chinook and coho, but too cool for rainbow trout which prefer warmer water for rearing.

Among the other tributaries, those with moderate summer thermal regimes include Prospect, Spahomin, Nuaitch, Shakan and Skuhun creeks, with their August average temperatures lying between 13 and 14 °C, and maximum levels not exceeding 18.2 °C. In general, these streams have favourable summer thermal regimes for salmonids, although temperatures in both Shakan and Skuhun creeks were slightly below that considered optimal for rainbow trout rearing.

Both Quilchena and Guichon creeks are characterized by relatively warm summer thermal regimes with monthly averages for July and August lying roughly between 16 and 18 °C. Maximum temperatures were recorded in July in both streams - Quilchena 24.4 °C; Guichon 25.2 °C, and summer temperatures occasionally exceeded the upper tolerance limits of all species. Summer temperatures in both streams are more suited for rainbow trout than the other salmonids.

DFO 2005 data

In 2005, the Department of Fisheries and Oceans collected hourly temperature data at five sites on the mainstem Nicola River (confluence of the Coldwater River to

downstream of Skuhun Creek) from late July to November. Stream temperatures were greater than 20 °C throughout July and mid August, exceeding the tolerance limits of all four salmonid species (Figure 29).

Discussion

During summer 2006, high stream temperatures occurred within the Nicola watershed, particularly within the mainstem and some of the larger tributaries of importance for salmonids. Nicola River mainstem temperatures were generally too warm for all salmonid species and exceeded the optimum rearing range during the majority of the growing season. Daily temperature variations increased during summer low flow conditions, with temperature shifts of up to 15 °C observed in streams with limited riparian cover and low flow. Fish mortality is generally minimal if stream temperatures reach upper tolerance levels for short periods and are restored to optimal levels (Oliver and Fidler 2001). The Nicola watershed has experienced severe degradation of riparian cover from various human activities (agriculture, logging, urban development) resulting in lower flows and warmer stream temperatures during summer. Although temperature increases were not as pronounced in the larger tributaries such as the Coldwater River, Spius, Quilchena and Guichon creeks, the upper tolerance limits of all four salmonid species were surpassed in 2006.

Temperature data collected on the Nicola mainstem at five sites in 2005 (DFO data) periodically exceeded the upper tolerance levels of all four salmonid species indicating that high temperatures do probably occur annually in the Nicola River. Fish kills of a limited spatial extent (spot kills in off-channels or mainstem) have been observed in the Nicola basin for both salmon and trout at stream temperatures of 24-25 °C (A. Caverly, MOE, pers. comm.).

The infestation of Mountain Pine Beetle throughout the Nicola watershed is also expected to impact stream temperatures. Significant levels of deforestation (up to 80%) and subsequent salvage operations are expected, both of which will increase the level of risk of warm stream temperatures.

The smaller tributaries such as Maka, Prospect, Nuaitch, Shakan, and Skuhun creeks were cooler (particularly Maka) with stream temperatures generally being ideal for both Chinook and coho salmon during the growing season. Smaller tributaries often have better shading due to narrower floodplains and greater canopy cover (Meehan et al. 1977). Although Spahomin Creek temperatures were within the optimal rearing range for salmonids, the upper tolerance level of Chinook was exceeded for part of the time in July.

Summer temperature conditions in the Nicola watershed are not well suited for bull trout. The species upper tolerance limit of 15 °C was surpassed at all sites, occasionally even in the smaller, cooler tributaries. During the summer months bull trout are likely confined to the cooler headwater areas, such as Maka Creek, as stream temperatures are too warm in much of the watershed.

As noted earlier in this report, the Nicola basin experienced very warm conditions and low flows in 2006. It is widely believed by fisheries personnel that the warm summer temperatures and low flows affected the well-being of salmonid populations. As limited summer temperature data exist for this watershed it would be desirable to repeat the study in two more years to further our understanding of the summer thermal regime of this watershed. As human impacts, climate change and the Mountain Pine Beetle epidemic continue to affect flow and water quality, stream temperatures will continue to be of concern for salmonid stocks in the Nicola watershed.

Acknowledgements

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TABLES

Table 1. Nicola watershed 2006 temperature sites.

Stream	General Location	Deployment Period	Maximum & Average Temperatures / Month			
			Jul	Aug	Sep	Oct
Nicola River	Beaks Bridge (above Nicola Lake)	Jul 11-Oct 10, 2006	Max = 27.6°C Ave = 19.2°C	Max = 27.0°C Ave = 16.9°C	Max = 21.5°C Ave = 13.2°C	Max = 13.2°C Ave = 8.5°C
Nicola River	Chutter Ranch (below Nicola Lake)	Jul 11-Oct 10, 2006	Max = 25.7°C Ave = 20.4°C	Max = 21.8°C Ave = 19.2°C	Max = 20.8°C Ave = 15.7°C	Max = 14.2°C Ave = 11.3°C
Coldwater River	Kingsvale bridge	Jul 12-Oct 11, 2006	Max = 24.9°C Ave = 16.9°C	Max = 22.5°C Ave = 16.2°C	Max = 21.0°C Ave = 12.8°C	Max = 12.9°C Ave = 8.2°C
Spilus Creek	Upper Bridge below Maka confluence (upper site)	Jul 13-Oct 11, 2006	Max = 25.1°C Ave = 16.6°C	Max = 21.0°C Ave = 15.1°C	Max = 18.6°C Ave = 11.9°C	Max = 11.1°C Ave = 7.2°C
Spilus Creek	Hatchery (close to confluence with Nicola River) (lower site)	Jul 11-Oct 10, 2006	Max = 27.0°C Ave = 18.1°C	Max = 24.2°C Ave = 17.4°C	Max = 22.0°C Ave = 13.7°C	Max = 13.9°C Ave = 9.00°C
Maka Creek	Bridge crossing 1 km on Maka forest service road	Jul 13-Oct 11, 2006	Max = 16.9°C Ave = 12.7°C	Max = 14.2°C Ave = 10.7°C	Max = 12.2°C Ave = 8.5°C	Max = 8.1°C Ave = 5.4°C
Prospect Creek	27 km bridge crossing. Merritt Snowmobile Club	Jul 11-Oct 10, 2006	Max = 18.8°C Ave = 13.9°C	Max = 16.4°C Ave = 13.1°C	Max = 14.5°C Ave = 10.0°C	Max = 9.1°C Ave = 6.3°C
Spahomin Creek	Smolt ponds. Old homestead.	Jul 11-Oct 10, 2006	Max = 22.3°C Ave = 16.6°C	Max = 18.2°C Ave = 13.7°C	Max = 16.9°C Ave = 10.8°C	Max = 10.4°C Ave = 6.5°C
Quilchena Creek	Golf Course (vicinity)	Jul 13-Oct 10, 2006	Max = 24.4°C Ave = 18.3°C	Max = 24.0°C Ave = 17.6°C	Max = 20.5°C Ave = 13.9°C	Max = 13.0°C Ave = 9.4°C
Guichon Creek	Lower bridge	Jul 11-Oct 10, 2006	Max = 25.2°C Ave = 17.9°C	Max = 21.3°C Ave = 16.3°C	Max = 18.3°C Ave = 12.9°C	Max = 12.0°C Ave = 8.7°C
Nuaitch Creek	Lower bridge	Jul 11-Oct 10, 2006	Max = 19.5°C Ave = 14.3°C	Max = 17.2°C Ave = 13.5°C	Max = 15.2°C Ave = 10.4°C	Max = 9.9°C Ave = 6.5°C
Shakan Creek	Lower bridge	Jul 13-Oct 10, 2006	Max = 18.6°C Ave = 14.4°C	Max = 16.2°C Ave = 13.4°C	Max = 14.3°C Ave = 10.6°C	Max = 9.8°C Ave = 7.0°C
Skuhun Creek	1.4km on forest service road	Jul 11-Oct 10, 2006	Max = 20.3°C Ave = 15.3°C	Max = 17.0°C Ave = 14.0°C	Max = 14.8°C Ave = 10.9°C	Max = 10.1°C Ave = 6.8°C

FIGURES

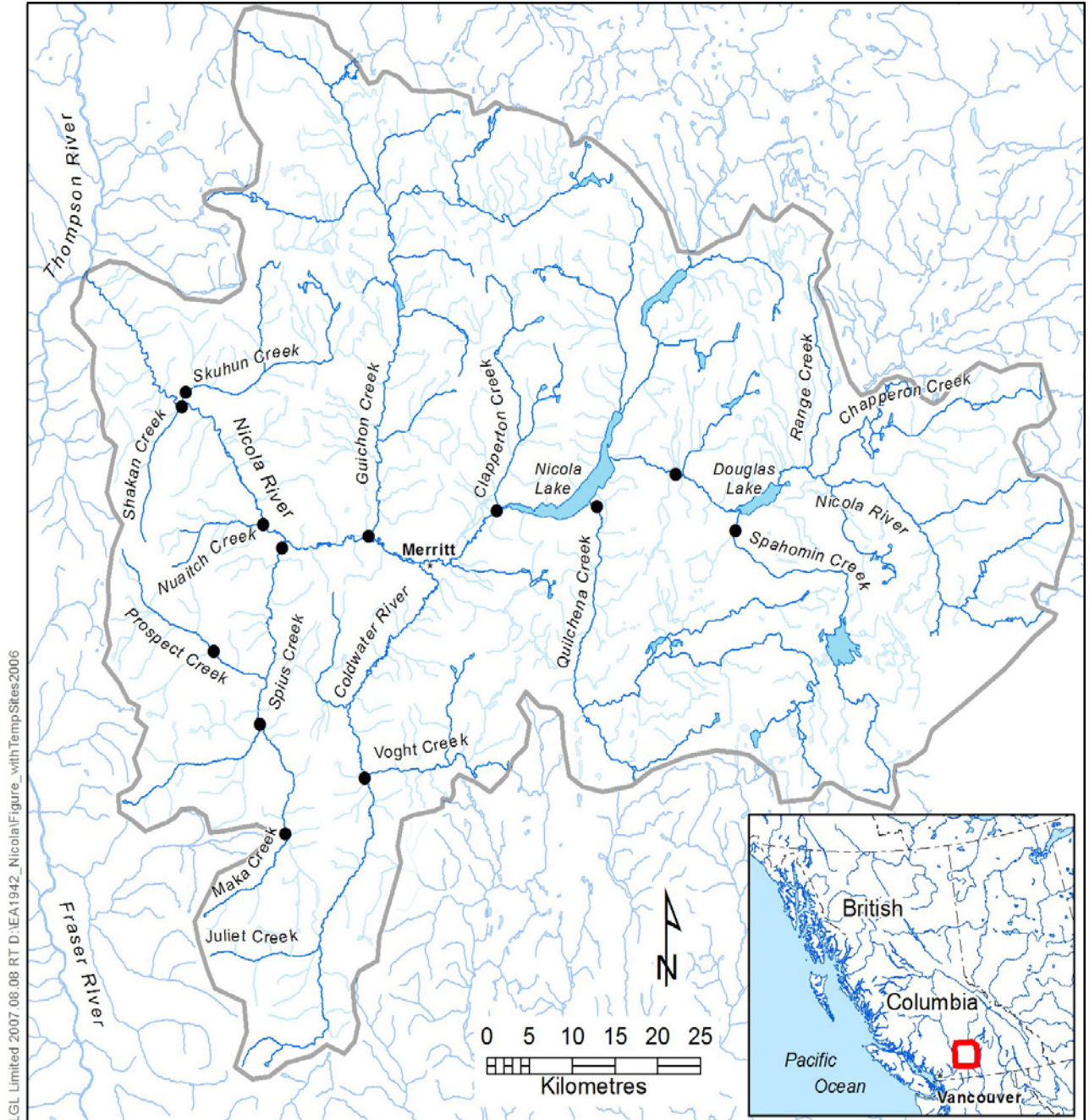


Figure 1. Map of Nicola River watershed showing temperature recording sites. Coldwater River site at which temperature recorder malfunctioned is not shown.

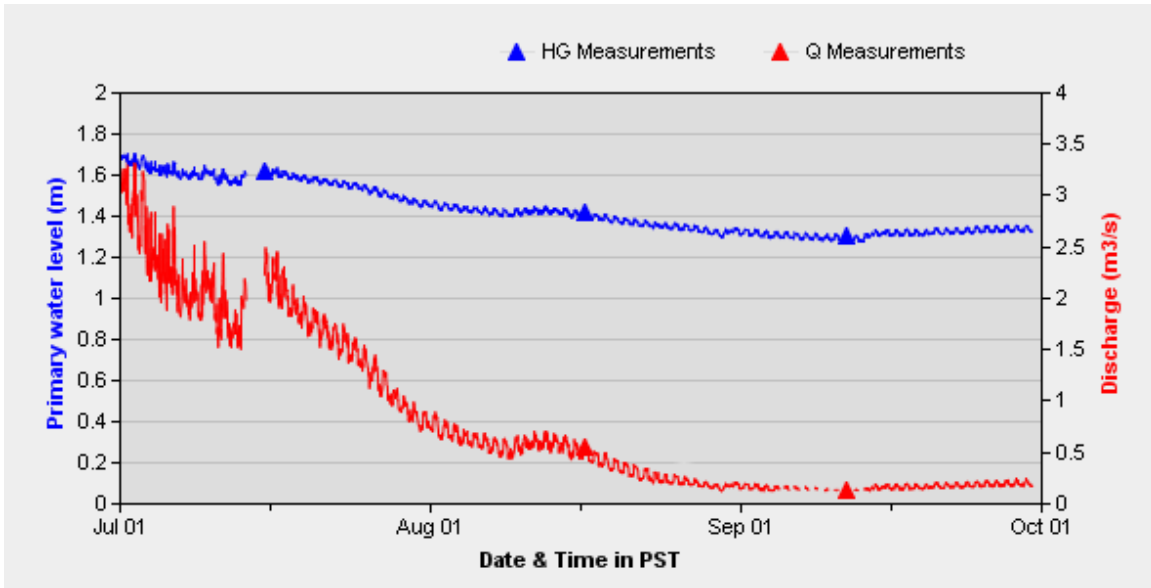


Figure 2. Water level (m) and discharge (m³/s) of the Nicola River above Nicola Lake, July – October, 2006.

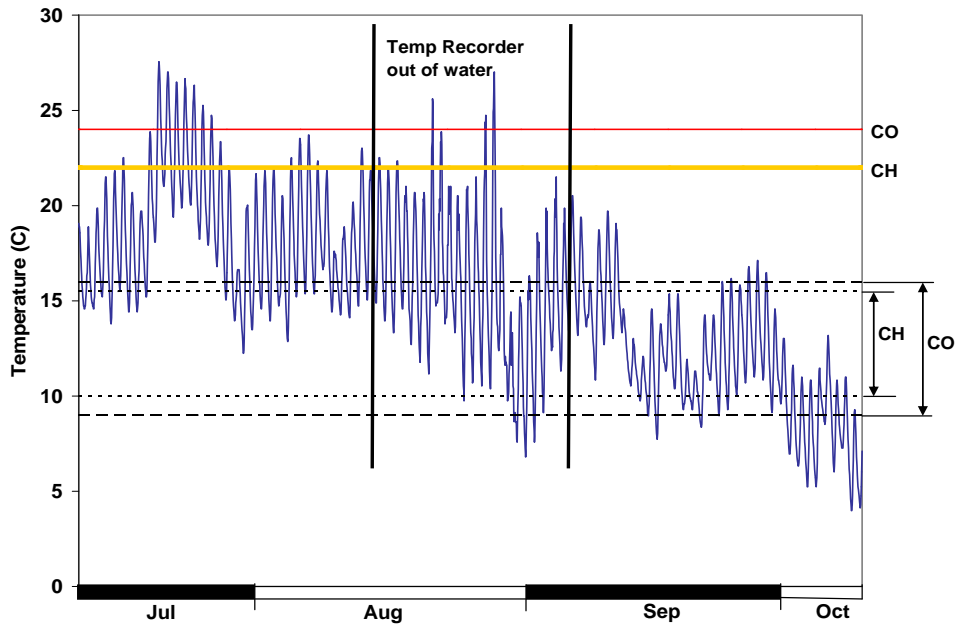


Figure 3. Temperature in the Nicola River above Nicola Lake with upper temperature limits (coloured solid lines) and optimum rearing temperature ranges (dotted lines) shown for coho (CO) and Chinook (CH) salmon. Temperature recorder out of water from mid August to early September.

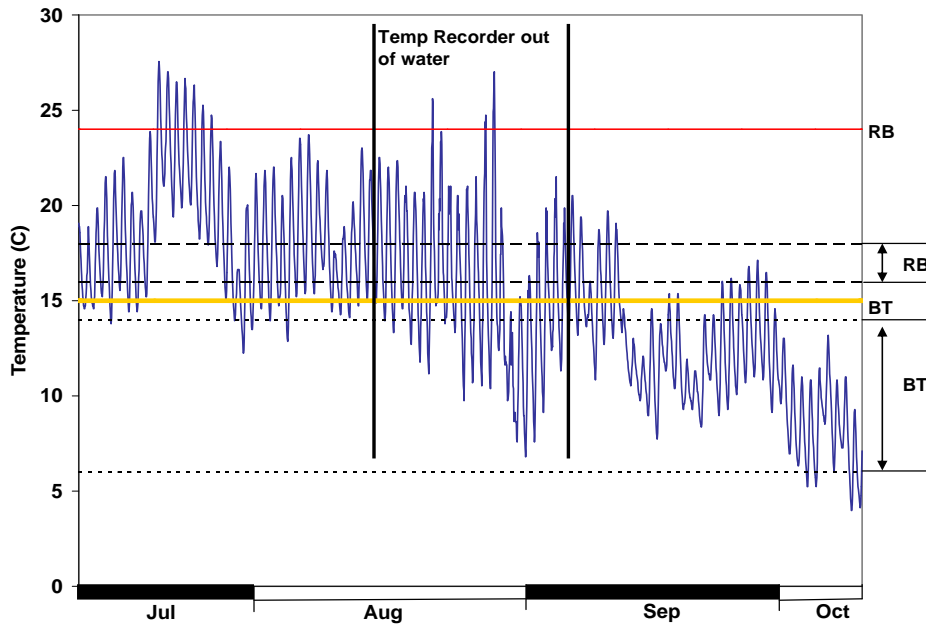


Figure 4. Temperature in the Nicola River above Nicola Lake with upper temperature limits (coloured solid lines) and optimum rearing temperature ranges (dotted lines) shown for rainbow trout (RB) and bull trout (BT). Temperature recorder out of water from mid August to early September.

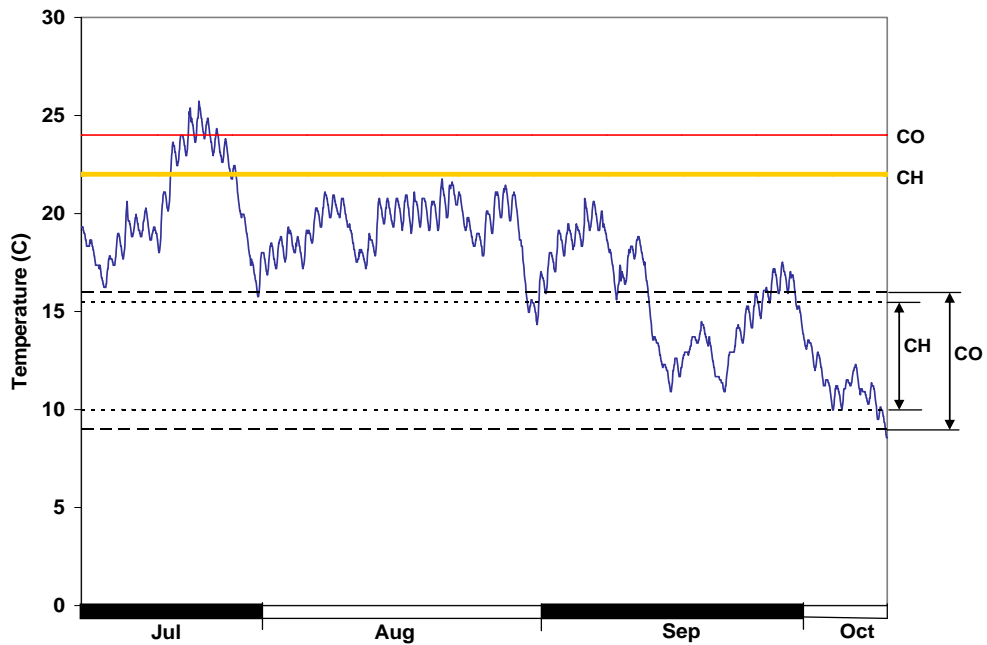


Figure 5. Temperature in the Nicola River below Nicola Lake. Symbols and notations as in Figure 3.

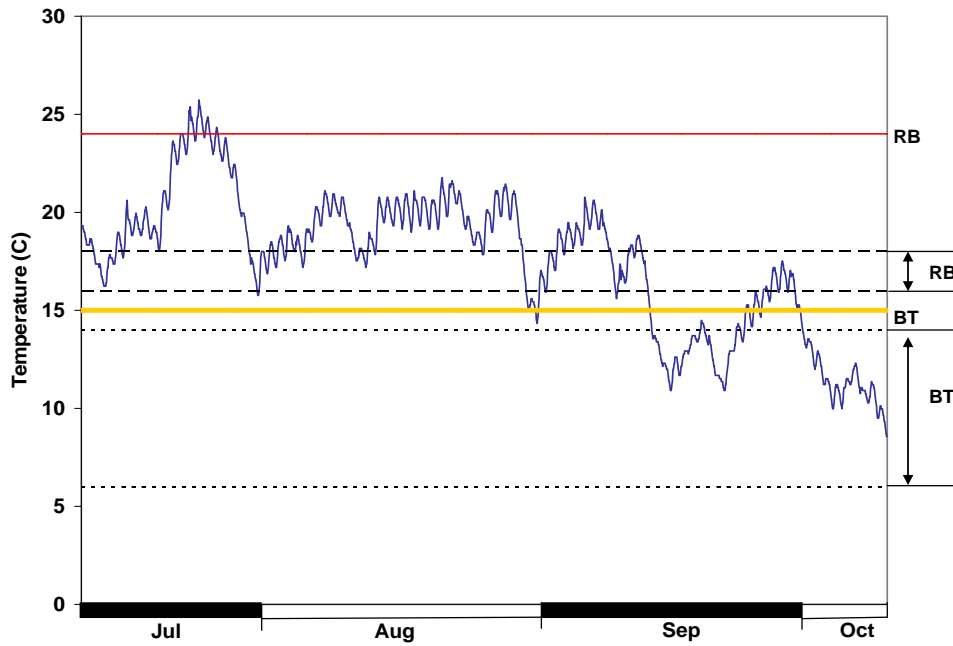


Figure 6. Temperature in the Nicola River below Nicola Lake. Symbols and notations as in Figure 4.

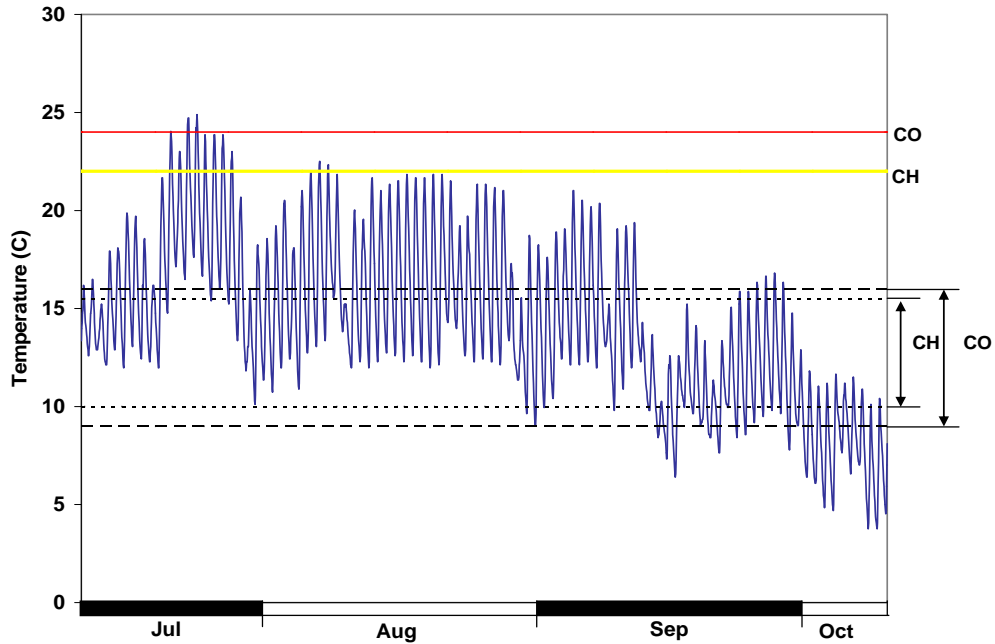


Figure 7. Temperature in the Coldwater River (at Kingsvale Bridge). Symbols and notations as in Figure 3.

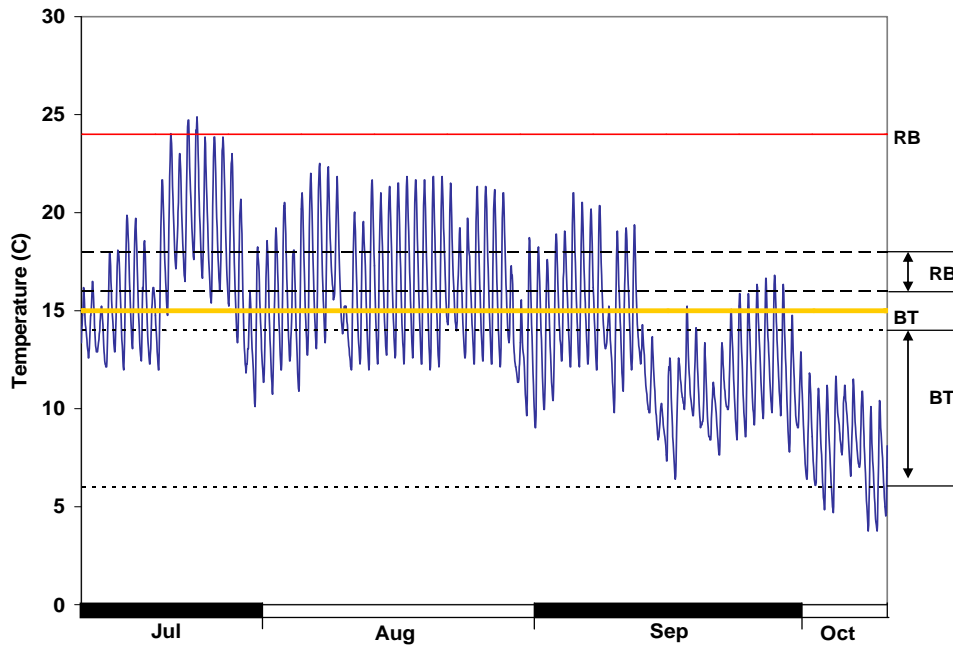


Figure 8. Temperature in the Coldwater River (at Kingsvale Bridge). Symbols and notations as in Figure 4.

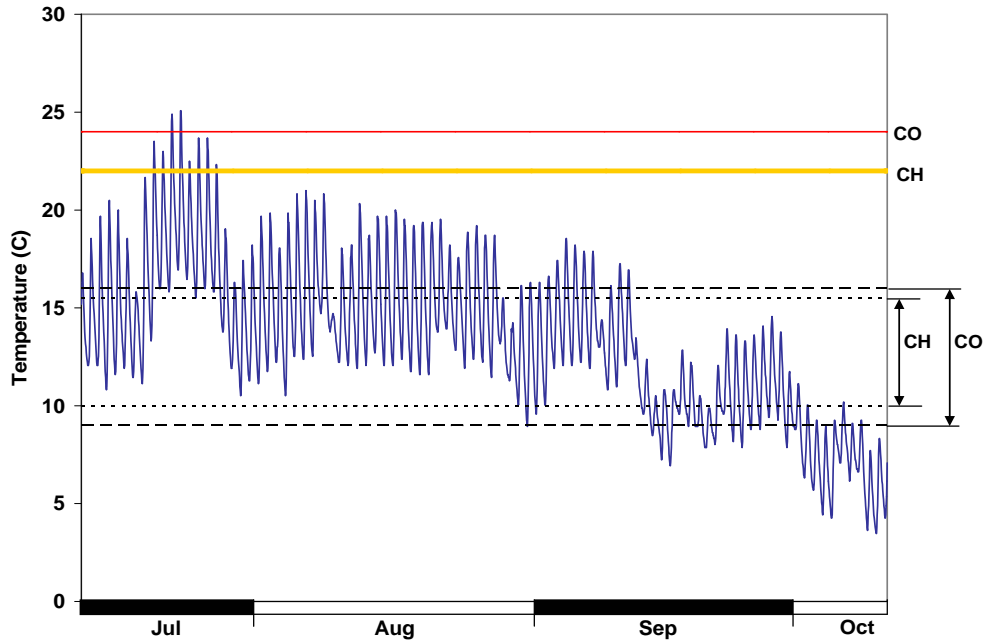


Figure 9. Temperature in upper Spius Creek (below Maka Creek confluence). Symbols and notations as in Figure 3.

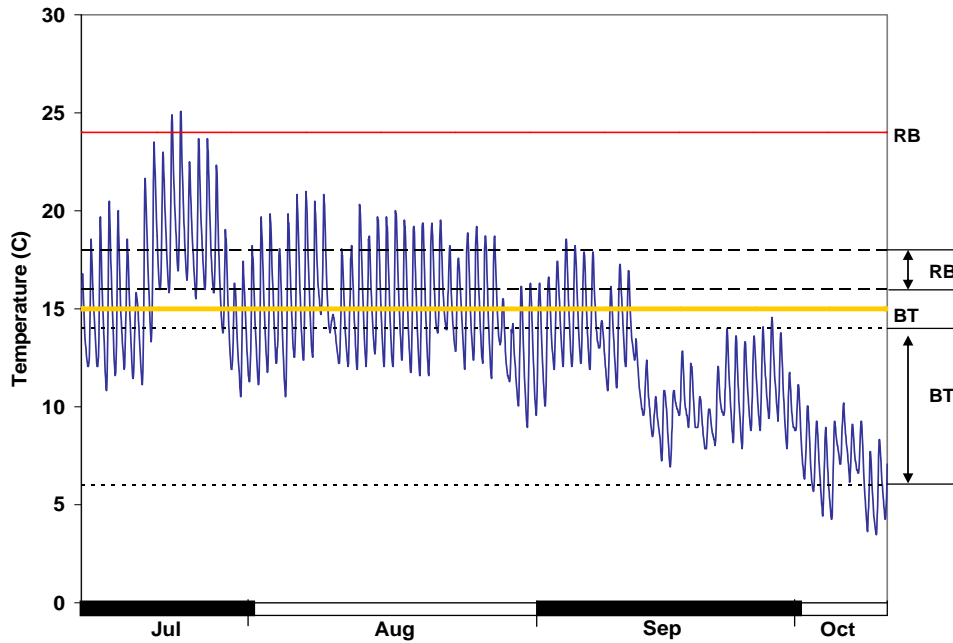


Figure 10. Temperature in upper Spius Creek (below Maka Ck confluence). Symbols and notations as in Figure 4.

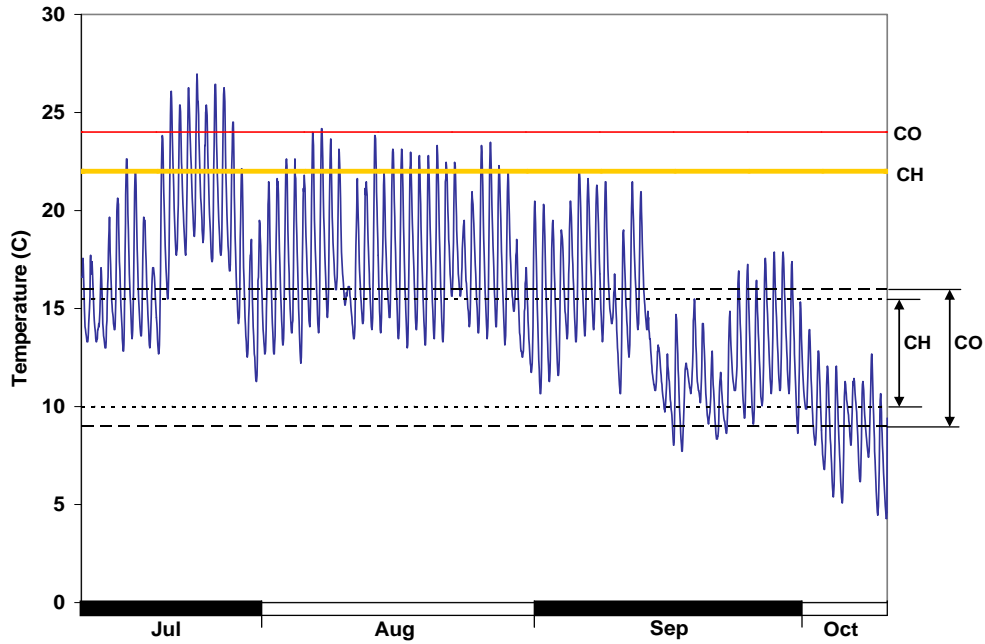


Figure 11. Temperature in lower Spius Creek (just above confluence with Nicola River). Symbols and notations as in Figure 3.

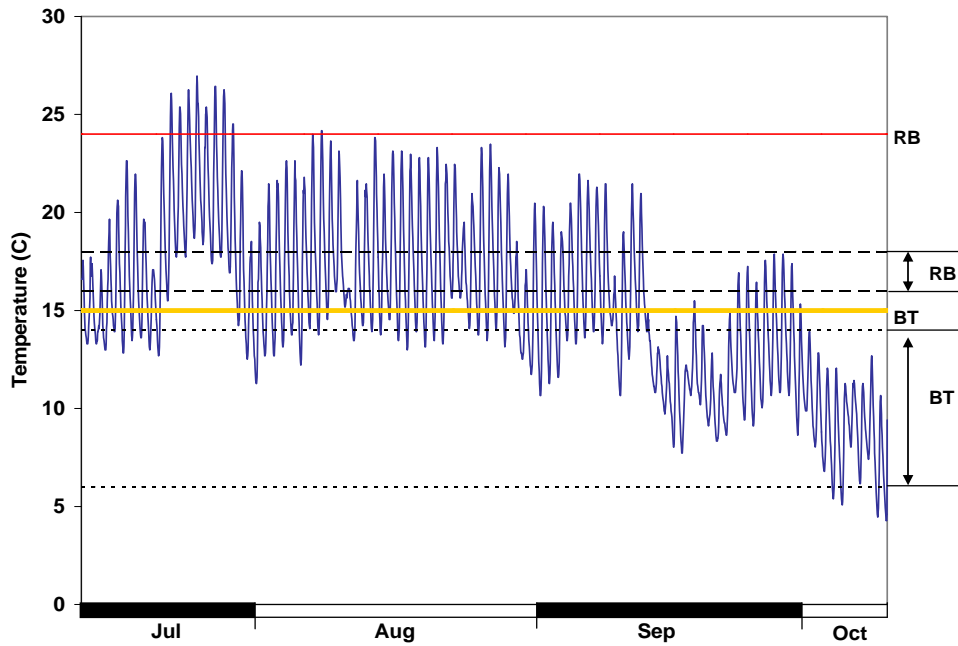


Figure 12. Temperature in lower Spius Creek (just above confluence with Nicola River). Symbols and notations as in Figure 4.

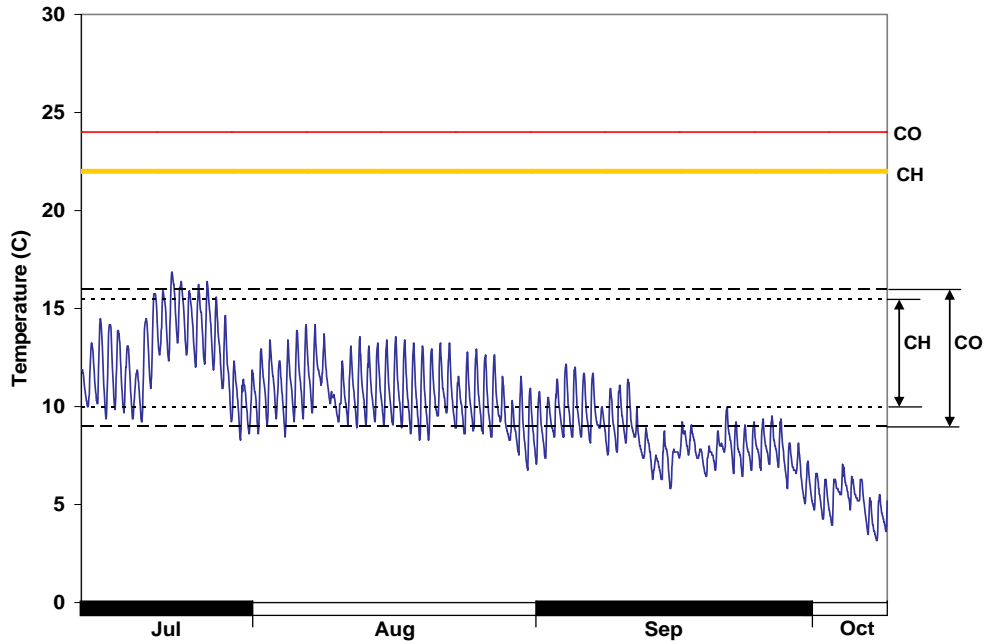


Figure 13. Temperature in Maka Creek. Symbols and notations as in Figure 3.

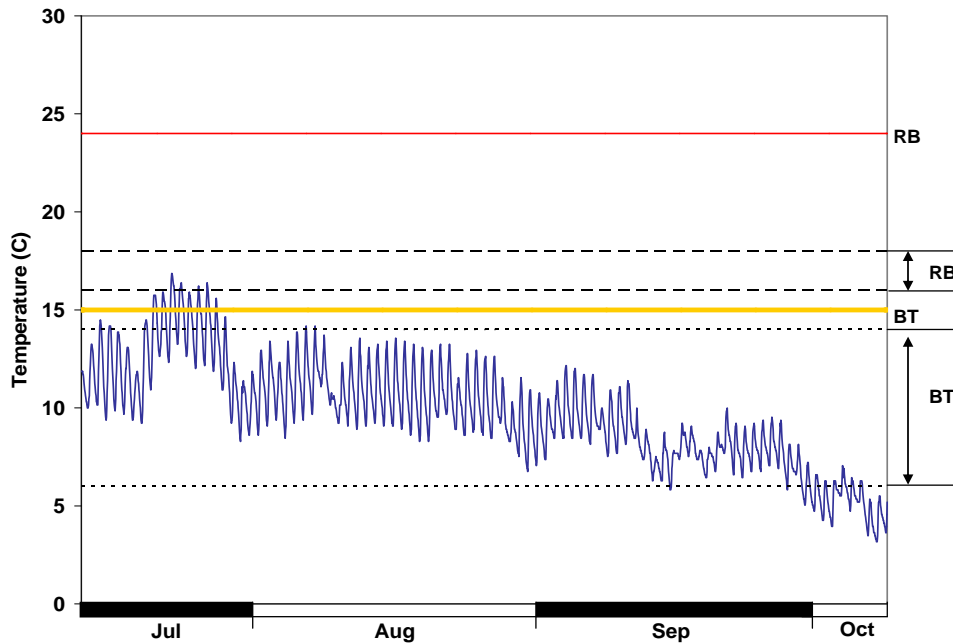


Figure 14. Temperature in Maka Creek. Symbols and notations as in Figure 4.

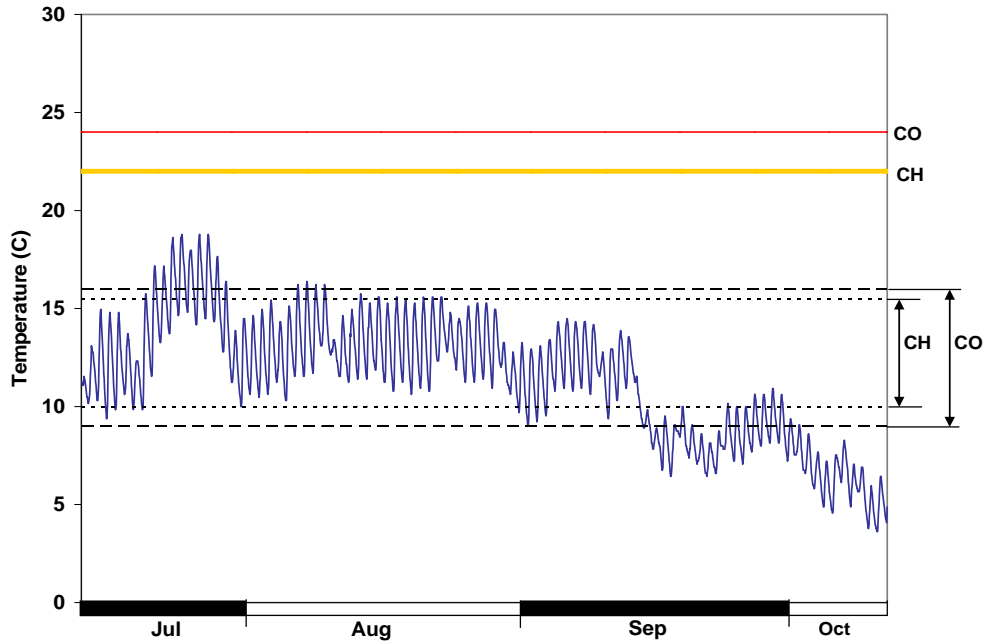


Figure 15. Temperature in Prospect Creek. Symbols and notations as in Figure 3.

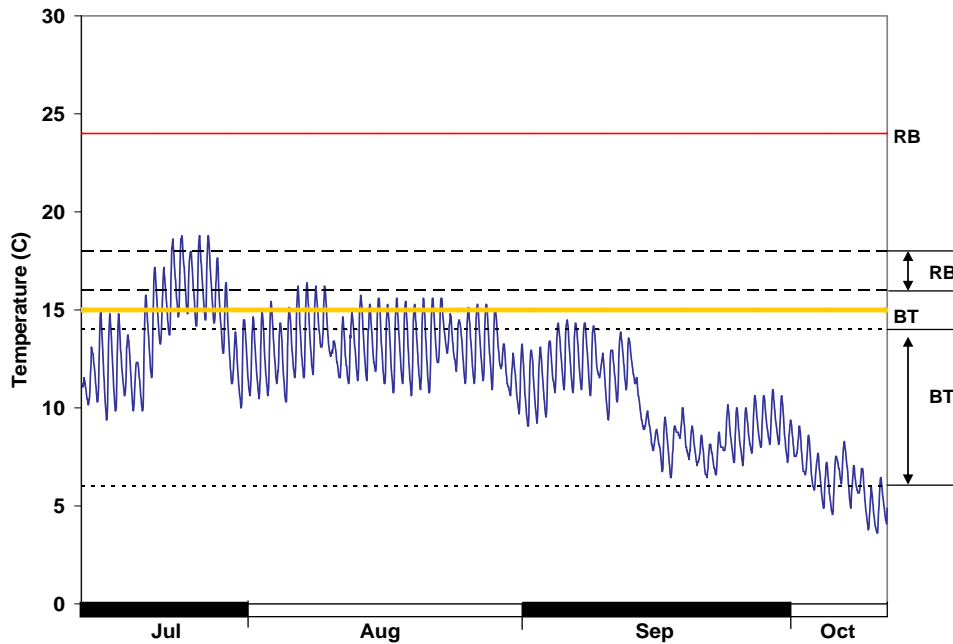


Figure 16. Temperature in Prospect Creek. Symbols and notations as in Figure 4.

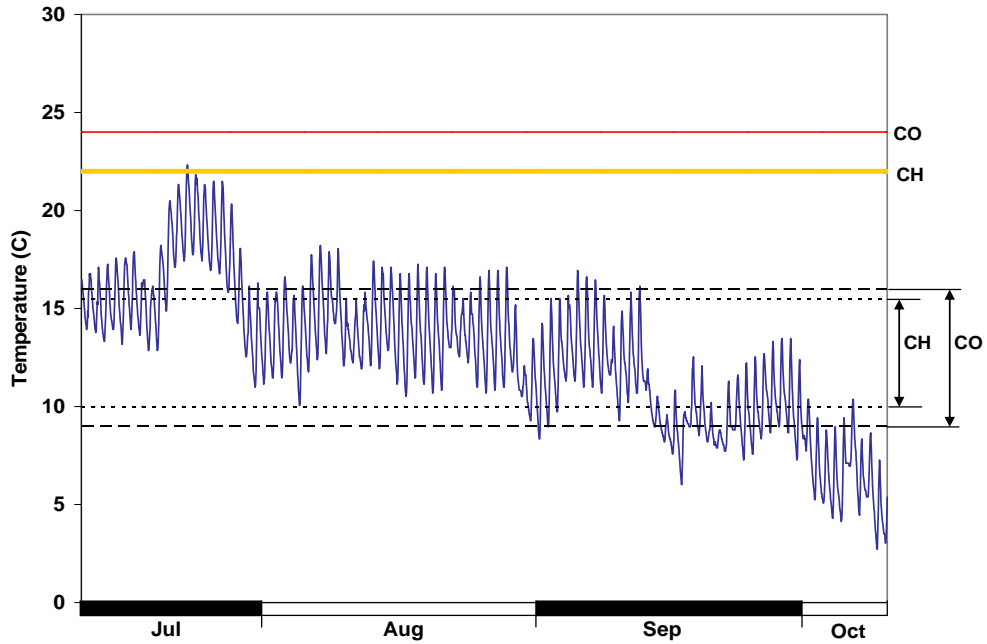


Figure 17. Temperature in Spahomin Creek. Symbols and notations as in Figure 3.

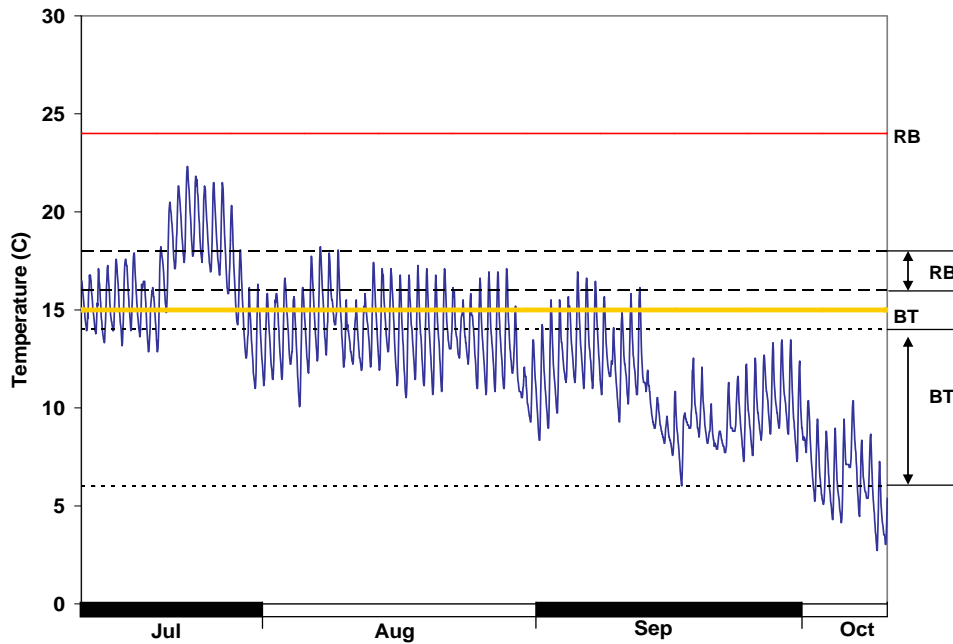


Figure 18. Temperature in Spahomin Creek. Symbols and notations as in Figure 4.

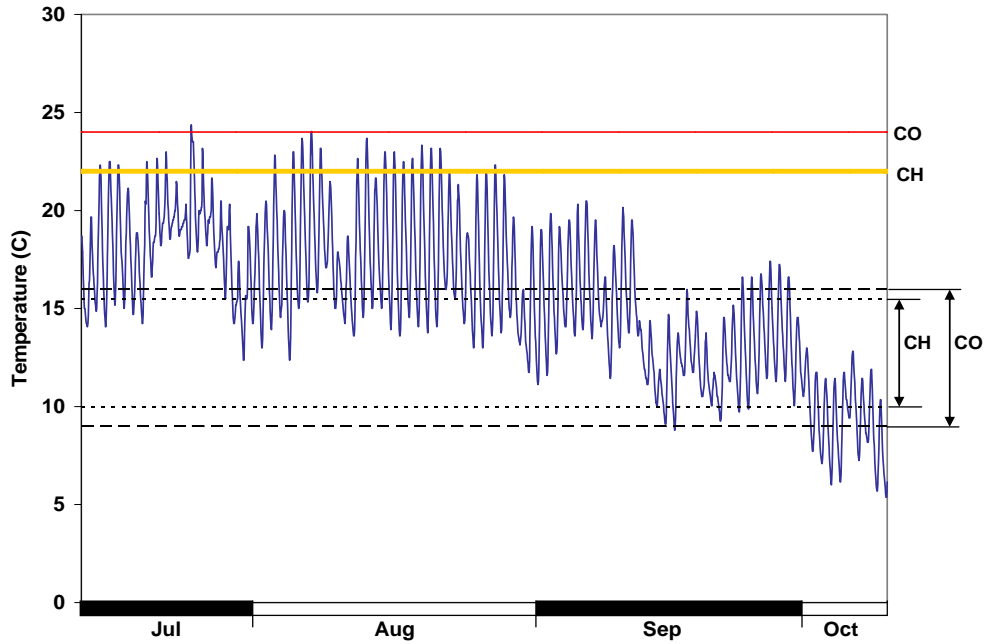


Figure 19. Temperature in Quilchena Creek. Symbols and notations as in Figure 3.

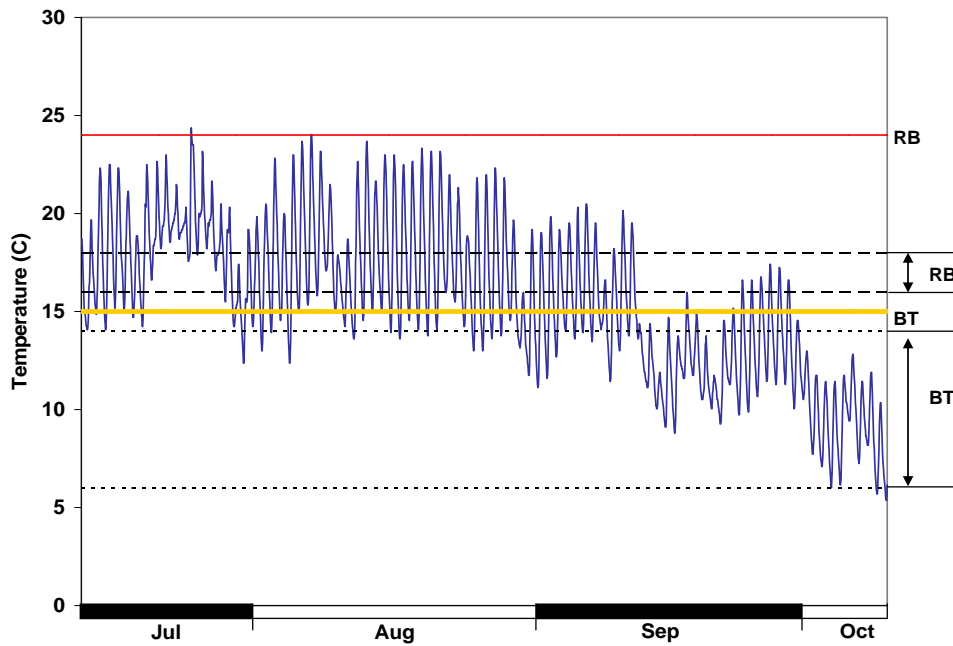


Figure 20. Temperature in Quilchena Creek. Symbols and notations as in Figure 4.

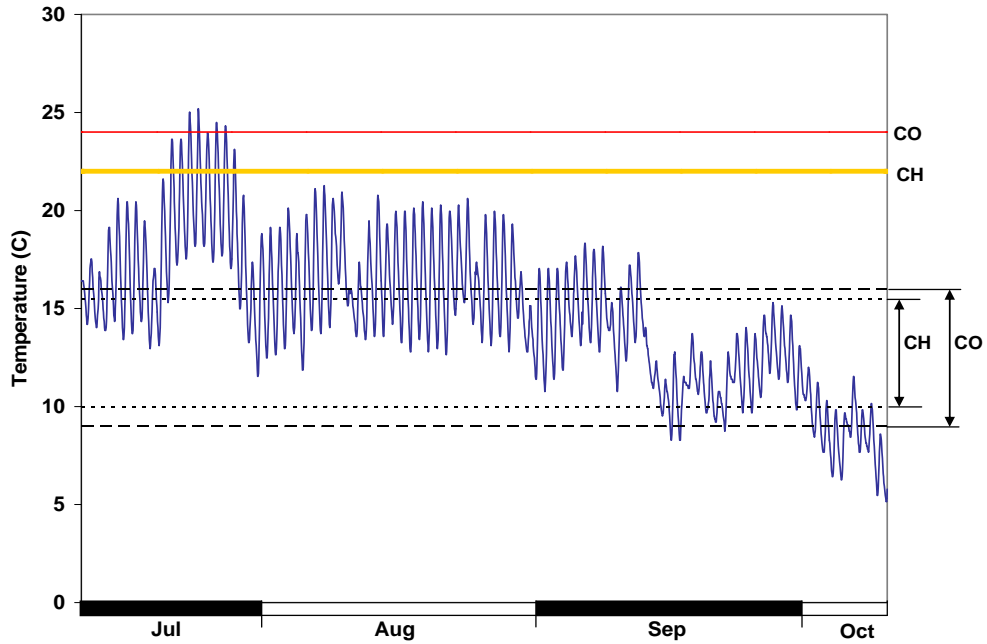


Figure 21. Temperature in Guichon Creek. Symbols and notations as in Figure 3.

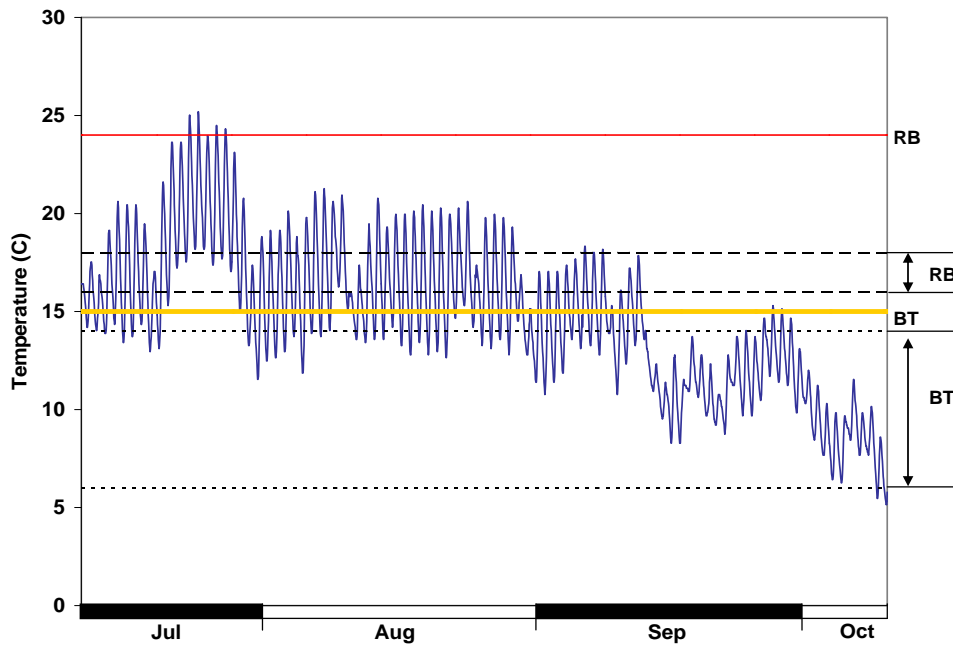


Figure 22. Temperature in Guichon Creek. Symbols and notations as in Figure 4.

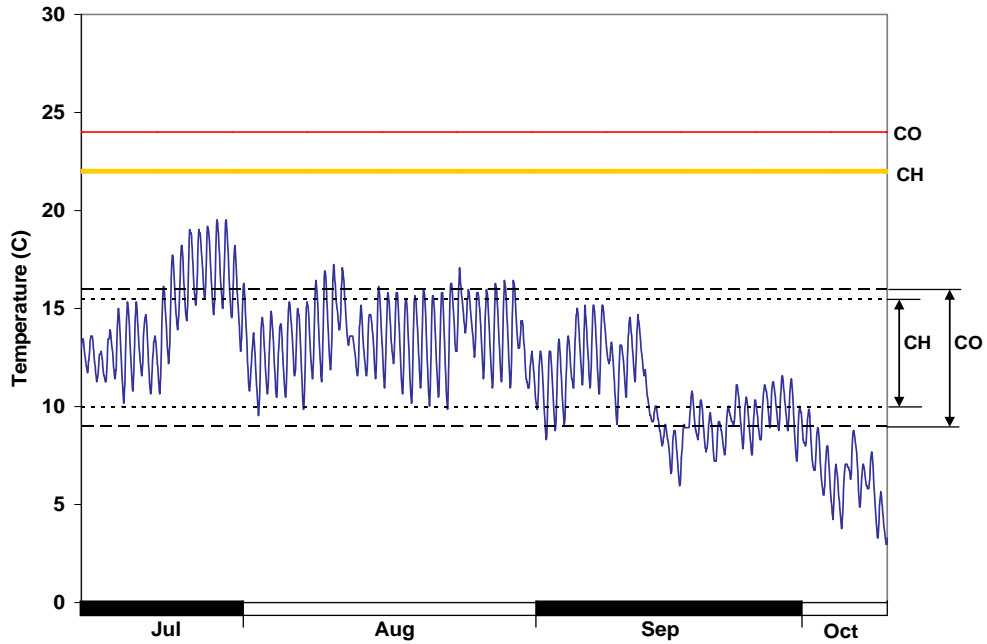


Figure 23. Temperature in Nuaitch Creek. Symbols and notations as in Figure 3.

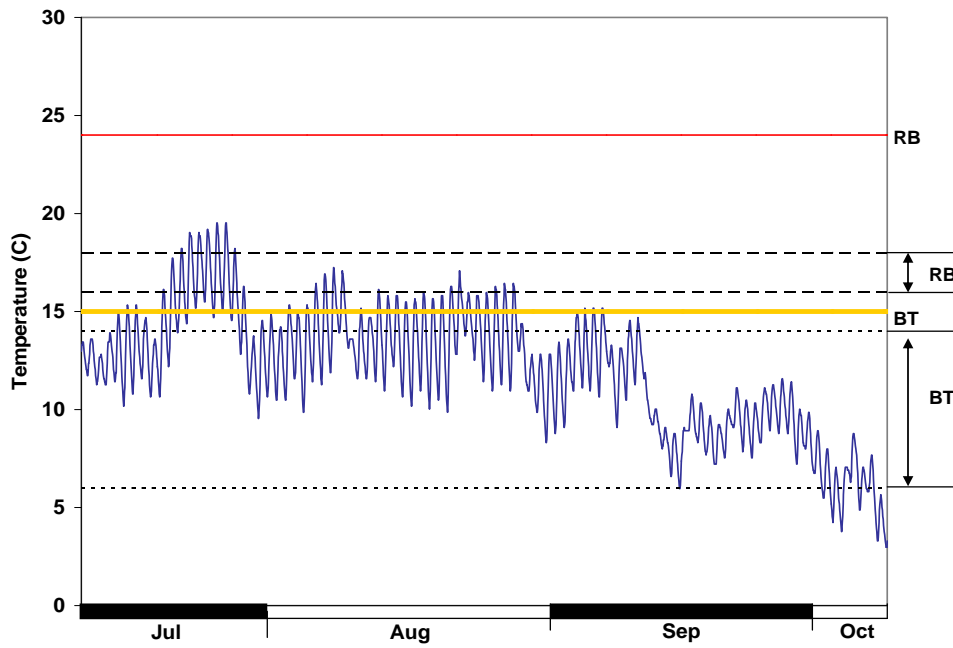


Figure 24. Temperature in Nuaitch Creek. Symbols and notations as in Figure 4.

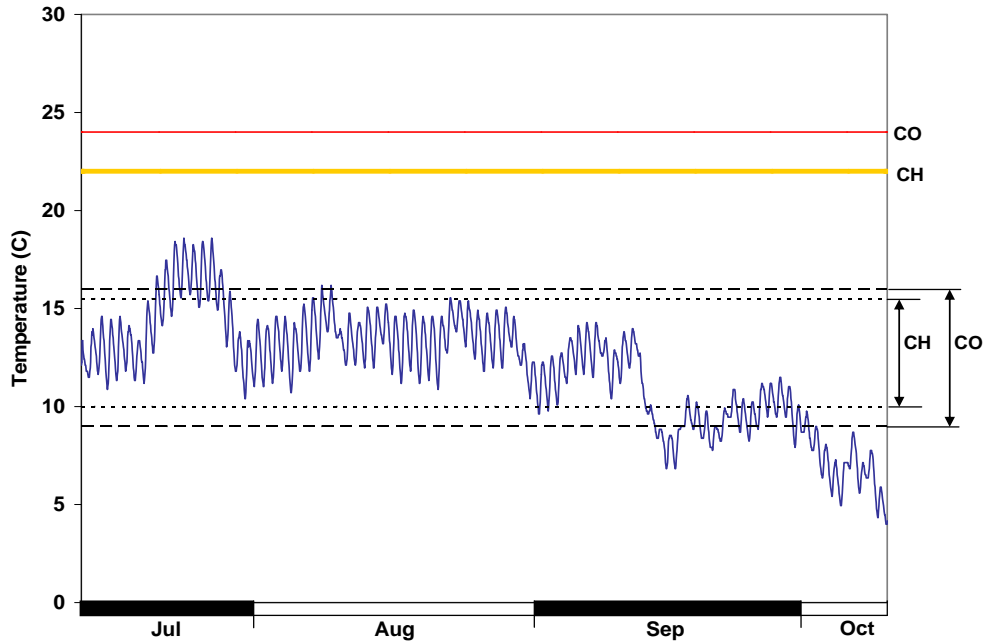


Figure 25. Temperature in Shakan Creek. Symbols and notations as in Figure 3.

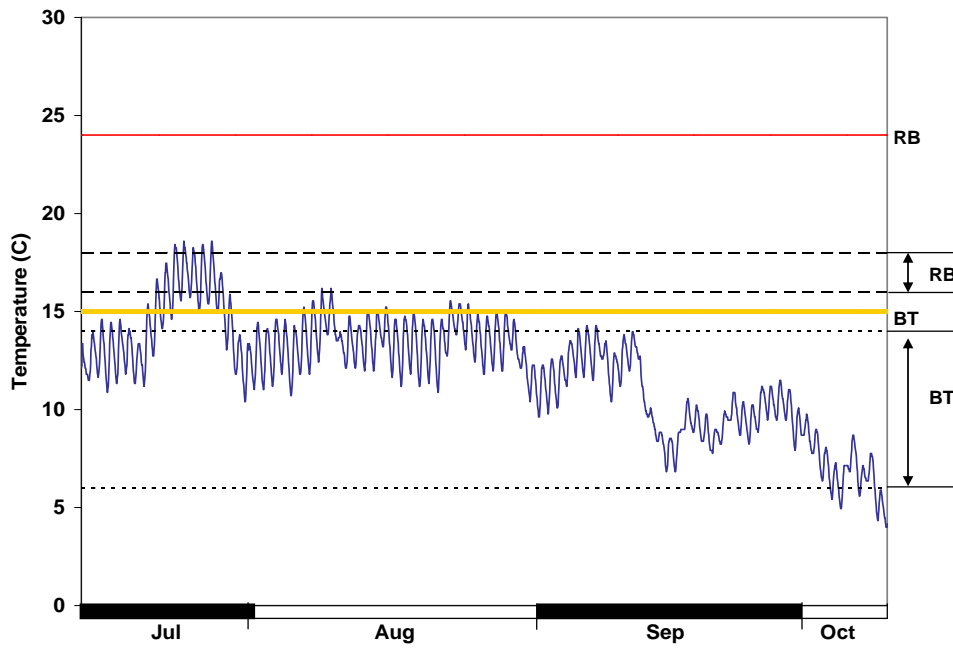


Figure 26. Temperature in Shakan Creek. Symbols and notations as in Figure 4.

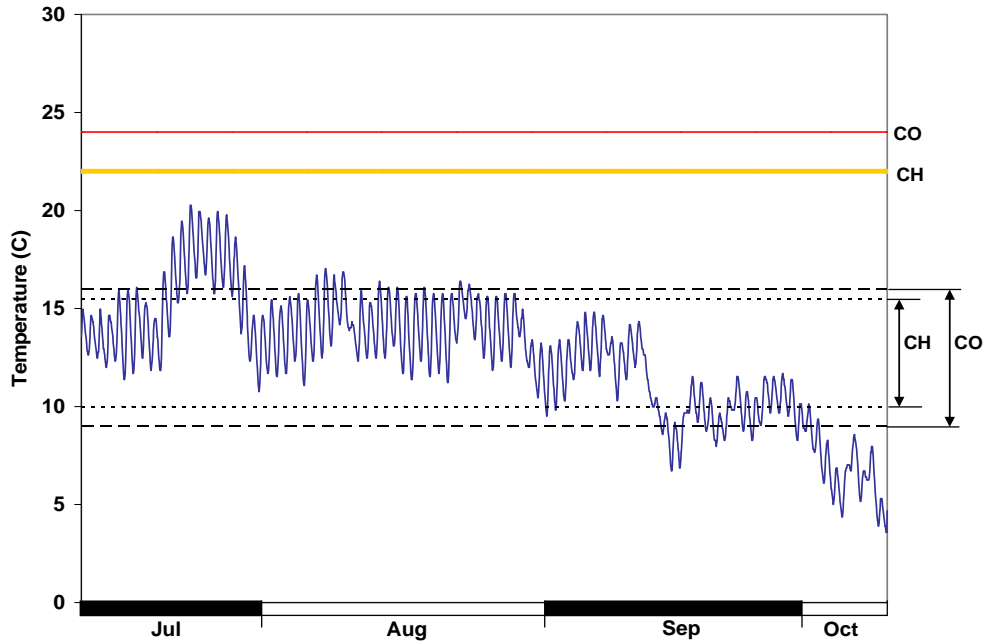


Figure 27. Temperature in Skuhun Creek. Symbols and notations as in Figure 3.

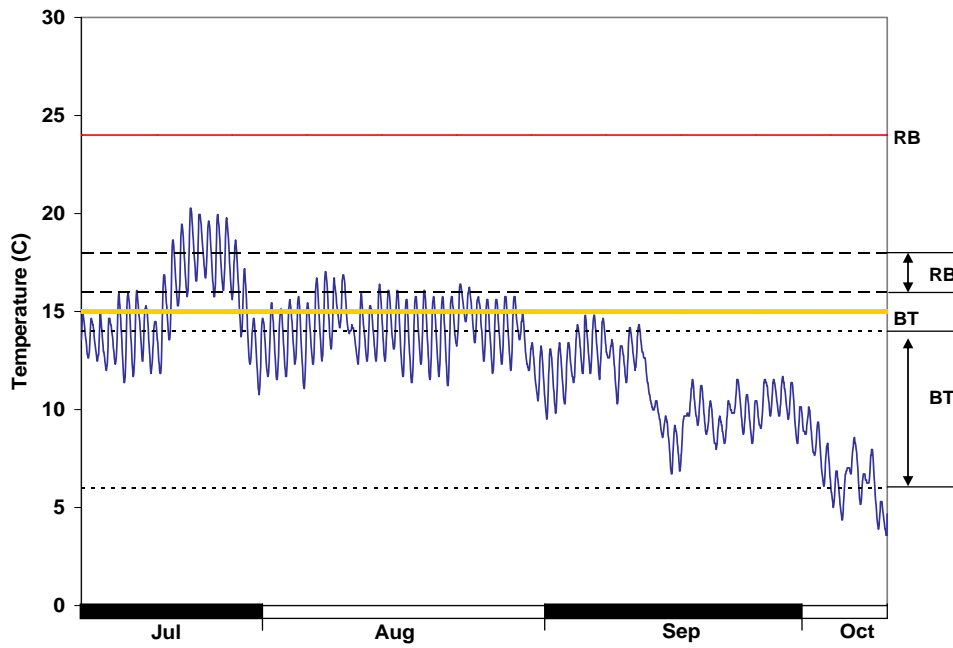


Figure 28. Temperature in Skuhun Creek. Symbols and notations as in Figure 4.

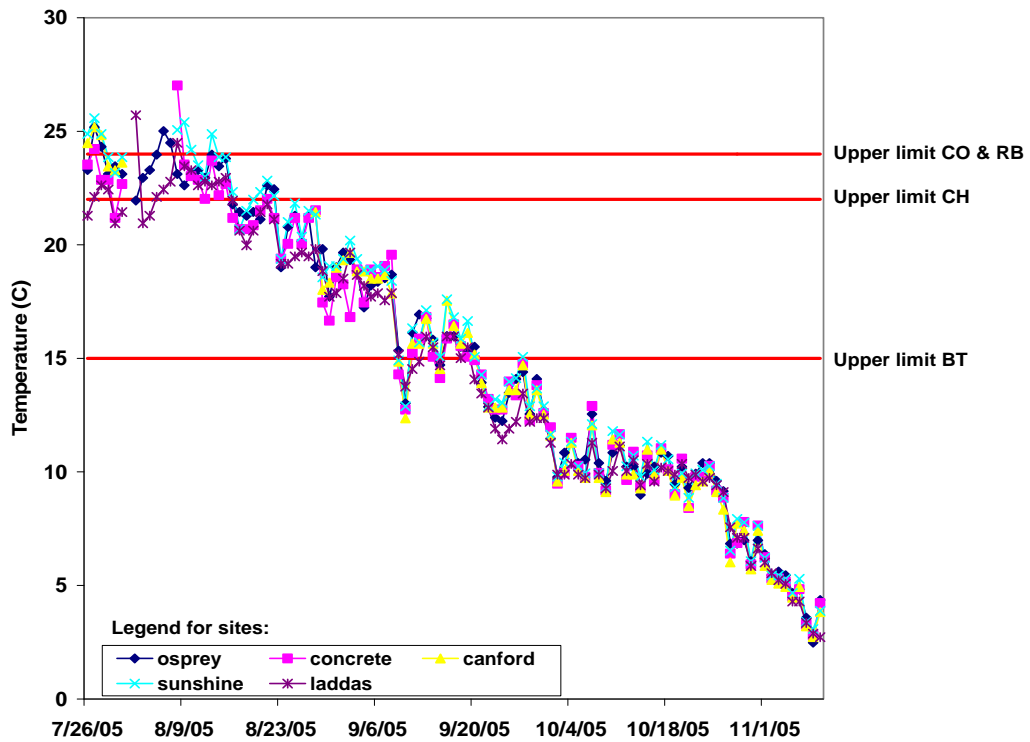


Figure 29. Daily maximum stream temperatures from five sites on the Nicola mainstem River (between the Coldwater River confluence and downstream of Skuhun Creek), late July to mid November, 2005. Upper temperature limits (red solid lines) are shown for coho (CO), Chinook (CH), rainbow trout (RB) and bull trout (BT).