Nicola River Watershed – Water Use Management Plan
Instream Flow Needs for Fish

prepared by: Todd Hatfield
Solander Ecological Research
Victoria BC

for: Allan Kenney
Pacific Salmon Foundation
Vancouver BC

October 30, 2006

1. BACKGROUND

Instream flows in the Nicola River and its major tributaries have been consistently identified as a substantial environmental concern. The watershed has numerous important fish stocks, and flows are often well below optimal for rearing and spawning, particularly during the summer and fall period. Water is extracted from the mainstem and its tributaries for agricultural, industrial, and domestic use and during low flow periods there appears to be a clear trade-off between these uses and instream environmental benefits. A public decision-making process has been initiated to develop a Water Use Management Plan (WUMP), with an aim to balance water use and instream flow needs. The purpose of this report is to summarize some of the existing information on instream flows and to provide recommendations for further work with respect to understanding and resolving fish-flow issues.

2. STREAMFLOW DATA

Water Survey of Canada (WSC) has several gauges in the watershed, with partial records dating back more than 90 years. In all cases, continuous year-round records are less than 50 years old, and in many cases considerably less. The primary gauges in the watershed, as available on the WSC Hydat database, are listed in Table 1.

Table 1. Water Survey of Canada gauging stations in the Nicola River watershed. Note: the last year of available data from Hydat is 2003.

Station Name	Station ID	Period of record	Complete years
Nicola River near Spences Bridge	08LG006	1911 - 2003	43 years
Nicola River near Merritt	08LG007	1911 - 2003	47 years
Nicola River at outlet of Nicola Lake	08LG065	1983 - 2003	20 years
Nicola River above Nicola Lake	08LG049	1915 - 2003	32 years
Coldwater River at Merritt	08LG010	1913 - 1995	33 years
Coldwater River at Brookmere	08LG048	1965 - 2003	36 years
Spius Creek near Canford	08LG008	1911 - 2003	33 years
Guichon Creek near Lower Nicola	08LG004	1911 - 1984	20 years
Guichon Creek at Mouth	08LG067	1984 - 2003	19 years
Guichon Creek at outlet of Mamit Lake	08LG041	1936 - 2003	18 years
Guichon Creek above Tunkwa Lake Diversion	08LG056	1967 - 2003	33 years
Pennask Creek near Quilchena	08LG016	1920 - 2003	33 years
Beak Creek at Mouth	08LG064	1982 - 2001	18 years
Spahomin Creek near Douglas Lake	08LG018	1920 - 1967	0 years
Spahomin Creek near the mouth	08LG060	1972 - 1996	23 years

3. WATER USES

A description and analysis of water uses in the Nicola watershed is currently underway as part of various studies being undertaken to support the Nicola WUMP. I undertook a brief analysis of water licences on Nicola River mainstem and its major tributaries based on queries of the Provincial water licence database available over the internet at: http://www.elp.gov.bc.ca:8000/pls/wtrwhse/water_licences.input. It should be noted that

many details of water licences are not available through this web query process. For example, one cannot conduct queries based on whole basins, sub-basins, or geographic points, nor does it return results based on time of year restrictions on licences. Results from queries do not include licences from tributary systems, necessitating a focus on mainstem systems. All data were converted to the same unit (m^3 $year^{-1}$) before plotting (Figure 1). The intent of this analysis was to examine the cumulative volume in different watersheds and the trends through time in allocating this resource for out-of-stream uses.

Two things are clear from this cursory analysis: the licensed volume of water use in the Nicola watershed is large, and out-of-stream water uses continue to be allocated. This analysis is cursory, since it ignores many factors and other sites in the watershed, such as those on smaller tributaries, but at the same time this also makes the analysis quite conservative. The analysis also ignores groundwater resources. We expect that more robust conclusions will be possible from the analysis of water licences currently underway for the WUMP.

4. NATURAL FLOWS

It is customary to begin analyses of instream flow needs by examining the natural availability of water and the temporal patterns in natural streamflows. These patterns provide a baseline that allows determination of impacts associated with past, present and future water uses. Virtually all overview assessment methods utilize natural streamflow data as the benchmark for acceptable limits to water use. (These methods contrast with empirical incremental methods, which analyse existing conditions with data-intensive techniques that are often time-consuming and expensive.)

Licensed water use in the Nicola watershed dates back to the late 1800s, many years before streamflow gauges were installed in the area. Some of these early licences were for considerable volumes, in association with agriculture. Water licences have continued to be granted in various parts of the watershed (Figure 1). Most water uses are not gauged, so obtaining an accurate measure of water use is not a simple task, and requires several assumptions to be made. "Naturalizing" the gauged data is therefore a difficult task, and one that should be performed by those with detailed knowledge of the existing water licences, regional patterns of water use, and regional differences in hydrology.

Spahomin and Pennask Creeks have few licensed water uses and gauged data may be considered approximately natural. All other gauged systems require application of some form of correction to naturalize the recorded flows. The task of naturalizing streamflow data has been completed for very few parts of the Nicola watershed. Ministry of Environment (MoE) hydrologists are undertaking to develop naturalized flow data for several points in the watershed. At present, draft naturalized data are available for only three locations: Spius Creek, Coldwater River at Brookmere, and Coldwater River at Merritt. It should be stressed that even these data are considered preliminary and in draft form only. Additional work is anticipated that will naturalize records for other locations in the watershed, but the delivery date for these data is unknown.

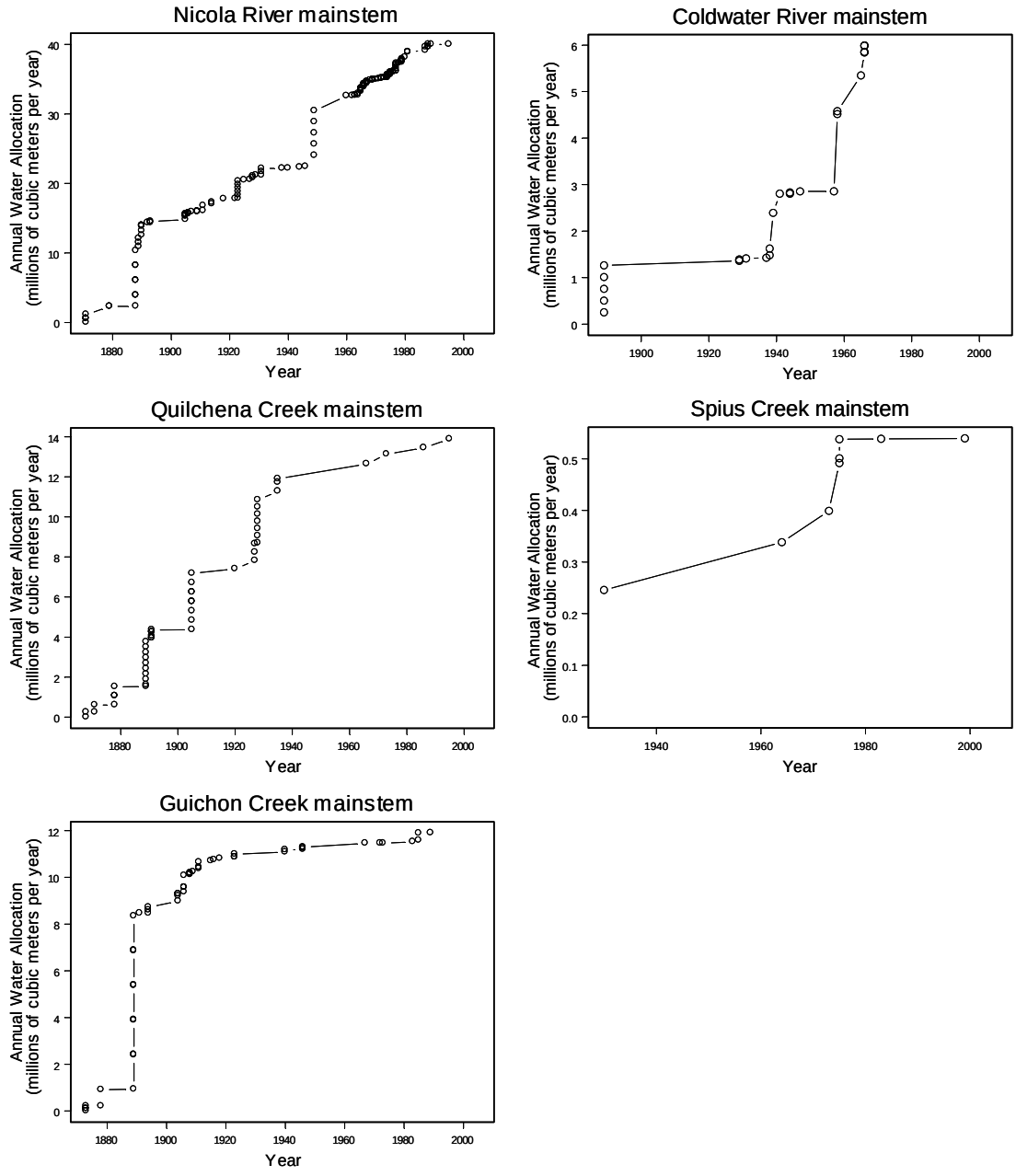

Figure 1. Cumulative volume of water allocated from five mainstem streams in the Nicola watershed. These amounts do not include licensed out-of-stream uses on tributaries. Data from water licence web query at: http://www.elp.gov.bc.ca:8000/pls/wtrwhse/water_licences.input.

5. GAUGED FLOWS

For each of the available datasets (see Table 1) we produced a variety of graphs and tables, to assess the patterns of gauged flows. These are provided in appendix A. Tables include summary statistics on both a monthly and annual time span. Graphs include summary graphs indicating general streamflow patterns, exceedence plots, and time series of summary data. The

methods used to produce each graph and the intent of the analyses are described in the text of Appendix A.

The results of graphical analysis of summary streamflow data indicate that all gauged streams in the watershed are snowmelt-driven systems, with peak flows in late spring and early summer. In general, there are two calendar months with high flows, two months with intermediate flows, and all remaining months have low to very low flows. 70 to 80% of days in the year have flows that are less than the mean annual discharge. September is typically the month of lowest flow during the season of active growth for fish. Very low flows also occur in some winter months.

There is considerable geographic variation in the watershed with respect to surface runoff (Table 2). Runoff is a measure of how much surface stream flow is produced by precipitation during the year. In general, sub-basins with streams flowing from south to north have considerably greater runoff than other portions of the Nicola watershed. This presumably reflects general precipitation patterns, especially snowpack. Runoff varies throughout the watershed by more than order of magnitude. Such variation in runoff makes it difficult to extrapolate from one portion of the watershed to another. It should be stressed that these values are calculated from gauged streamflows and do not correct for water use within the watershed. As a result, these values are underestimates of true runoff and the degree of underestimation likely varies among sub-basins. They are nevertheless likely acceptable in reflecting trends in geographic differences in runoff.

Patterns of streamflow at many of the gauge locations show clear indications of climate change over the period of record. This is most apparent as a shift in the timing of freshet to earlier in the year, and in many instances a smaller freshet. This pattern is consistent with a loss of low- to mid-elevation snowpack as more precipitation falls as rain, and an earlier runoff from snowmelt. In some systems, notably the Coldwater River, there is a marked increase in duration of the low flow period during late summer and fall. I interpret these changes as climate change induced, because water use is not likely to be sufficient to affect timing and magnitude of the freshet. In most systems, there was no trend in water levels during the low flow period (i.e., low flows did not become lower through time). I had expected a trend of decreasing low flows, due to water use, climate change or both. For example, one would expect water use to be most noticeable during the low flow period because this is also the period of greatest water extraction. There may be one or more reasons for a lack of obvious trends in low flows: lack of sensitivity of gauging sites for detecting trends in low flows, water use and climate change effects are "noisy" signals that are difficult to detect against a high variance background, improper selection of streamflow metric for trend analysis, or no real trend in water use and climate change impacts. This issue deserves additional analytic effort, and would be informed by the water use study underway for the WUMP.

Table 2. Discharge summaries from Water Survey of Canada gauging stations in the Nicola River watershed. Note: the last year of available data from Hydat is 2003. Mean discharge and runoff are calculated on gauged data and do not correct for water uses.

Station Name	Station ID	Drainage Area (km^2)	Mean annual discharge ($m^3\ sec^{-1}$)	Runoff ($cm\ year^{-1}$)
Nicola River near Spences Bridge	08LG006	7280	26.7	11.6
Nicola River near Merritt	08LG007	4350	14	10.2
Nicola River at outlet of Nicola Lake	08LG065	2990	5.5	5.5
Nicola River above Nicola Lake	08LG049	1500	4.2	8.8
Coldwater River at Merritt	08LG010	914	8.2	28.4
Coldwater River at Brookmere	08LG048	316	6.9	68.7
Spius Creek near Canford	08LG008	780	10.2	41.4
Guichon Creek near Lower Nicola	08LG004	1230	1.04	2.7
Guichon Creek at Mouth	08LG067	1230	0.74	1.9
Guichon Creek at outlet of Mamit Lake	08LG041	842	0.8	2.9
Guichon Creek above Tunkwa Lake Diversion	08LG056	78.2	0.13	5.1
Pennask Creek near Quilchena	08LG016	87	0.74	26.9
Beak Creek at Mouth	08LG064	85	0.47	17.6
Spahomin Creek near Douglas Lake	08LG018	233	na	na
Spahomin Creek near the mouth	08LG060	241	0.678	8.7

6. Overview Methods for Instream Flow Recommendations

6.1 Previous analyses of fish-flow issues

Kosakoski and Hamilton (1982) conducted detailed analyses of fish-flow issues in the Nicola watershed, using repeated measurements at transects at multiple points on the Nicola and Coldwater Rivers. Their analyses led to flow recommendations for several points on the Nicola River, the Coldwater River and several tributaries to the Nicola. Table 3 lists the recommendations based on transect analysis. The report lists flow recommendations of 20% mad on several other tributaries, but since the %mad recommendations are not based on empirical work, they are not discussed here.

Table 3. Flow recommendations made by Kosakoski and Hamilton (1982) for sections of the Nicola and Coldwater Rivers.

Stream	Fisheries Resource Maintenance Flow (cfs)		Point of measurement
	Aug to Nov	Dec to Apr	
Nicola River (Thompson R to Spius Cr)	200	200	8LG006
Nicola River (Spius Cr to Coldwater R)	110	110	8LG007
Nicola River (Coldwater R to Nicola Lake)	60	40	8LG065
Coldwater River at Merritt	50	50	8LG010

Since the Kosakoski and Hamilton results are now more than 20 years old, the question arises whether the results have any validity today. As with all incremental methods this concern is real since the results are based on channel conditions in a previous time, and changes in channel morphology have likely occurred over the intervening period. Indeed, one of the myriad criticisms levelled at instream flow recommendations based on IFIM and similar approaches is that results reflect the present condition of a stream (Bovee et al. 1998), yet morphology, sediment conditions, and water quality may change when flow becomes regulated, which in

turn affects the quantity and quality of available habitat (Church 1995; Bovee et al. 1998; Trush et al. 2000).

There are two primary reasons to think that Kosakoski and Hamilton's recommendations would be similar if the study were to be repeated today. The first is that water use has increased since their study, but not markedly, and magnitude of flood flows, which are the flows primarily responsible for channel morphology, have changed little over the intervening period. Second, there is evidence that channel morphology is in a form of dynamic equilibrium. That is, channel changes occur through time at any one location, but river-wide patterns in habitat availability remain fairly constant, provided influences like climate, land use, water use, etc., remain similar. Work undertaken by BC Hydro on the Alouette River indicated that instream flow models based on older transect data remained accurate for fisheries-flow planning purposes over at least a 10-year period (Bruce 2005). Transect data at fixed sites changed through time, but when taken as a whole, a group of transects gave similar results through time. It is possible that transects taken at different points in the river, analysis based on additional transects, or updated HSI curves may alter the resulting recommendations, but it seems likely that the original analysis is reasonably robust.

We analysed the Kosakoski and Hamilton results in terms of the availability of flows to meet the recommended minimum flows. In the following tables and figures, we show the patterns of streamflow relative to the recommendations, and tally the number of days in different periods in which the measured flow is below the recommended minimum.

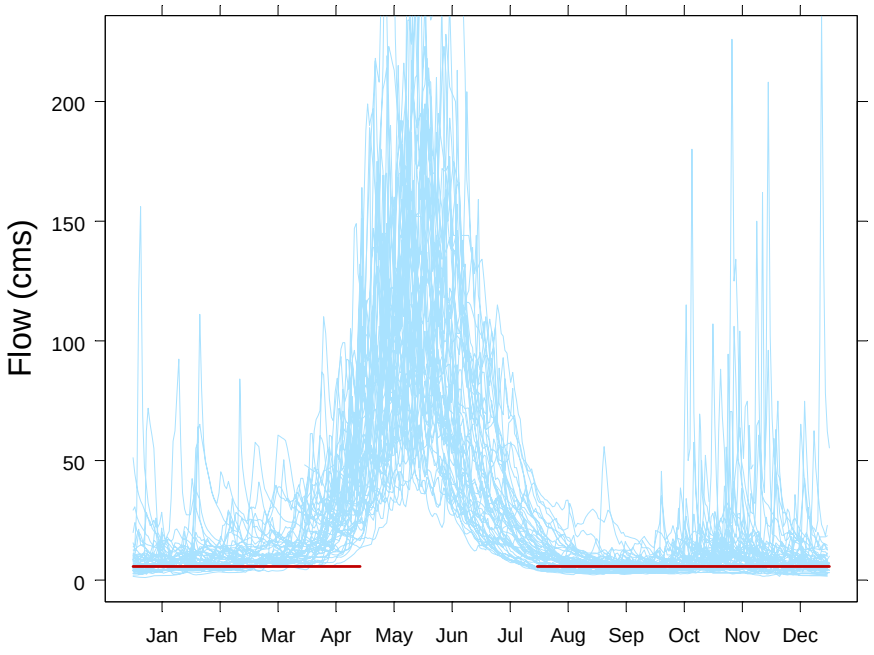

Figure 2. Nicola River flows at Spences Bridge (08LG006). The red line indicates 200 cfs (5.66 m^3 sec^{-1}), the minimum flow recommended by Kosakoski and Hamilton (1982) for this portion of the river.

Table 4. Number of days in which Nicola River flow at Spences Bridge was below 200 cfs in reach N1 for the period August through April. 200 cfs is the minimum flow recommended by Kosakoski and Hamilton (1982) for this portion of the river. Counts are based on gauged flows at 08LG006.

Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec	Sum	Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec	Sum
1911	31	28	31	30	0	0	19	19	31	189	1976	0	0	0	0	0	0	0	0	0	0
1912	31	29	31	4	0	24	3	0	21	143	1977	13	0	0	0	27	30	24	5	11	110
1913	31	28	31	30	2	2	6	0	25	155	1978	19	24	6	0	23	2	8	3	24	109
1914	31	28	31	19	27	28	29	27	31	251	1979	14	0	0	0	31	29	27	30	5	136
1915	31	28	31	0	0	6	14	26	31	167	1980	18	17	0	0	12	0	3	0	0	50
1916	31	29	31	0	0	0	7	30	31	159	1981	0	0	0	0	3	11	0	0	1	15
1917	31	28	31	0	5	30	29	3	27	184	1982	7	1	0	0	0	0	0	3	3	14
1918	28	25	15	0	6	30	26	25	28	183	1983	0	0	0	0	0	0	0	0	4	4
1919	31	28	28	17	21	29	31	30	31	246	1984	0	0	0	0	13	23	8	13	31	88
1920	31	29	23	17	25	21	31	30	31	238	1985	31	21	14	0	31	30	15	20	31	193
1957	31	28	31	30	3	27	31	14	1	196	1986	17	16	0	0	0	0	5	3	7	48
1958	0	0	0	0	31	25	10	0	0	66	1987	4	0	0	0	31	30	31	30	31	157
1959	0	0	0	0	0	4	0	0	0	4	1988	31	29	30	2	28	24	10	0	9	163
1960	31	29	14	0	16	28	13	7	23	161	1989	13	7	0	0	0	0	0	0	0	20
1961	24	0	0	0	20	21	0	7	29	101	1990	3	16	0	0	0	10	3	0	2	34
1962	9	0	0	0	0	0	26	8	31	74	1991	4	0	0	0	0	0	1	0	0	5
1963	31	0	0	0	0	24	18	0	0	73	1992	2	0	0	0	21	24	16	3	15	81
1964	0	0	0	0	0	0	0	0	2	2	1993	28	17	4	0	0	0	0	5	0	54
1965	0	0	0	0	0	29	7	0	7	43	1994	0	2	0	0	26	30	26	27	16	127
1966	7	28	6	0	0	24	16	0	2	83	1995	27	0	0	0	0	27	0	1	0	55
1967	0	0	0	0	13	30	14	0	1	58	1996	0	0	0	0	5	28	10	0	3	46
1968	0	0	0	0	0	0	0	0	5	5	1997	0	0	0	0	0	0	0	0	0	0
1969	9	1	0	0	14	12	0	0	0	36	1998	0	0	0	0	27	30	31	14	13	115
1970	31	28	5	0	31	30	31	30	31	217	1999	0	0	0	0	0	0	0	0	0	0
1971	12	0	0	0	4	21	3	0	31	71	2000	0	0	0	0	0	2	1	0	13	16
1972	31	11	0	0	0	8	5	6	19	80	2001	10	26	6	0	10	30	24	0	5	111
1973	17	4	5	0	31	30	19	15	14	135	2002	4	2	3	0	4	30	31	13	20	107
1974	14	0	0	0	0	19	31	22	21	107	2003	21	4	10	0	31	30	16	2	10	124
1975	29	28	11	0	0	22	15	0	0	105											

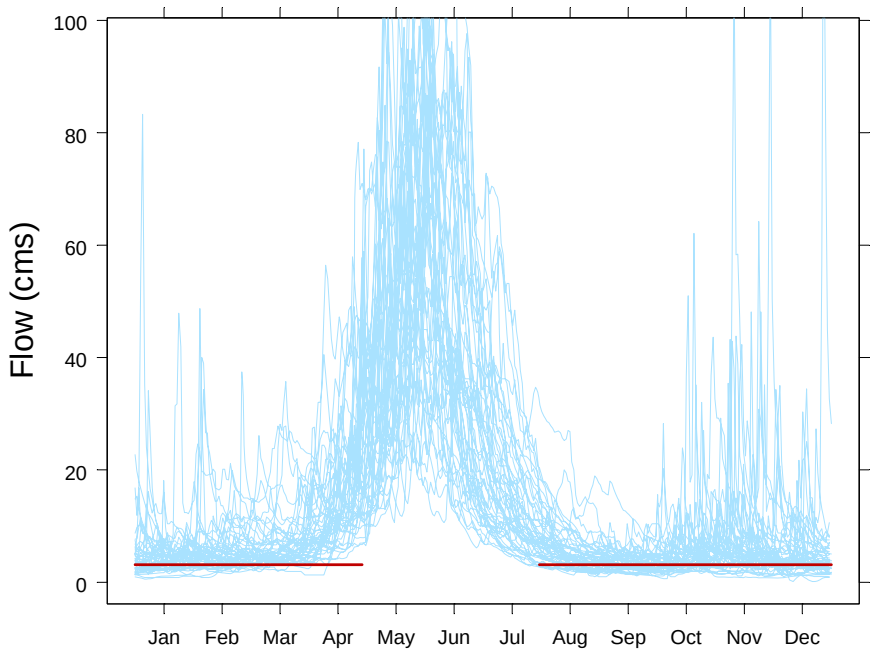

Figure 3. Nicola River flows at Merritt (08LG007). The red line indicates 110 cfs (3.11 m^3 sec^{-1}), the minimum flow recommended by Kosakoski and Hamilton (1982) for this portion of the river.

Table 5. Number of days in which Nicola River flow at Merritt (08LG007) was below 110 cfs (3.11 m^3 sec^{-1}) in reach N2 for the period Jan through Apr and August through Dec. 110 cfs is the minimum flow recommended by Kosakoski and Hamilton (1982) for this portion of the river.

Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec	Sum	Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec	Sum
1911	31	28	31	30	0	0	25	22	28	195	1979	23	11	0	0	31	30	28	30	9	162
1912	13	0	0	0	4	20	30	17	28	112	1980	26	26	0	0	6	0	2	0	2	62
1913	31	14	29	12	9	18	10	23	31	177	1981	0	0	0	0	0	1	0	0	0	1
1914	8	21	0	0	20	30	30	30	31	170	1982	2	0	0	0	0	0	0	5	2	9
1915	31	28	31	0	9	30	31	30	31	221	1983	0	0	0	0	0	0	9	0	0	9
1957	31	28	31	30	31	30	31	30	16	258	1984	0	0	0	0	0	0	5	11	29	45
1958	5	4	0	0	24	21	10	1	0	65	1985	31	20	7	0	31	30	15	20	31	185
1959	0	0	0	0	0	0	0	0	0	0	1986	23	22	0	0	0	0	0	2	7	54
1960	0	0	0	0	21	30	23	22	31	127	1987	3	2	0	0	27	30	31	30	31	154
1961	24	0	0	0	17	28	7	21	28	125	1988	31	29	30	2	28	24	11	0	6	161
1962	0	0	0	0	0	15	18	4	0	37	1989	13	6	0	0	0	0	0	0	0	19
1963	20	1	0	0	0	0	0	0	0	21	1990	0	10	0	0	0	5	2	0	3	20
1964	0	0	0	0	0	0	0	0	1	1	1991	4	0	0	0	0	0	0	0	0	4
1965	0	0	0	0	0	30	18	2	4	54	1992	3	0	0	0	0	16	9	4	17	49
1966	0	7	9	0	1	30	22	0	5	74	1993	27	14	3	0	0	0	0	4	0	48
1967	2	1	4	0	11	30	17	0	2	67	1994	0	0	0	0	2	21	21	21	15	80
1968	3	0	0	0	0	0	0	0	11	14	1995	14	1	0	0	0	0	0	0	0	15
1969	31	3	0	0	17	18	0	0	1	70	1996	0	0	0	0	0	0	0	0	12	12
1970	22	17	3	0	0	30	30	30	31	163	1997	5	0	0	0	0	0	0	0	0	5
1971	24	0	0	0	6	28	24	4	21	107	1998	0	0	0	0	12	30	31	13	4	90
1972	31	27	5	0	0	0	21	30	29	143	1999	0	0	0	0	0	0	0	0	0	0
1974	14	0	0	0	0	1	20	12	6	53	2000	0	0	0	0	0	0	0	0	5	5
1975	26	13	2	0	0	14	6	0	0	61	2001	3	22	0	0	0	7	8	0	0	40
1976	0	0	0	0	0	0	0	0	5	5	2002	2	0	0	0	0	19	15	13	22	71
1977	10	0	0	0	31	30	25	8	14	118	2003	23	7	11	0	31	30	13	2	18	135
1978	29	28	7	0	0	0	0	0	13	77											

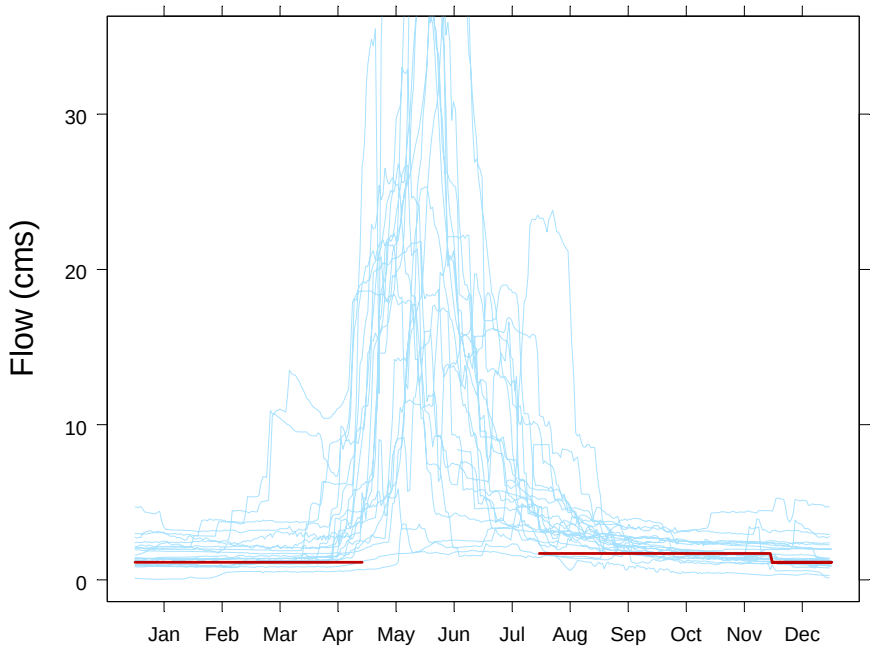

Figure 4. Nicola River flows at the outlet of Nicola Lake (08LG065). The red line indicates 60 cfs (1.7 m^3 sec^{-1}), the minimum flow recommended by Kosakoski and Hamilton (1982) for this portion of the river during the months of August through November, and 40 cfs (1.13 m^3 sec^{-1})

Table 6. Number of days in which Nicola River flow at the outlet of Nicola Lake (08LG065) was below 60 cfs (1.7 m^3 sec^{-1}) for the period August through November and below 40 cfs (1.13 m^3 sec^{-1}) for the period December through April. These values were the minimum flows recommended by Kosakoski and Hamilton (1982) for this portion of the river.

Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec	Sum
1983	0	0	0	0	0	0	8	9	0	17
1984	0	0	0	0	0	11	31	30	31	103
1985	31	28	3	0	25	30	31	30	31	209
1986	31	28	30	30	0	0	22	30	2	173
1987	2	1	0	0	30	15	31	30	31	140
1988	31	29	31	30	31	8	29	30	19	238
1989	31	28	31	14	0	0	0	0	0	104
1990	0	0	0	0	0	0	4	24	0	28
1991	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	28	30	0	58
1993	0	2	0	0	0	0	0	0	0	2
1994	0	0	0	0	0	0	11	26	0	37
1995	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	22	31	30	29	112
1999	31	28	18	0	0	0	0	0	0	77
2000	0	0	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	10	0	10
2002	0	0	0	0	0	0	23	30	30	83
2003	31	28	31	28	0	10	31	30	28	217

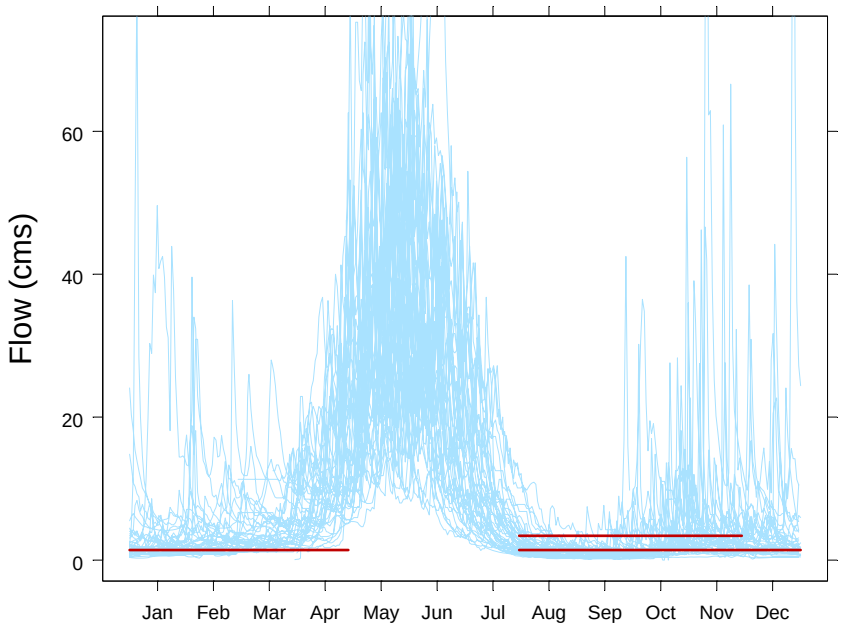

Figure 5. Coldwater River flows at Merritt (08LG010). The lower red line indicates 50 cfs (1.42 m^3 sec^{-1}), the "Fisheries Resource Maintenance Flow" recommended by Kosakoski and Hamilton (1982). The upper red line for months of August through November indicates 120 cfs (3.4 m^3 sec^{-1}), the optimum spawning flow as calculated by Kosakoski and Hamilton.

Table 7. Number of days in which the Coldwater River flow at Merritt (08LG010) was below 120 cfs (3.4 m^3 sec^{-1}) for the period August through November (left portion of table) and below 50 cfs (1.42 m^3 sec^{-1}) for the period April through January. 120 cfs is the optimum spawning flow calculated by Kosakoski and Hamilton (1982) and 50 cfs was the recommended "Fisheries Resource Maintenance Flow."

Year	Aug	Sep	Oct	Nov	Sum	Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec	Sum
1913	29	30	31	30	120	1913	31	28	31	27	24	30	31	30	31	263
1914	31	29	30	8	98	1914	31	28	31	4	31	24	20	8	25	202
1915	31	30	22	16	99	1915	31	28	16	0	28	30	14	2	2	151
1916	14	30	31	30	105	1916	31	29	18	0	0	17	30	21	31	177
1917	26	30	30	30	116	1917	31	28	31	0	4	27	22	30	31	204
1918	31	30	16	20	97	1918	31	28	31	30	3	30	11	2	0	166
1919	18	30	31	30	109	1919	31	28	0	0	0	0	4	16	31	110
1920	31	11	0	6	48	1920	30	29	27	4	20	11	0	0	2	123
1921	27	24	31	30	112	1921	31	28	0	0	3	20	31	30	31	174
1961	31	28	16	25	100	1961	31	28	31	19	28	21	0	4	6	168
1962	29	30	26	16	101	1962	0	0	0	0	0	23	6	0	0	29
1963	28	30	22	15	95	1963	0	0	0	0	0	27	21	0	0	48
1964	20	16	1	22	59	1964	0	0	0	0	0	0	0	1	0	1
1965	31	30	26	15	102	1965	9	0	0	0	18	30	6	0	0	63
1966	31	30	23	26	110	1966	10	28	21	0	17	30	21	0	0	127
1967	31	30	25	1	87	1967	0	0	0	0	19	30	10	0	0	59
1968	31	28	24	15	98	1968	0	0	0	0	19	15	5	0	0	39
1969	31	25	20	19	95	1969	0	0	7	0	31	22	0	0	7	67
1970	31	30	31	30	122	1970	31	23	0	0	31	28	24	29	31	197
1971	25	30	30	29	114	1971	16	0	0	0	7	29	3	0	29	84
1972	12	28	29	30	99	1972	31	8	0	0	0	20	19	25	31	134
1973	31	30	27	30	118	1973	31	28	5	0	31	30	14	0	0	139
1974	16	30	31	29	106	1974	0	0	0	0	0	29	28	19	8	84
1975	31	30	25	1	87	1975	23	28	19	5	8	25	14	0	0	122
1976	0	25	31	28	84	1976	0	0	0	0	0	4	30	11	1	46
1977	31	30	30	18	109	1977	0	0	0	0	31	30	24	5	4	94
1978	31	25	28	20	104	1978	2	0	0	0	25	2	5	0	12	46
1979	31	30	31	30	122	1979	20	19	0	0	31	30	25	22	0	147
1980	31	28	30	10	99	1980	6	0	0	0	0	1	0	0	0	7
1981	30	30	23	16	99	1981	0	0	0	0	20	30	1	0	16	67
1982	28	30	28	30	116	1982	16	7	0	0	11	30	9	14	10	97
1983	31	30	31	8	100	1983	1	0	0	0	20	22	22	0	13	78
1984	31	30	27	30	118	1984	0	0	0	0	16	18	8	6	30	78
1985	31	30	15	21	97	1985	29	11	15	0	31	30	15	10	31	172
1986	31	30	29	20	110	1986	14	12	0	0	24	29	21	2	4	106
1987	31	30	31	30	122	1987	3	2	0	0	31	30	31	30	31	158
1988	31	30	26	14	101	1988	31	29	10	0	28	27	14	0	3	142
1989	26	30	22	4	82	1989	0	1	0	0	12	23	11	0	0	47
1990	31	30	6	0	67	1990	5	17	4	0	27	26	4	0	0	83
1991	18	29	31	9	87	1991	0	0	0	0	0	11	24	4	2	41
1992	31	30	26	28	115	1992	2	0	0	0	31	26	19	5	10	93
1993	27	30	31	30	118	1993	27	17	4	0	1	26	25	22	21	143
1994	31	30	31	30	122	1994	3	17	0	0	31	30	27	27	12	147
1995	31	30	31	30	122	1995	10	0	0	0	31	30	31	30	31	163

In general, the Kosakoski and Hamilton recommendations seem to be streamflow targets that are reachable in most years, with the exception of Coldwater River. There is no striking evidence that recent years have more days below the flow targets than do earlier years, and there is no striking evidence that some months are more flow-limited now than they were in the past. It should be noted that the measure of limitation I have used here is simply the number of days below the threshold, and it is possible that a more detailed analysis (e.g., using magnitude of flow) would detect trends not evident in the current analysis. Nevertheless, this result underscores the notion that the Kosakoski and Hamilton recommendations are "reasonable" in that they are reachable, and that they are as reachable today as they were when they were made.

The Coldwater River appears to present a somewhat special case, in that low flows are usually well below the flow targets, particularly in the late summer and fall (Figure 6). Water use appears to have an effect on fish habitat availability, but in most years water use itself is not responsible for reducing flows to critical levels. Rather, natural availability is consistently below the target flow threshold, often for extended periods during fish migration and spawning.

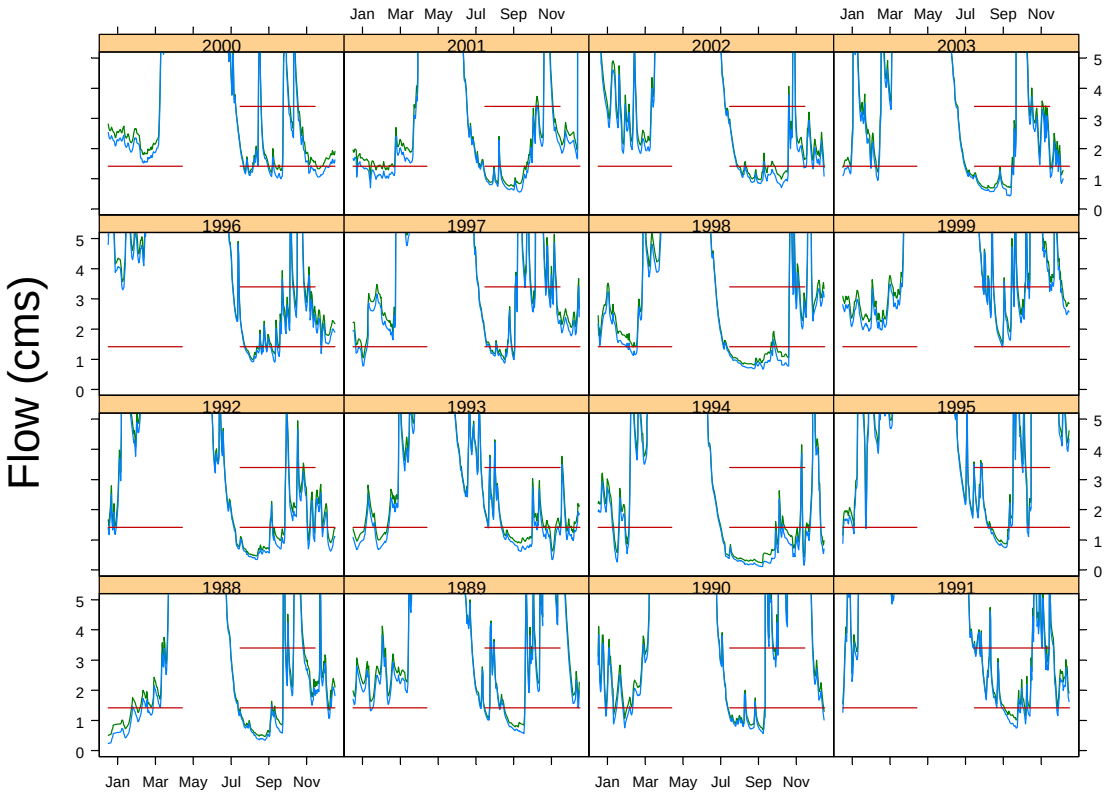

Figure 6. Coldwater River flows at Merritt. The blue lines indicate observed flows at 08LG010 for the years 1988 through 2003, the most recent 16 years on record. Naturalized flows (i.e., observed flows plus assumed water uses) are indicated in green, based on modeling undertaken by MoE hydrologists. Red lines indicate the optimum spawning flow for chinook (120 cfs, upper line) and the Fisheries Resource Maintenance Flow (50 cfs, lower line) as calculated by Kosakoski and Hamilton. Note: the y-axis is limited to flows below 5 cms to show detail during low flows.

6.2 BC Instream Flow Guidelines for Fish

The Ministry of Water, Land and Air Protection (MWLAP), Ministry of Sustainable Resource Management (MSRM), Land and Water BC Inc. (LWBC), and Fisheries and Oceans Canada (DFO) developed the British Columbia Instream Flow Guidelines for Fish to aid in the process of setting instream flows in British Columbia streams. These Guidelines deal specifically with instream flow requirements to support aquatic ecosystem values. The Guidelines are made up of two main components, Flow Thresholds (Hatfield et al. 2003) and Assessment Methods (Lewis et al. 2003), to support a two-tiered review process for proposed water uses on BC streams. The first tier is a scoping level process that provides thresholds for alterations to natural stream flows that are expected to result in low risk to fish, fish habitat, and productive capacity. These thresholds are meant to act as a "coarse filter" during the review of proposed water uses on BC streams when there is little or no biological or physical data available. The second tier applies to projects that propose to exceed these flow thresholds. Such projects must collect additional data, using the Assessment Methods to support a more detailed review.

In this section we calculate the flow threshold for five sites in the Nicola watershed for which natural or naturalized flows are currently available. Spahomin and Pennask Creeks are two gauged systems that have relatively little water use, and we treat them as natural. Flow records for Spius Creek and Coldwater River (2 sites: Brookmere and Merritt) have been naturalized by MoE staff and we have used these records. The flow thresholds for these systems are plotted in Figure 7 through Figure 11.

Each system is similar in that flows are snowmelt-driven, have relatively low flows during non-freshet times of the year, and exhibit considerable among-year variance in flow magnitude and timing. The calculated flow thresholds underscore two main points: these systems are "water-rich" only during the spring freshet, and have low flows that are potentially limiting to fish for much of the year, including late summer, fall, and winter. The thresholds indicate that water extraction during the low flow periods should be permitted only after studies are undertaken to examine how such water use would interact with instream fisheries needs.

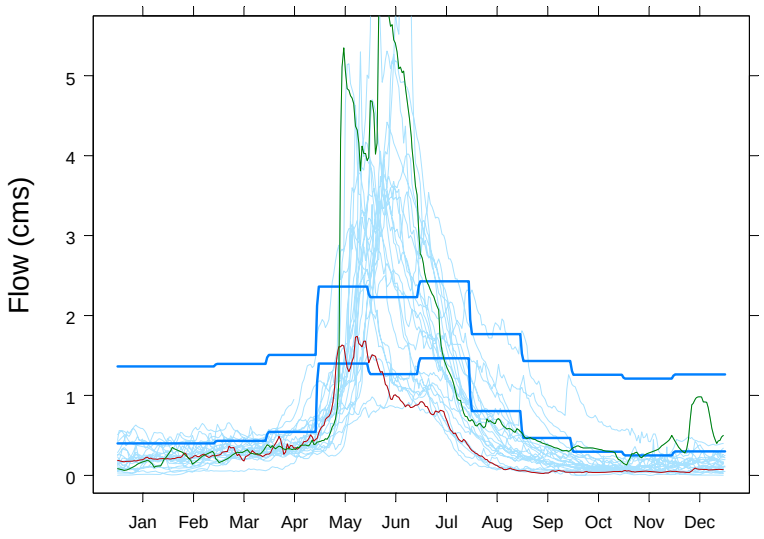

Figure 7. Spahomin Creek flows (08LG060). Light blue lines indicate daily flows, overlaid for the years 1972 through 1996. The green line indicates flows in the year 1995, a relatively wet year. The red line indicates flows in 1977, a relatively dry year. The dark blue lines indicate calculated minimum and maximum flow thresholds, based on the BC Instream Flow Guidelines.

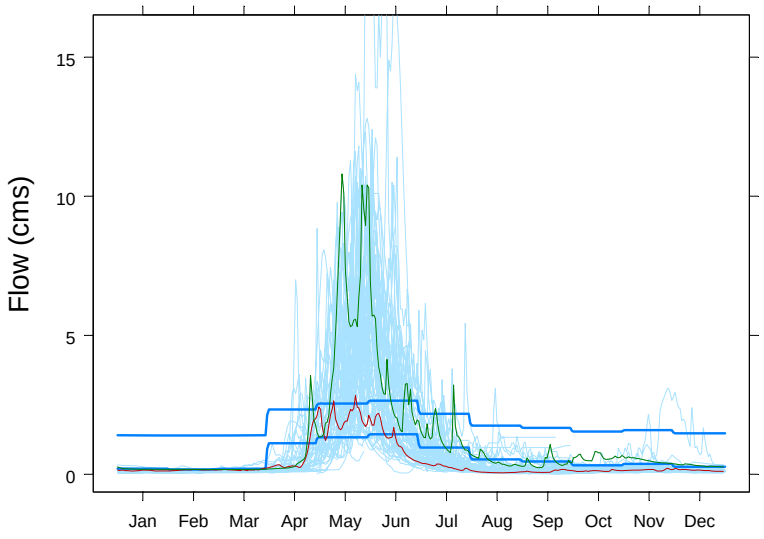

Figure 8. Pennask Creek flows (08LG016). Light blue lines indicate daily flows, overlaid for the years 1920 through 2003. The green line indicates flows in the year 1997, a relatively wet year. The red line indicates flows in 1977, a relatively dry year. The dark blue lines indicate calculated minimum and maximum flow thresholds, based on the BC Instream Flow Guidelines.

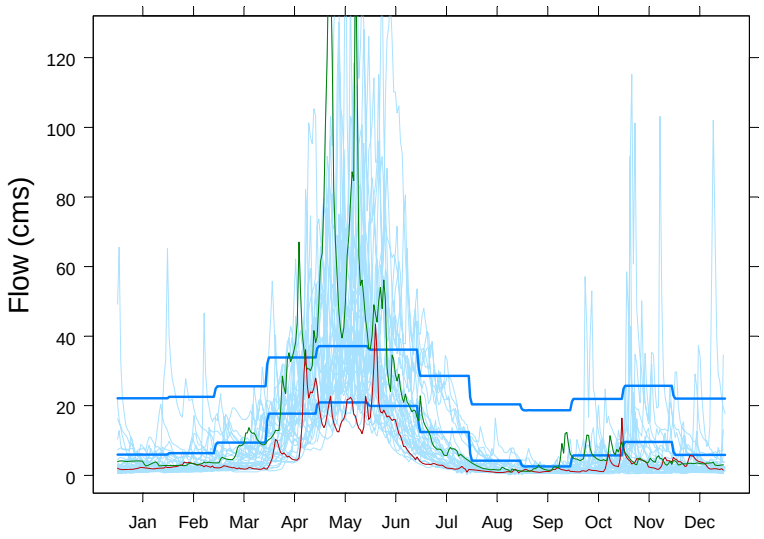

Figure 9. Spius Creek flows based on naturalized data from MoE. Light blue lines indicate daily flows, overlaid for the years 1970 through 2003. The green line indicates flows in the year 1997, a relatively wet year. The red line indicates flows in 1977, a relatively dry year. The dark blue lines indicate calculated minimum and maximum flow thresholds, based on the BC Instream Flow Guidelines.

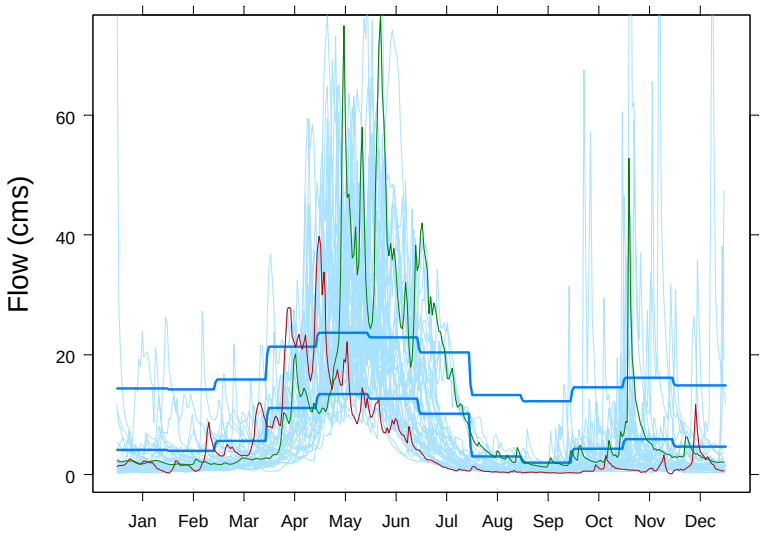

Figure 10. Coldwater River flows at Brookmere, based on naturalized data from MoE. Light blue lines indicate daily flows, overlaid for the years 1965 through 2003. The green line indicates flows in the year 1999, a relatively wet year. The red line indicates flows in 1994, a relatively dry year. The dark blue lines indicate calculated minimum and maximum flow thresholds, based on the BC Instream Flow Guidelines.

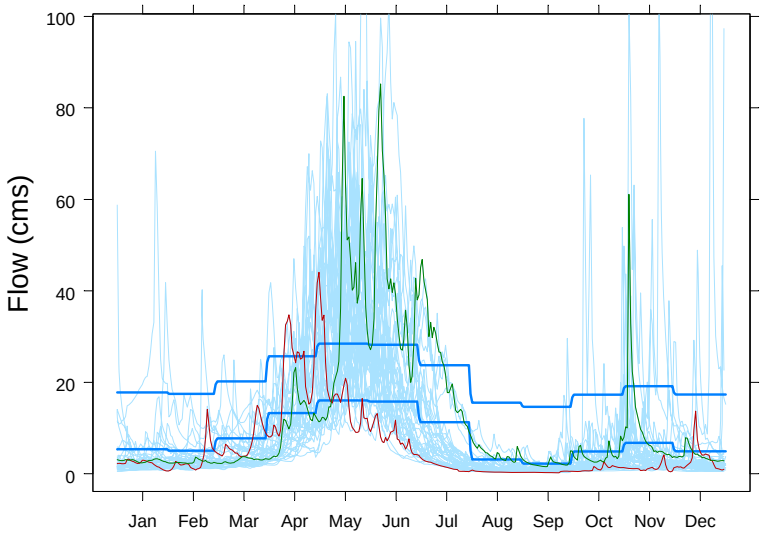

Figure 11. Coldwater River flows at Merritt, based on naturalized data from MoE. Light blue lines indicate daily flows, overlaid for the years 1965 through 2003. The green line indicates flows in the year 1999, a relatively wet year. The red line indicates flows in 1994, a relatively dry year. The dark blue lines indicate calculated minimum and maximum flow thresholds, based on the BC Instream Flow Guidelines.

6.3 Other Overview Methods

Several methods exist for providing office-based recommendations of streamflow targets for the protection of fish resources (e.g., Tennant Method, BC Modified-Tennant Method, Meta-analysis regression equations, etc.). Virtually all of these rely natural or naturalized flow records and are therefore not currently available for most stream sections in the Nicola watershed.

7. Conclusions and Recommendations

Patterns of streamflow and an overview of fisheries concerns in the Nicola watershed indicate that natural patterns of streamflow are critically low during important life history periods for local fish stocks. All systems have snowmelt-driven hydrographs, with low flow periods in late summer, fall and winter. In many years low flow periods are well-below recommended minimum flows for maintenance of instream values such as fish habitat.

Climate change impacts are apparent in systems with long flow records, and likely reflect patterns occurring throughout the larger watershed, as similar trends have been observed elsewhere in this portion of the province (e.g., Leith and Whitfield 1998). These changes include an earlier snowmelt season and longer duration of low flows, particularly in late summer and fall. Such changes are likely to remain or worsen as global warming and climate change continue to affect patterns of precipitation in the interior of BC (Ministry of Environment 2006). These changes may be exacerbated over the next decade as hydrology is further altered by increases in forest harvest related to the ongoing mountain pine beetle outbreak. My analysis

did not detect trends in low flows (that is, there was no evidence of low flows becoming lower through time), however, it is possible that these trends exist but are not detectable with available data.

A cursory analysis of water licences in the Nicola watershed shows licenced water use to be of considerable magnitude. A detailed analysis of water use is being undertaken in a separate study as part of the Nicola WUMP. Until this study is complete it is difficult to quantitatively assess the effect of water use on fish habitat, other than to say that it is likely to negatively influence the quality and quantity of available fish habitat.

Kosakoski and Hamilton (1982) made a number of recommendations to protect fish and fish habitat from the effects of excessive water use. Their first recommendation was stated as follows: "To ensure that the salmonid production potential of the Nicola River system is maintained, it is recommended that: There be no increase in water diversion from the Nicola mainstem, Spius Creek, and Coldwater River during low flow periods, and no new water diversion licences unless they are supported by storage." This recommendation is reiterated here, and would likely be reiterated by any examination of fish-flow issues in the area. Nevertheless, it appears that water allocation is continuing in the area and it is not clear why water management staff are allowing further allocation of this resource. It will be necessary to address this issue directly during the Nicola WUMP.

Kosakoski and Hamilton undertook a detailed study of the Nicola mainstem and the Coldwater River. Based on their study they were able to provide recommendations for flows to protect instream fish habitat. These recommendations are likely valid today, although it may be useful to re-analyse the data if they are available. Re-analysis could include use of updated HSI curves, calculation of confidence intervals, and application of analytic techniques discussed in Lewis et al. (2003). It seems unlikely that resources are available to repeat this study or to add to the number of transects used. It may be preferable to expend effort establishing flow targets for other portions of the watershed. To the extent possible, all flow targets should be based on empirical work using methods described in Lewis et al. (2003). Overview methods may be required to establish flow targets in some parts of the watershed.

There have been a variety of discussions regarding the use of Nicola Lake to provide additional water storage to support both water use and instream fish needs, and there continues to be interest in pursuing this option. Figure 12 shows recent patterns of outflow from Nicola Lake, and provides a visual sense of the potential for water storage. The red lines in the figure represent the minimum flows recommended by Kosakoski and Hamilton (1982). Observed flows (blue lines) above the red lines indicate storage potential to meet minimum instream flows and other demands. It is apparent that considerable storage potential exists, but it is also apparent that inflow to the lake is very low in some years (e.g., 1988, 1992 and 2003). In years such as these the lake is barely refilling, and additional water use may prevent it from completely refilling. It should also be noted that storage in the lake would come at a cost of increased fluctuations in water levels and reduced flushing rates, and there can be severe ecological costs, including effects on fish distribution and abundance (Cohen and Radomski 1993; Paller 1997; Turner et al. 2005). There should be some assessment of the ecological trade-offs between lake and stream ecosystems.

Many of the issues raised here and elsewhere have been slated for discussion and analysis within the Nicola WUMP, as it strives for a balance between instream (environmental) and out-of-stream (human) benefits of water allocation. There appear to be fundamental trade-offs between these two uses in that increased allocation for one, will de facto imply a loss for the other. It is unlikely that a "win-win" situation exists for water allocation across most of this watershed. The process of decision-making with respect to water allocation therefore needs to be carefully planned to ensure that one user group does not dominate another and that the trade-offs are made in a defensible and transparent manner, and reflect the values of society as a whole and not those of a single user group.

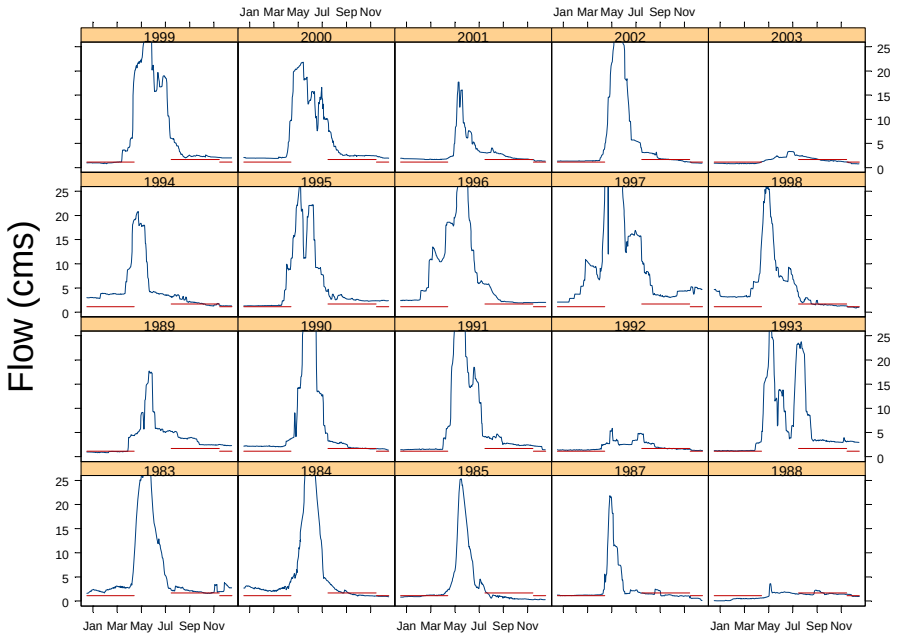

Figure 12. Outflow from Nicola Lake as recorded at 08LG65. The red line indicates 60 cfs (1.7 m^3 sec^{-1}), the minimum flow recommended by Kosakoski and Hamilton (1982) for this portion of the river during the months of August through November, and 40 cfs (1.13 m^3 sec^{-1}) for December through April.

8. SUMMARY OF RECOMMENDATIONS

1. produce defensible time series of naturalized flows for Nicola River and its tributaries
2. conduct a quantitative analysis of water use and its effects on fish habitat
3. establish instream flow targets for fisheries, based on empirical and overview methods, including temperature modeling
4. conduct trade-off analyses in the WUMP using a third party experienced decision analyst and facilitator
5. develop tools to manage water resources in the face of conflicting needs, including development of rules under different flow scenarios such as wet and dry years

6. incorporate climate change projections into water management decisions
7. establish and maintain gauging stations at key points in the watershed
8. avoid further water allocation for out-of-stream uses

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Appendix A
Analysis of WSC Gauge Data

The following pages contain a variety of graphical analyses of streamflow data. All data are from the Hydat database available from the Water Survey of Canada (WSC). Over the years WSC has operated several streamflow gauges in the Nicola watershed, some of which are no longer maintained.

For each streamflow gauge I have provided two sheets of graphs and tables. The graphs and tables do not have captions, as the analysis has been repeated across all available gauges. The following text describes each graph and table.

Page 1, Row 1, left. This table lists the name of the gauge, period of record, description of the watershed, and basic descriptors of flow.

Page 1, Row 1, middle. The plot shows the Nicola watershed, the major streams, and maps the location of the gauge.

Page 1, Row 1, right. This table lists the basic streamflow statistics for the available gauge data on a monthly basis, and over the period of record (PoR).

Page 1, Row 2, left. This graph indicates the general pattern of streamflow through the year on a monthly basis. The two lines indicate mean monthly flows (upper) and median monthly flows (lower). The mean annual flow and median annual flow are both indicated as horizontal lines.

Page 1, Row 2, middle. Exceedence graphs indicate the probability of flows of different magnitude. Exceedences are plotted on both a monthly basis, and over the period of record. The mean annual flow is shown as a reference point.

Page 1, Row 2, right. Trends in annual streamflow metrics through the period of record. Trends are shown for mean, median, 10^{th} percentile and minimum.

Page 1, Row 3, left. General pattern of streamflow. Light blue lines are super-imposed traces of daily average flow across all years in the period of record. Dark blue, red and green lines are 90^{th}, 50^{th} and 10^{th} percentiles respectively.

Page 1, Row 3, middle. This graph displays super-imposed traces of daily average flow across all years in the period of record (light blue). The streamflow record is split into two equal periods and the median daily flow in each period is plotted as a red and green line. The comparison of the two periods provides a rough indication of trends induced by climate change.

Page 1, Row 3, right. Trends in streamflow metrics for the month of September, which is typically the month of lowest flow during the growing period for fish in this watershed. Trends are shown for mean flow and minimum flow for all Septembers in the period of record.

Page 2, Row 1, left. This table is repeated from this location on page 1. It lists the name of the gauge, period of record, description of the watershed, and basic descriptors of flow.

Page 2, Row 1, middle. This image is repeated from this location on page 1. It shows the Nicola watershed, the major streams, and maps the location of the gauge.

Page 2, Row 1, right. This graph shows the trend in the duration of low flows during the growing season of fish (defined as April through October). Low flows are defined as flow less than the median September flow (calculated over the period of record). A trend line is shown in red, and is calculated using a locally-weighted regression (loess), which can be thought of as similar to a rolling average. Trends in duration of low flows can be brought about by changes in water use, climate, or both.

Page 2, Row 2, left. This image presents a trend analysis by month, using minimum flow in each of twelve calendar months. The trends of greatest interest for the purpose of this analysis were low flows during the fish growing season, so the y-axis scale has been limited to the typical magnitude of low flows. For this reason, observations in April through July are often missing, as they are greater than the maximum indicated on the scale. Trends are indicated with a locally-weighted regression (loess) line. The primary purpose of this analysis is to ascertain trends in low flows across the period of record.

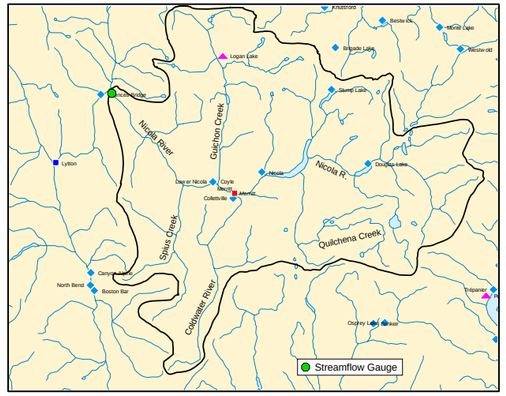
Page 2, Row 2, middle. This image is similar to Page 2, Row 2, left, except that the flow metric is mean monthly flow. The primary purpose of this analysis is to ascertain trends in mean flows across the period of record.

Page 2, Row 3, left. This image is similar to Page 2, Row 2, left, except that the flow metric is 10^{th} percentile of monthly flow. The primary purpose of this analysis is to ascertain trends in low flows across the period of record.

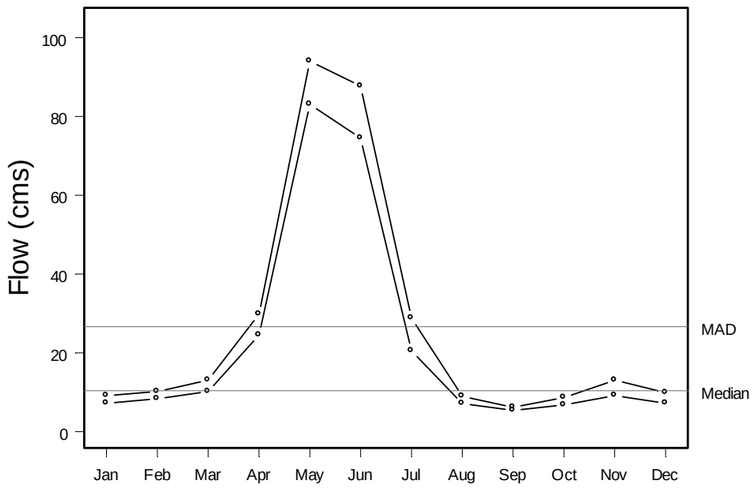
Page 2, Row 2, middle. This image is similar to Page 2, Row 2, left, except that the flow metric is the 90^{th} percentile of monthly flow. The primary purpose of this analysis is to ascertain trends in high flows across the period of record.

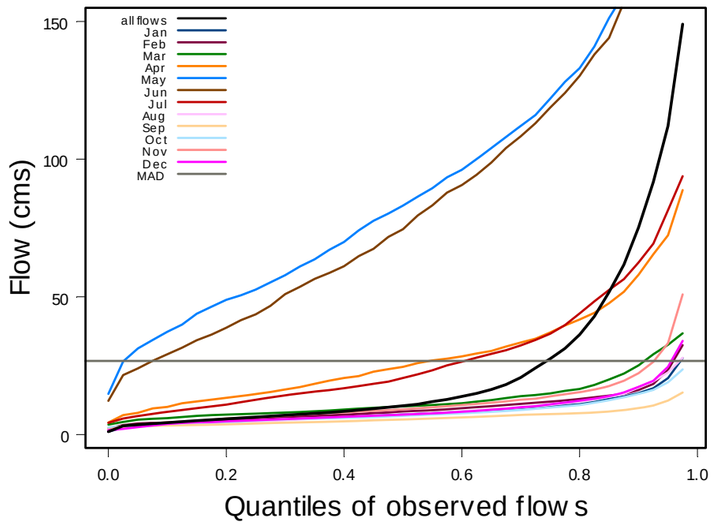
Page 2, Row 2, right. This image is an attempt to analyse trends in flow patterns using a slightly different metric. For each month during the period of record a mean flow was calculated. Deviations were then calculated for each month for each year on record. A positive residual indicates a higher flow than average, while a negative residual indicates a lower flow than the long term average. Thus, an upward trend would indicate an increasing streamflow during that month across the period of record. Trends are indicated with a locally-weighted regression (loess) line. The primary purpose of this analysis is to ascertain trends in mean water availability by month across the period of record.

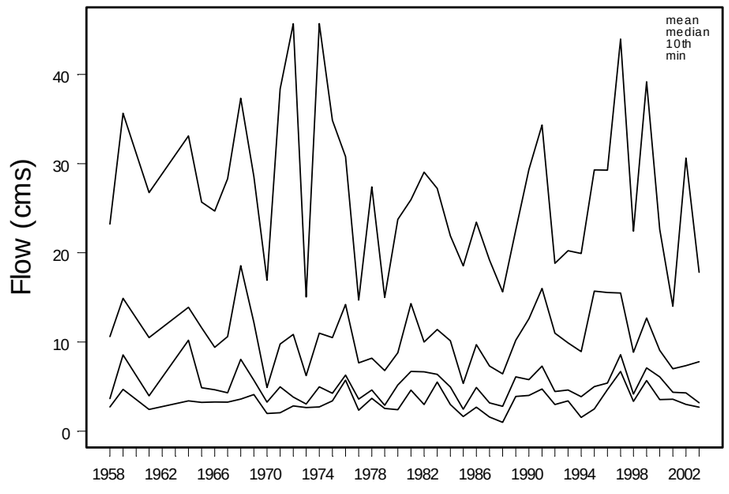
Station Name: Nicola River near Spences Bridge
Station ID: 08LG006
Period of record: 1911-2003
Complete records: 43 years
Drainage area: 7280 km^2
Mean Annual Discharge: 26.7 m^3 sec^{-1}
Runoff: 120.4 L m^{-2} year^{-1}

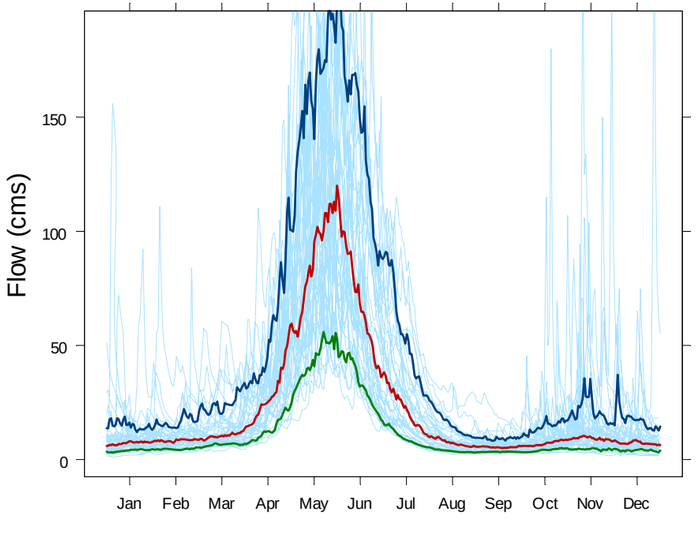


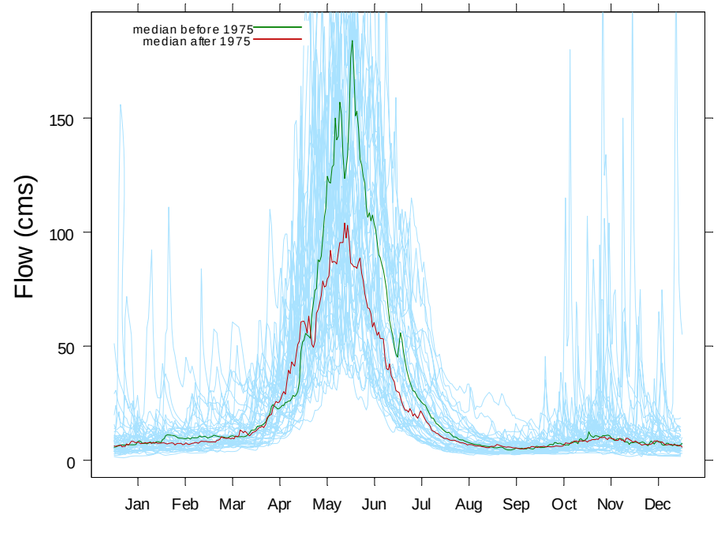
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
					percentiles									
Jan	9.2	7.2	1.0	156.0	3.7	4.5	5.4	6.3	7.2	8.3	9.6	11.0	15.0	Jan
Feb	10.2	8.4	2.2	111.0	4.3	5.2	6.4	7.2	8.4	9.5	11.1	12.9	16.2	Feb
Mar	13.1	10.2	3.6	60.6	6.0	7.2	8.0	9.0	10.2	11.3	13.9	16.5	25.1	Mar
Apr	29.8	24.5	4.4	151.0	10.0	13.3	16.3	20.5	24.5	28.3	33.4	41.7	58.0	Apr
May	94.0	83.1	14.7	378.0	37.3	48.9	57.9	69.9	83.1	96.1	112.0	133.0	169.0	May
Jun	87.7	74.5	12.2	320.0	29.1	38.8	51.0	61.1	74.5	90.6	108.3	130.2	167.0	Jun
Jul	28.8	20.5	4.2	159.0	8.2	10.8	14.3	16.8	20.5	26.4	32.3	44.0	62.5	Jul
Aug	9.0	7.1	2.2	38.1	3.6	4.3	5.2	6.1	7.1	8.4	9.8	12.0	17.1	Aug
Sep	6.2	5.4	2.3	29.2	3.3	3.7	4.3	4.8	5.4	6.2	7.0	7.8	9.6	Sep
Oct	8.7	6.8	2.6	180.0	3.8	4.5	5.5	6.0	6.8	7.7	8.9	10.7	14.7	Oct
Nov	13.0	9.2	1.6	226.0	4.4	5.8	6.8	8.0	9.2	10.7	12.6	15.3	22.2	Nov
Dec	9.9	7.2	1.5	236.0	3.8	4.8	5.6	6.4	7.2	8.3	9.9	12.3	17.3	Dec
PoR	26.7	10.4	1.0	378.0	4.3	5.7	7.0	8.4	10.4	13.8	20.7	36.2	75.2	PoR

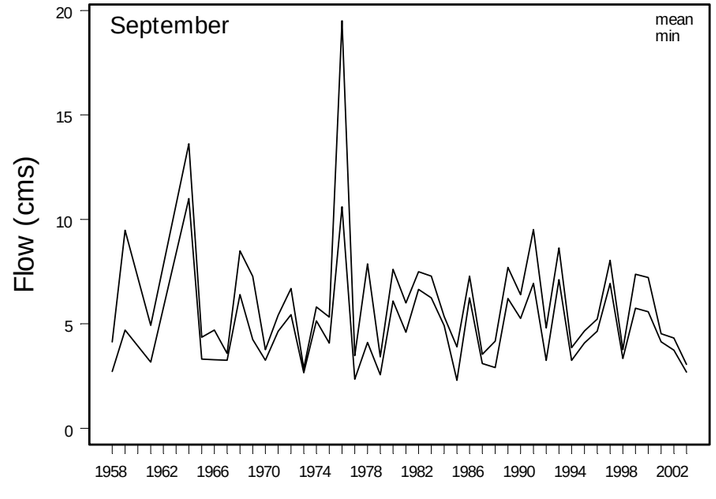




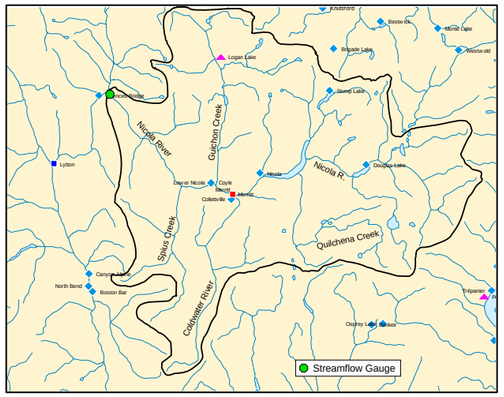


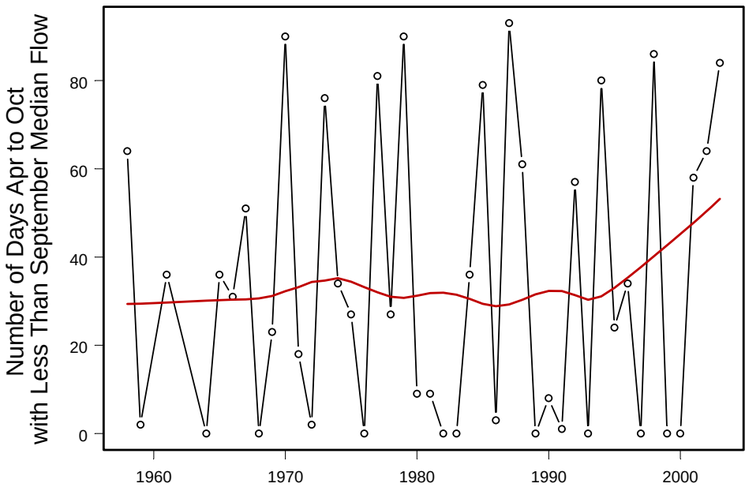


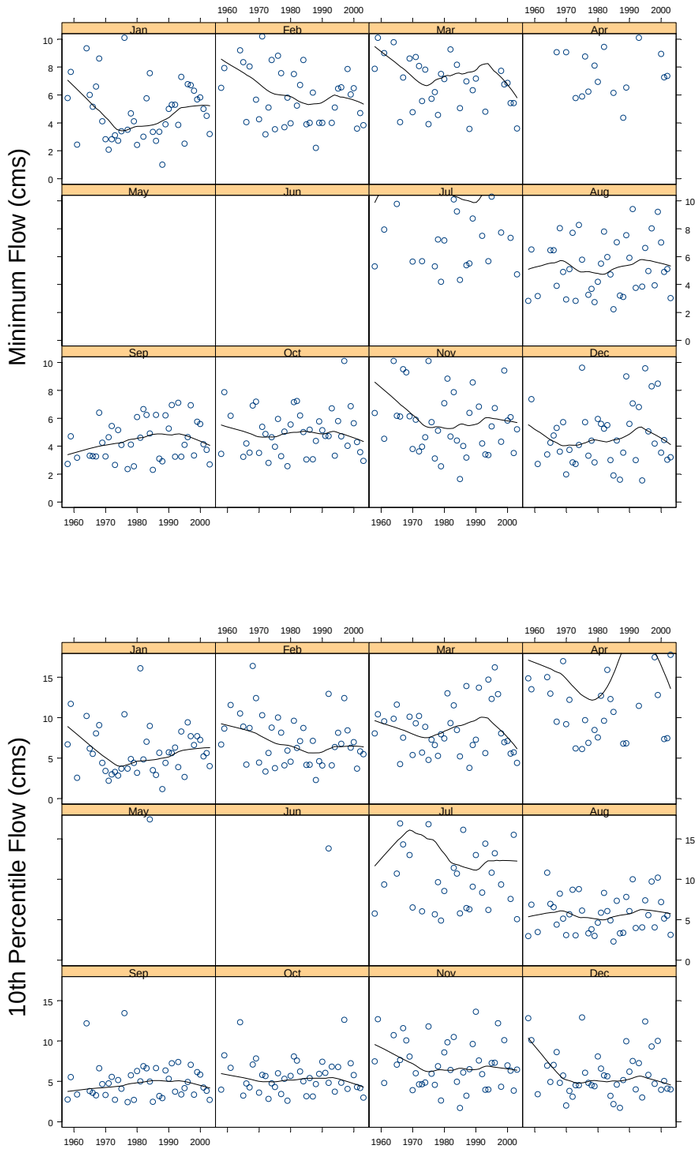


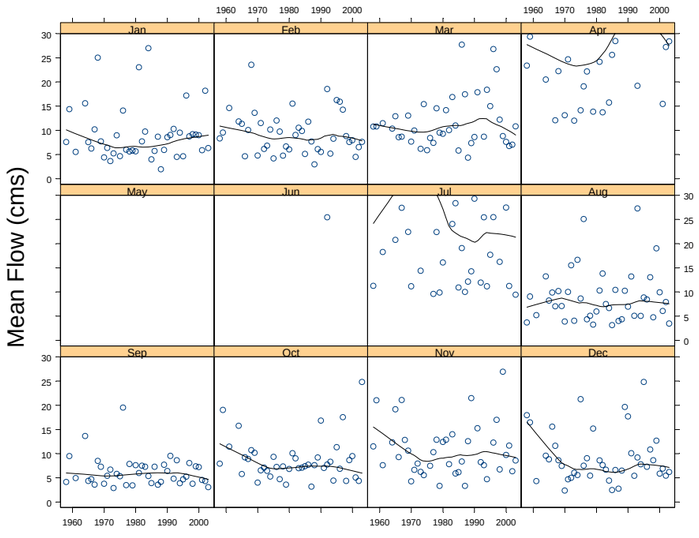


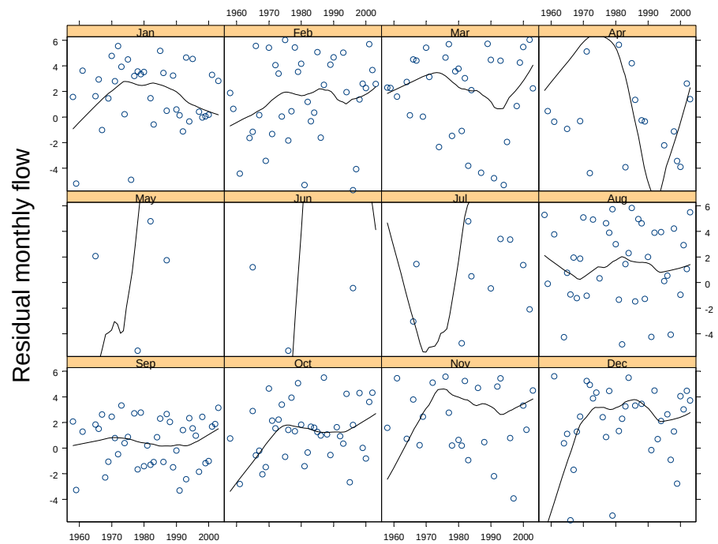
Station Name: Nicola River near Spences Bridge
Station ID: 08LG006
Period of record: 1911-2003
Complete records: 43 years
Drainage area: 7280 km^2
Mean Annual Discharge: 26.7 m^3 sec^{-1}
Runoff: 120.4 L m^{-2} year^{-1}

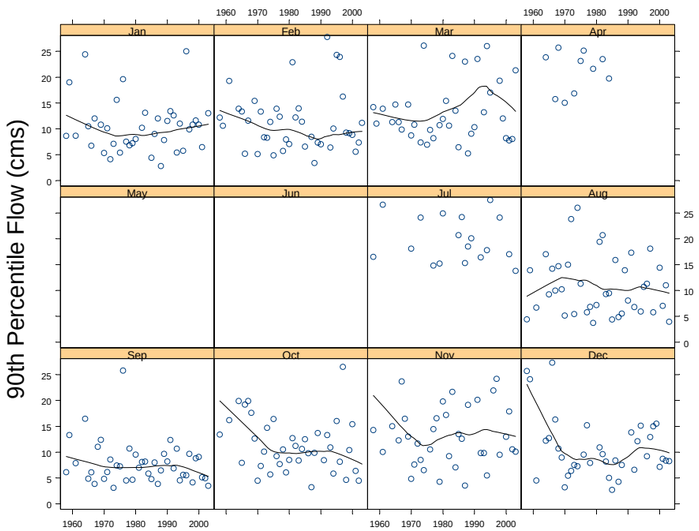




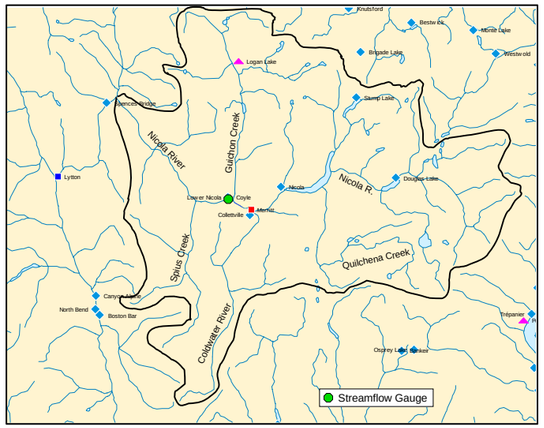






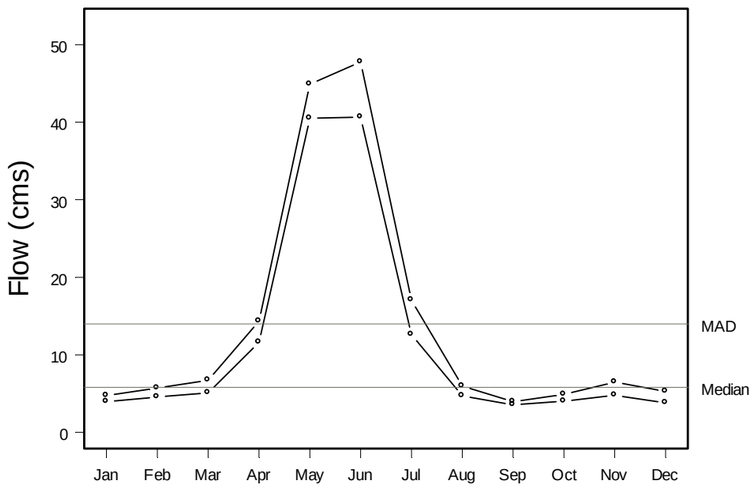


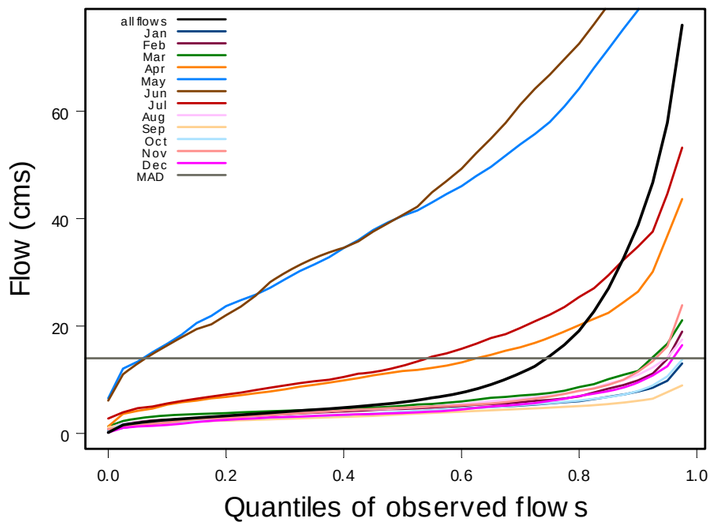
Station Name: Nicola River near Merritt
Station ID: 08LG007
Period of record: 1911-2003
Complete records: 47 years
Drainage area: 4350 km^2
Mean Annual Discharge: 14.0 m^3 sec^{-1}
Runoff: 105.8 L m^{-2} year^{-1}

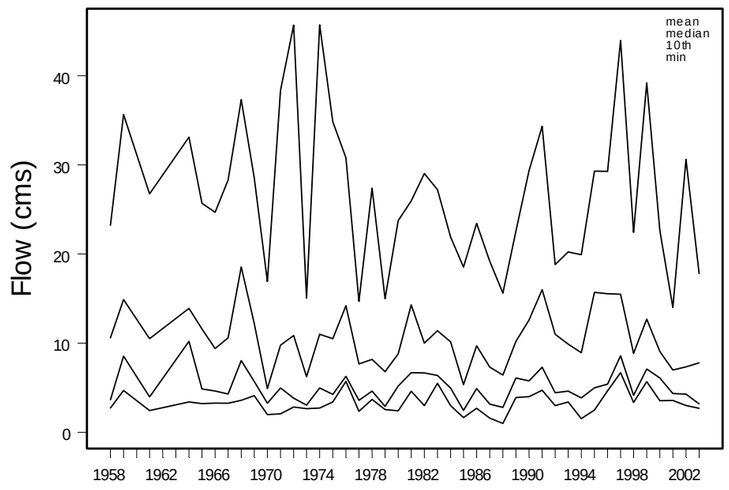


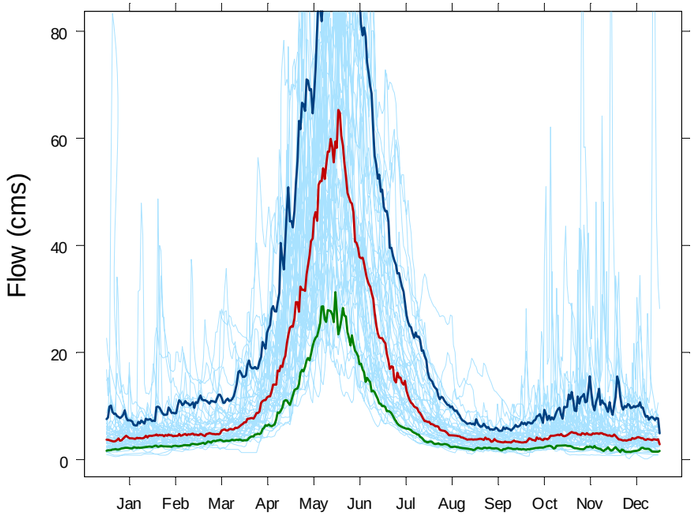
percentiles

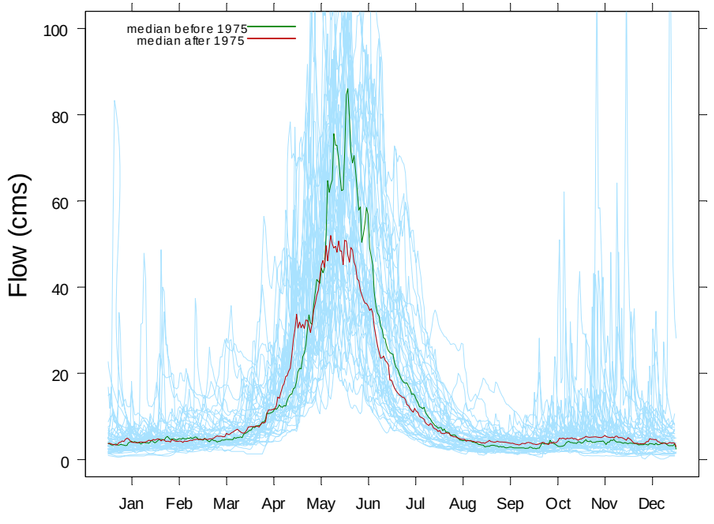
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	4.7	4.0	0.6	83.3	2.0	2.5	2.9	3.3	4.0	4.6	5.2	6.0	7.8	Jan
Feb	5.7	4.6	0.8	48.7	2.5	3.1	3.6	4.1	4.6	5.1	5.8	6.9	9.9	Feb
Mar	6.7	5.1	1.3	35.7	3.3	3.8	4.2	4.6	5.1	6.0	7.1	8.6	11.6	Mar
Apr	14.3	11.6	1.3	78.3	5.3	6.8	8.2	9.9	11.6	13.2	16.0	20.1	26.4	Apr
May	44.9	40.5	6.5	145.0	16.7	23.7	28.7	34.5	40.5	46.0	53.8	64.2	78.8	May
Jun	47.8	40.7	6.1	161.0	16.4	22.0	29.9	34.6	40.7	49.3	61.2	72.6	86.6	Jun
Jul	17.1	12.6	2.8	72.8	5.6	7.2	8.9	10.5	12.6	15.8	19.6	25.4	34.8	Jul
Aug	6.0	4.7	1.0	32.0	2.4	3.0	3.6	4.3	4.7	5.4	6.5	7.9	10.9	Aug
Sep	3.9	3.5	1.1	18.0	2.0	2.4	2.7	3.1	3.5	4.1	4.5	5.1	6.1	Sep
Oct	4.9	4.0	0.6	62.1	2.1	2.7	3.0	3.4	4.0	4.5	5.3	6.1	7.9	Oct
Nov	6.5	4.8	0.8	115.0	2.0	2.8	3.6	4.3	4.8	5.2	6.1	7.9	11.5	Nov
Dec	5.3	3.8	0.1	136.0	1.6	2.5	3.1	3.5	3.8	4.4	5.4	7.0	9.5	Dec
PoR	14.0	5.8	0.1	161.0	2.5	3.3	4.0	4.8	5.8	7.6	11.2	19.1	38.8	PoR

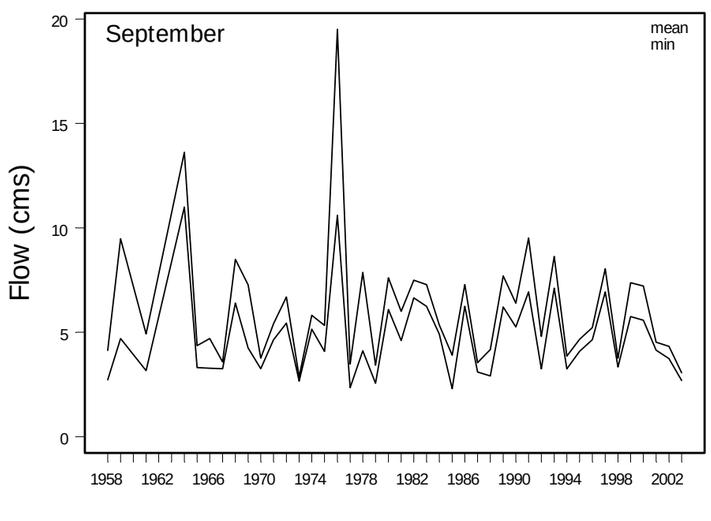




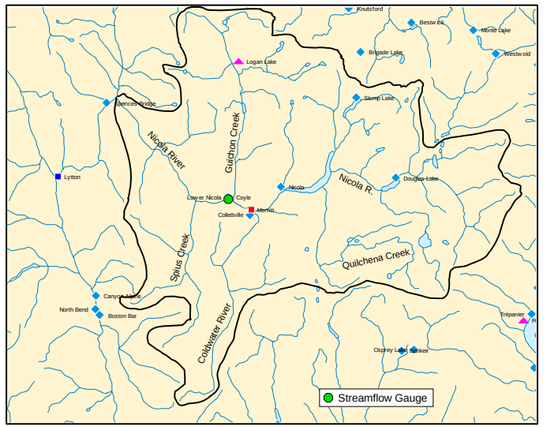


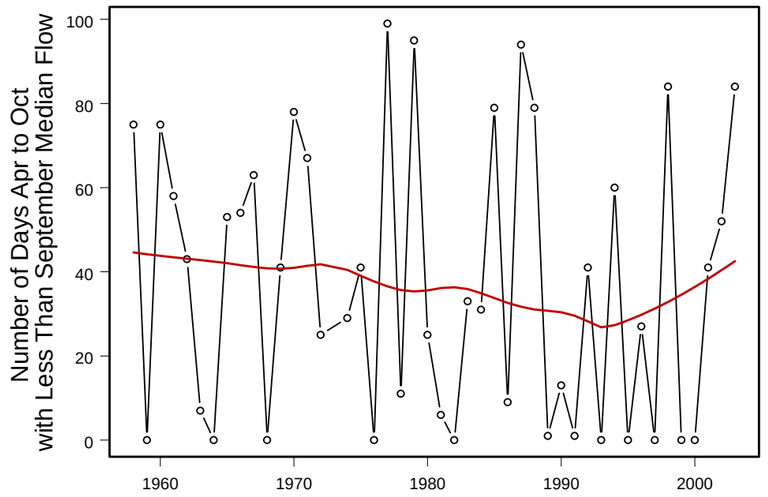


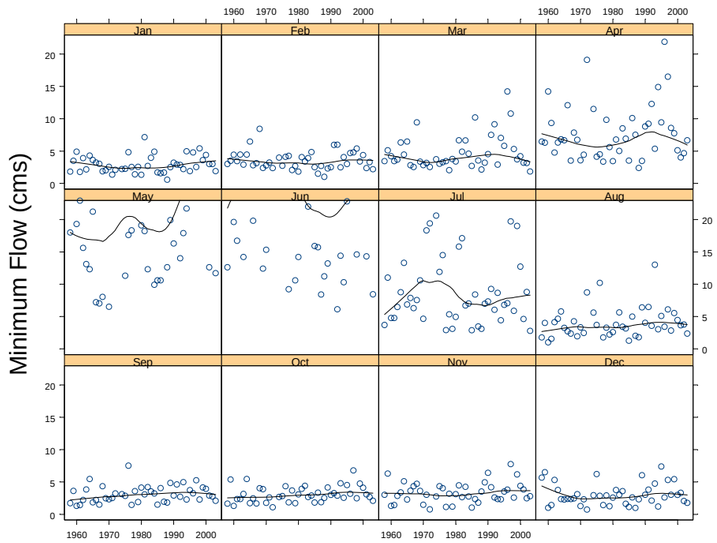


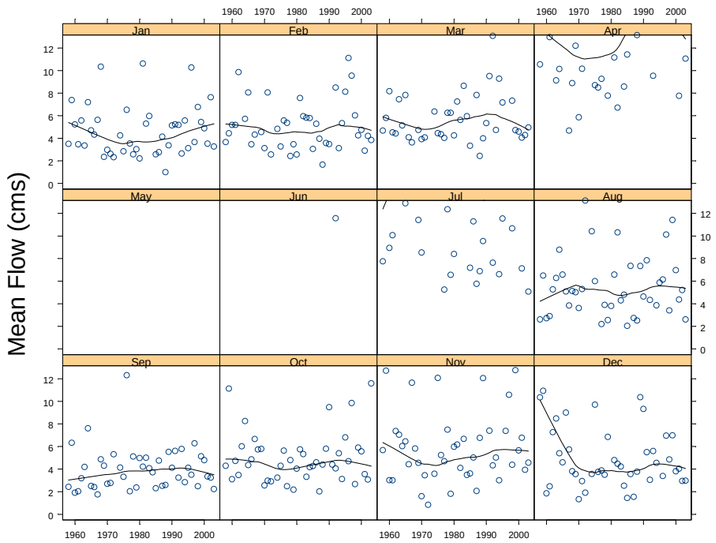


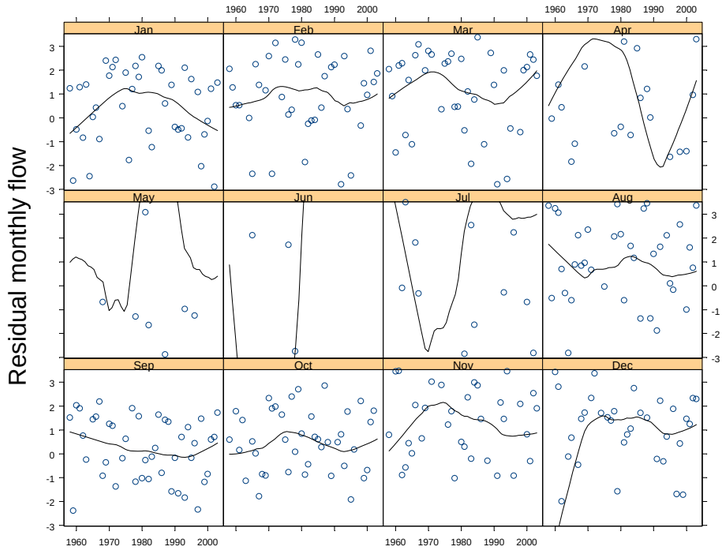
Station Name: Nicola River near Merritt
Station ID: 08LG007
Period of record: 1911-2003
Complete records: 47 years
Drainage area: 4350 km^2
Mean Annual Discharge: 14.0 m^3 sec^{-1}
Runoff: 105.8 L m^{-2} year^{-1}

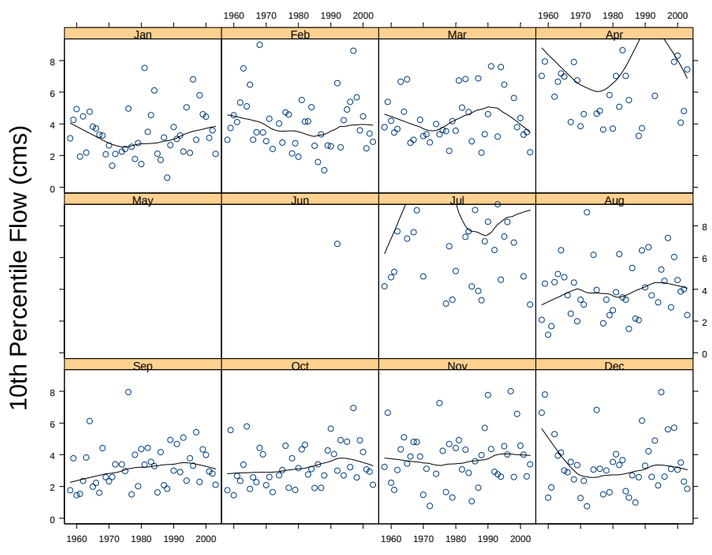


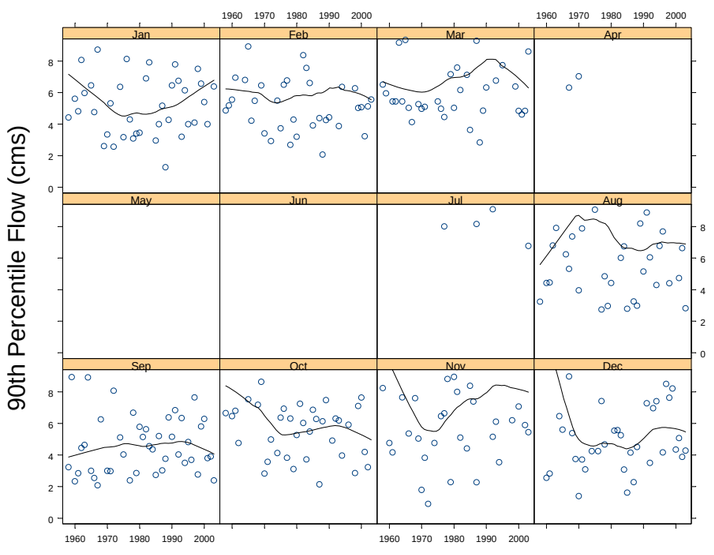




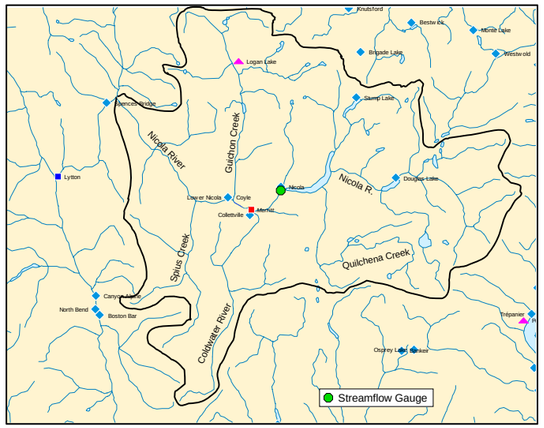




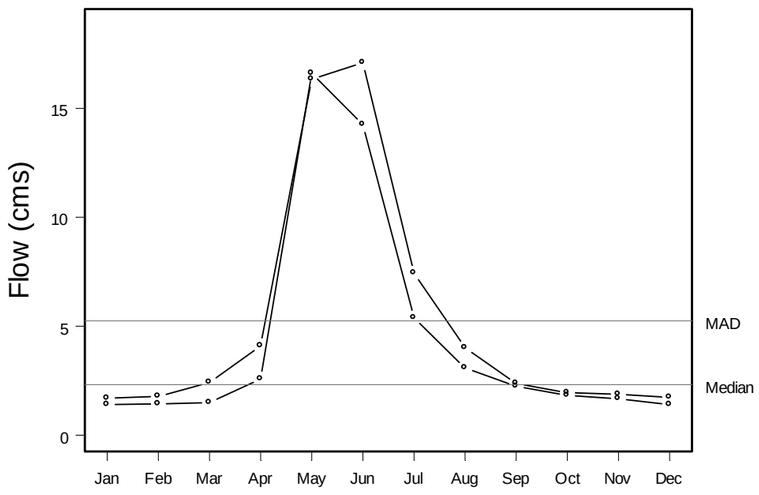


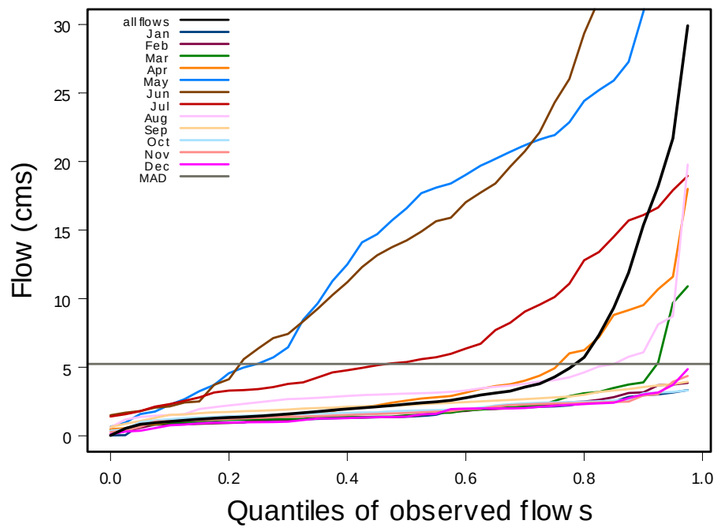


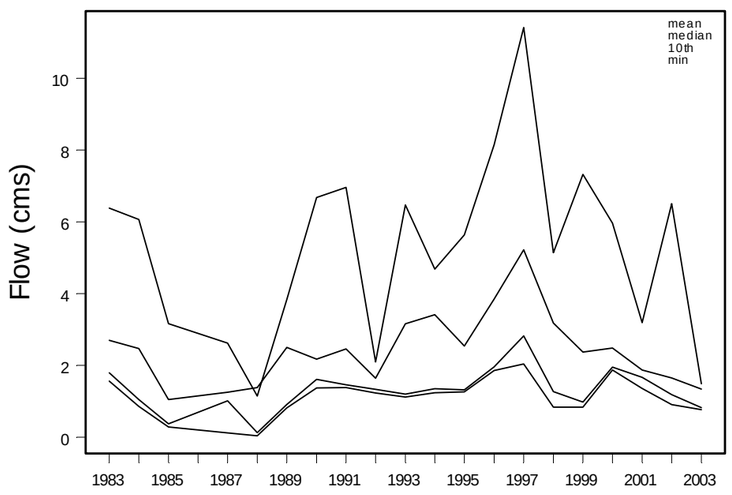
Station Name: Nicola River at
outlet of Nicola Lake
Station ID: 08LG065
Period of record: 1983-2003
Complete records: 20 years
Drainage area: 2990 km^2
Mean Annual Discharge: 5.2 m^3 sec^{-1}
Runoff: 57.66 L m^{-2} year^{-1}

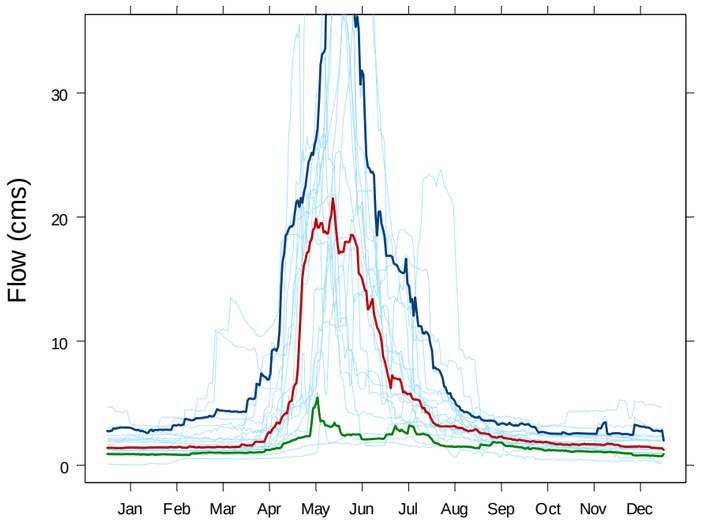


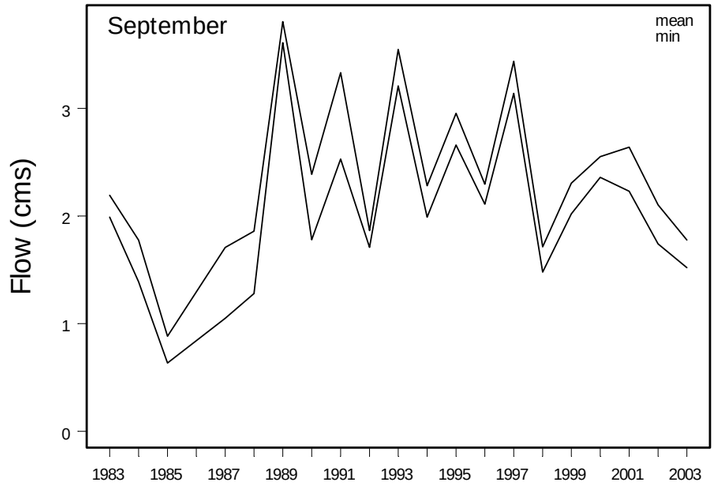
month	mean	median	min	max	10th percentiles									month
					10th	20th	30th	40th	50th	60th	70th	80th	90th	
Jan	1.7	1.4	0.0	4.7	0.9	1.0	1.2	1.3	1.4	1.9	2.1	2.4	3.0	Jan
Feb	1.8	1.4	0.1	4.5	0.8	0.9	1.2	1.3	1.4	1.8	2.1	2.5	3.2	Feb
Mar	2.4	1.5	0.4	13.5	1.0	1.2	1.2	1.4	1.5	1.9	2.1	3.1	3.9	Mar
Apr	4.1	2.6	0.5	26.6	1.0	1.3	1.5	2.0	2.6	3.1	4.0	6.2	9.5	Apr
May	16.3	16.6	0.7	53.8	2.3	4.6	6.5	12.5	16.6	19.0	21.2	24.4	30.9	May
Jun	17.1	14.3	1.5	58.2	2.2	4.1	7.4	11.2	14.3	17.0	20.8	29.3	39.2	Jun
Jul	7.4	5.4	1.4	26.4	2.3	3.3	3.8	4.8	5.4	6.4	9.1	12.8	16.1	Jul
Aug	4.0	3.1	0.6	23.8	1.5	2.2	2.7	2.9	3.1	3.3	3.8	4.6	6.1	Aug
Sep	2.4	2.2	0.6	6.1	1.5	1.8	1.9	2.1	2.2	2.5	2.7	3.0	3.6	Sep
Oct	1.9	1.8	0.4	4.3	1.2	1.4	1.6	1.7	1.8	2.0	2.4	2.5	3.1	Oct
Nov	1.9	1.7	0.3	4.5	1.1	1.2	1.4	1.5	1.7	2.0	2.3	2.4	3.0	Nov
Dec	1.7	1.4	0.1	5.3	0.8	1.0	1.0	1.3	1.4	2.0	2.0	2.3	3.0	Dec
PoR	5.2	2.3	0.0	58.2	1.0	1.4	1.6	2.0	2.3	2.8	3.6	5.7	15.4	PoR



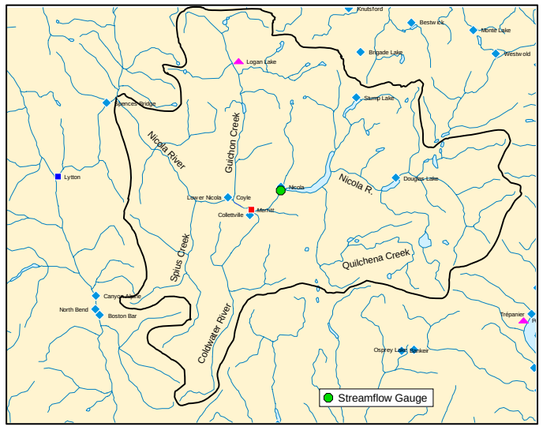


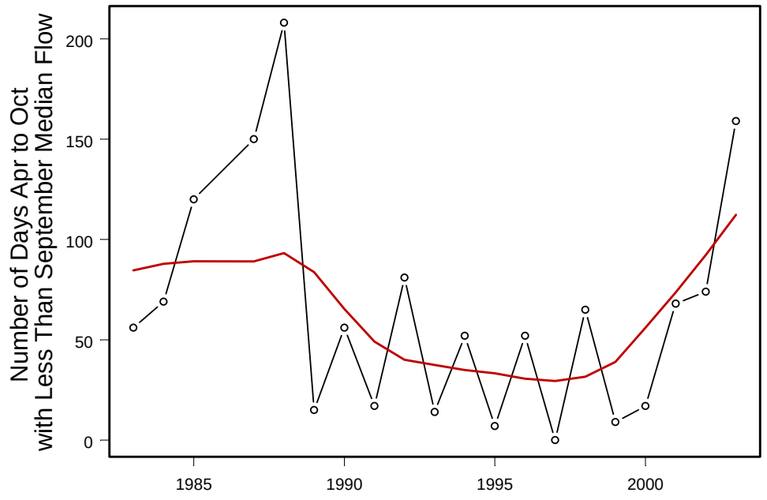


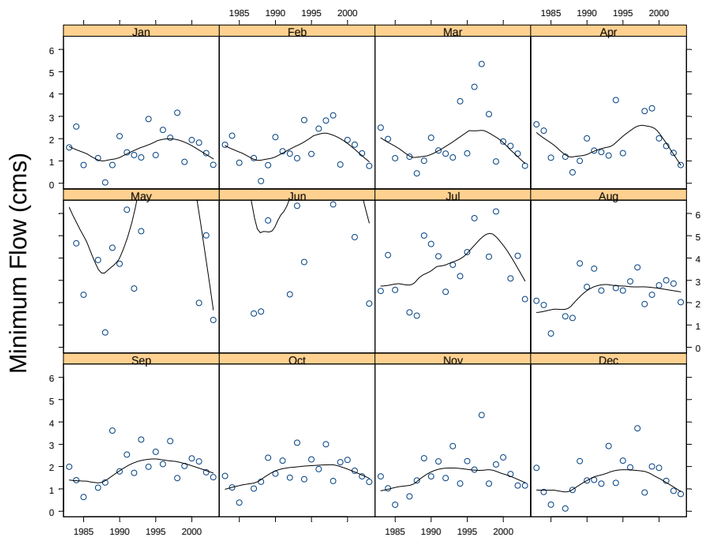


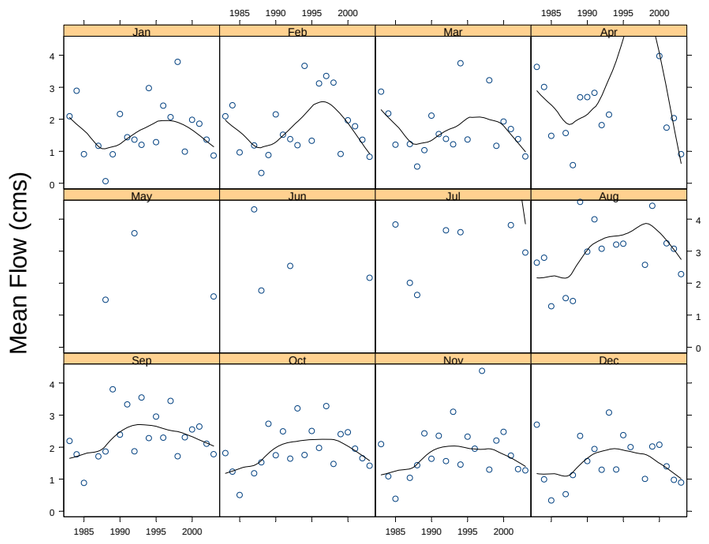


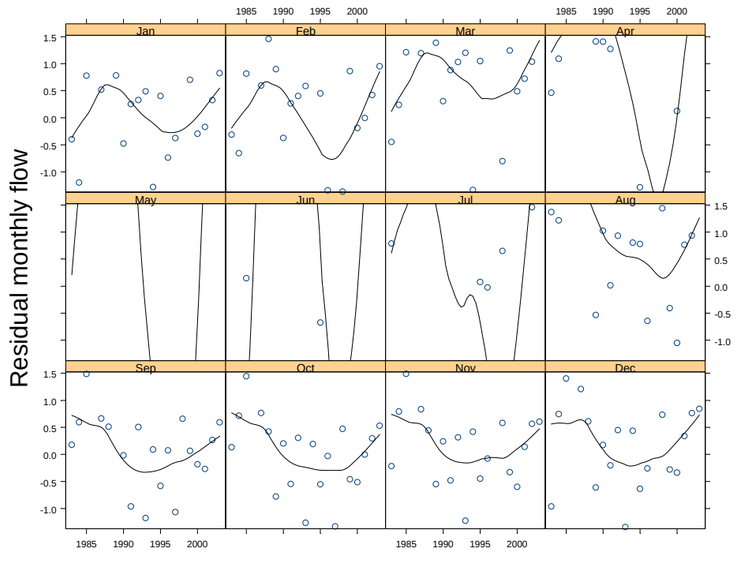
Station Name: Nicola River at
outlet of Nicola Lake
Station ID: 08LG065
Period of record: 1983-2003
Complete records: 20 years
Drainage area: 2990 km^2
Mean Annual Discharge: 5.2 m^3 sec^{-1}
Runoff: 57.66 L m^{-2} year^{-1}

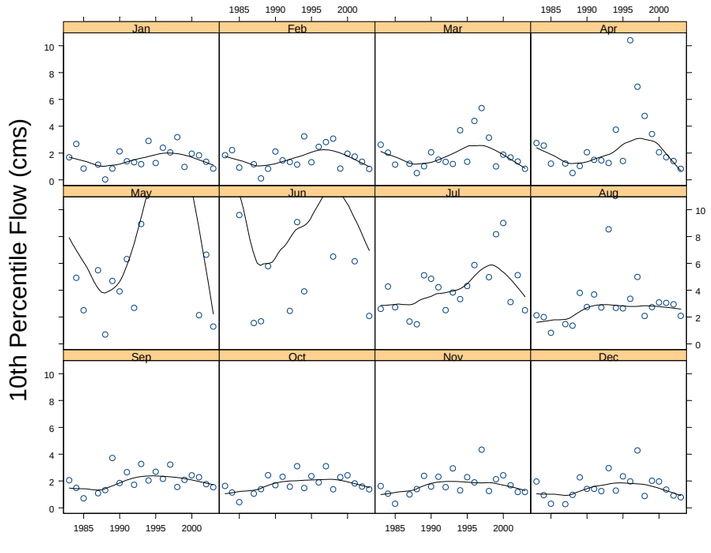


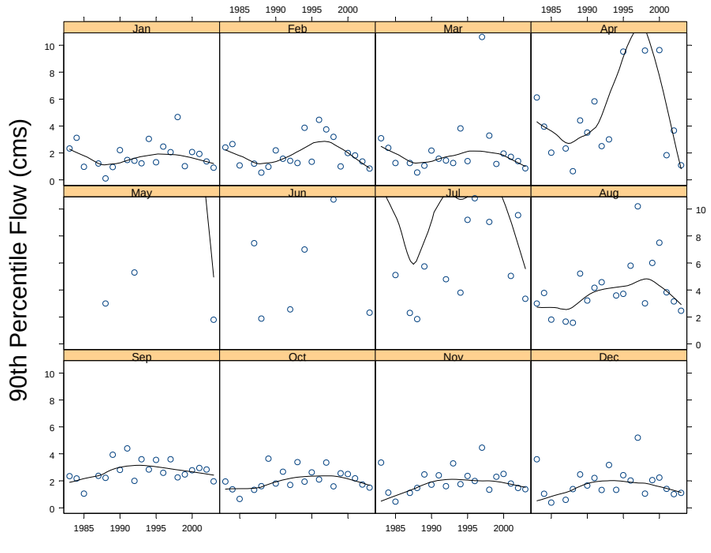




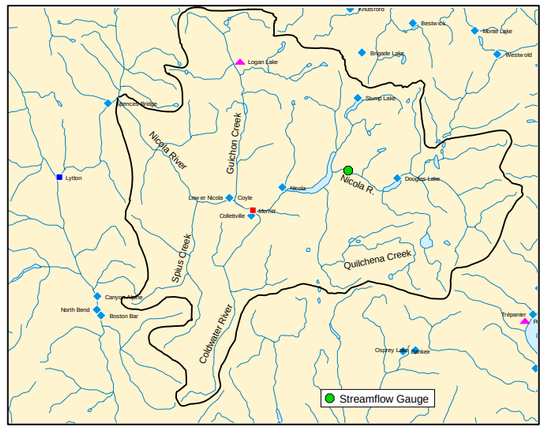






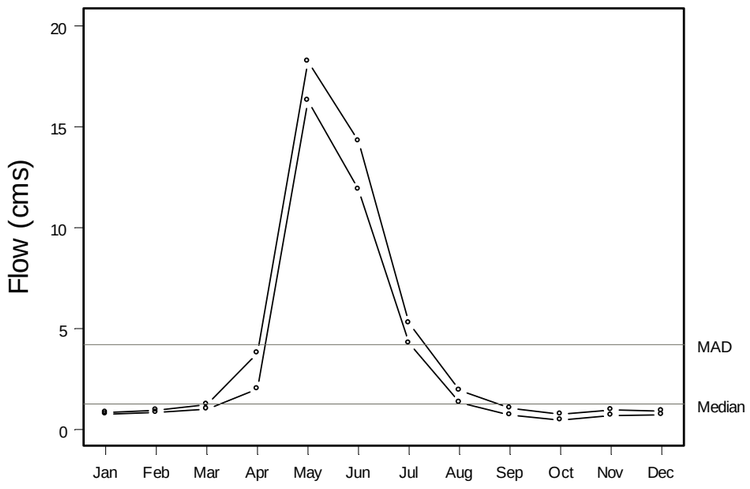


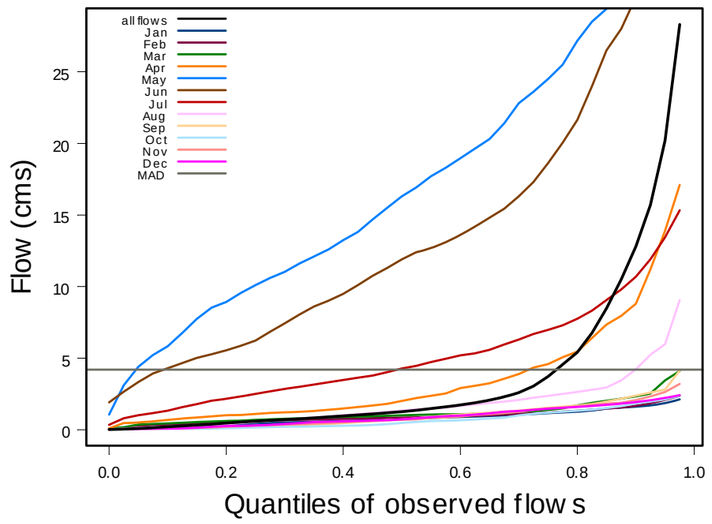
Station Name: Nicola River above Nicola Lake
Station ID: 08LG049
Period of record: 1915-2003
Complete records: 32 years
Drainage area: 1500 km^2
Mean Annual Discharge: 4.2 m^3 sec^{-1}
Runoff: 92.15 L m^{-2} year^{-1}

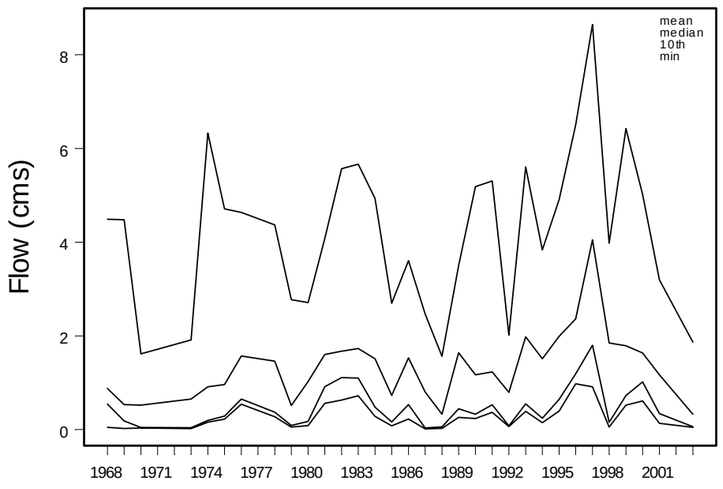


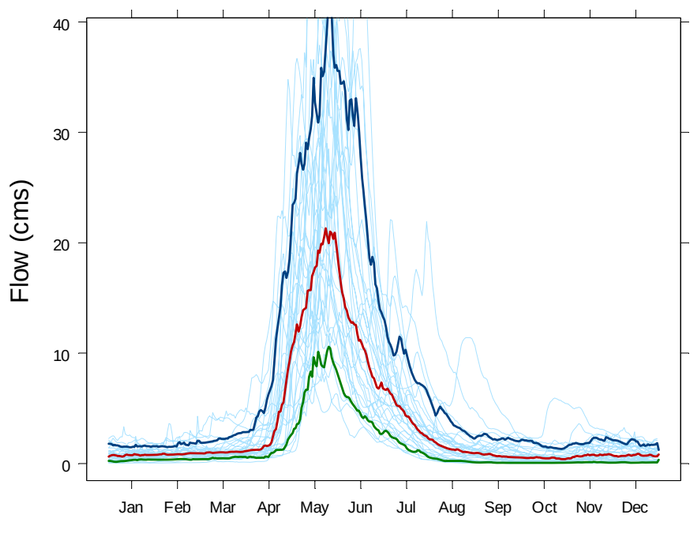
percentiles

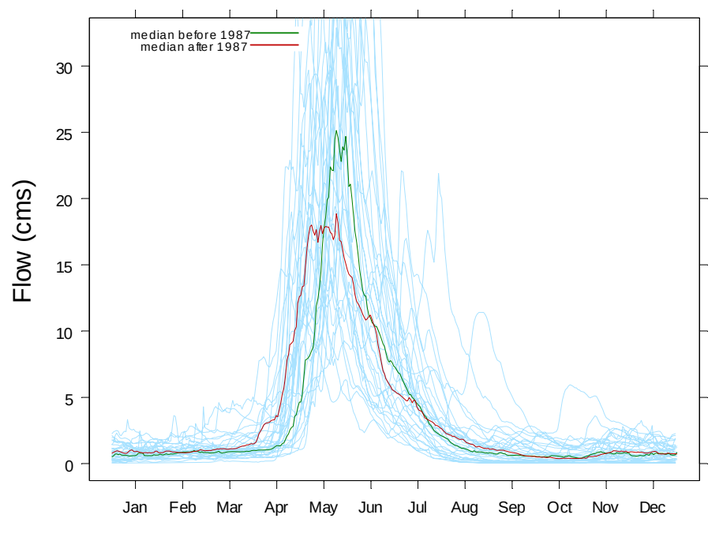
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	0.8	0.8	0.0	3.3	0.2	0.4	0.5	0.6	0.8	0.9	1.1	1.3	1.6	Jan
Feb	1.0	0.9	0.0	3.6	0.4	0.5	0.7	0.8	0.9	0.9	1.1	1.3	1.7	Feb
Mar	1.2	1.0	0.1	4.9	0.4	0.6	0.8	0.9	1.0	1.1	1.3	1.7	2.3	Mar
Apr	3.8	2.0	0.1	34.8	0.7	1.0	1.2	1.5	2.0	2.9	3.9	5.5	8.8	Apr
May	18.2	16.3	1.1	64.7	5.8	8.9	11.0	13.2	16.3	19.0	22.8	27.2	33.4	May
Jun	14.3	11.9	1.9	49.3	4.3	5.6	7.4	9.5	11.9	13.6	16.3	21.6	30.2	Jun
Jul	5.3	4.3	0.3	22.1	1.3	2.2	2.9	3.5	4.3	5.2	6.3	7.8	10.7	Jul
Aug	1.9	1.3	0.0	20.4	0.2	0.4	0.7	1.0	1.3	1.7	2.1	2.7	4.2	Aug
Sep	1.1	0.7	0.0	10.1	0.1	0.2	0.2	0.5	0.7	1.1	1.3	1.7	2.4	Sep
Oct	0.8	0.5	0.0	5.9	0.1	0.1	0.2	0.3	0.5	0.7	1.0	1.3	1.8	Oct
Nov	1.0	0.7	0.0	5.4	0.1	0.2	0.4	0.5	0.7	0.9	1.3	1.6	2.1	Nov
Dec	0.9	0.7	0.0	3.3	0.1	0.3	0.4	0.6	0.7	1.0	1.3	1.6	1.9	Dec
PoR	4.2	1.3	0.0	64.7	0.2	0.5	0.7	1.0	1.3	1.7	2.6	5.4	12.8	PoR

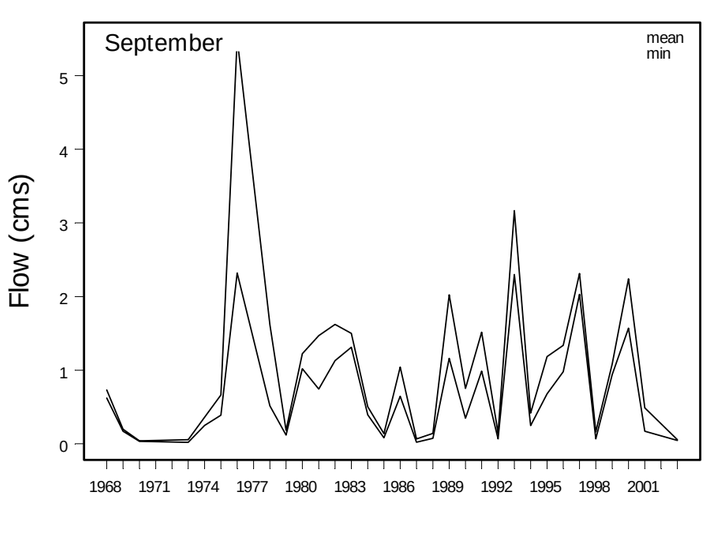




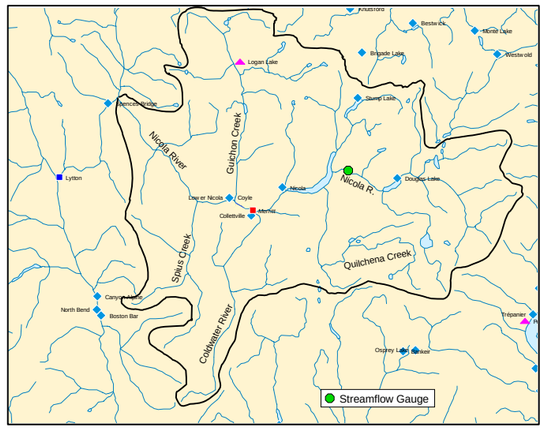


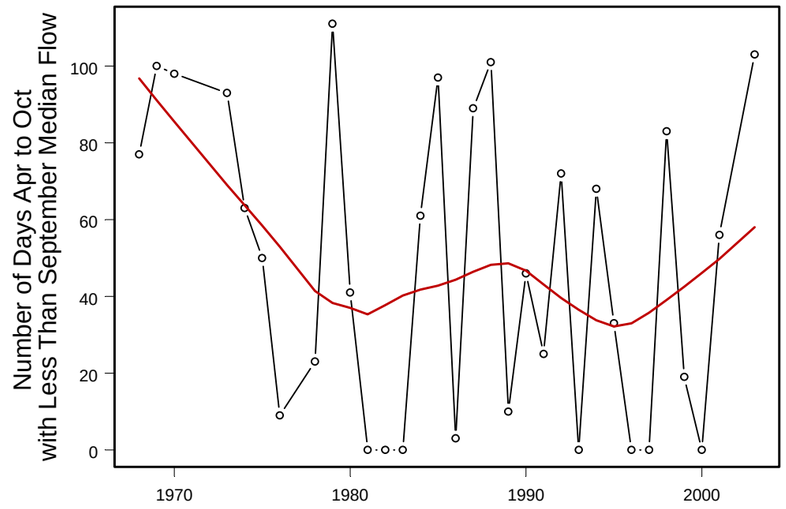


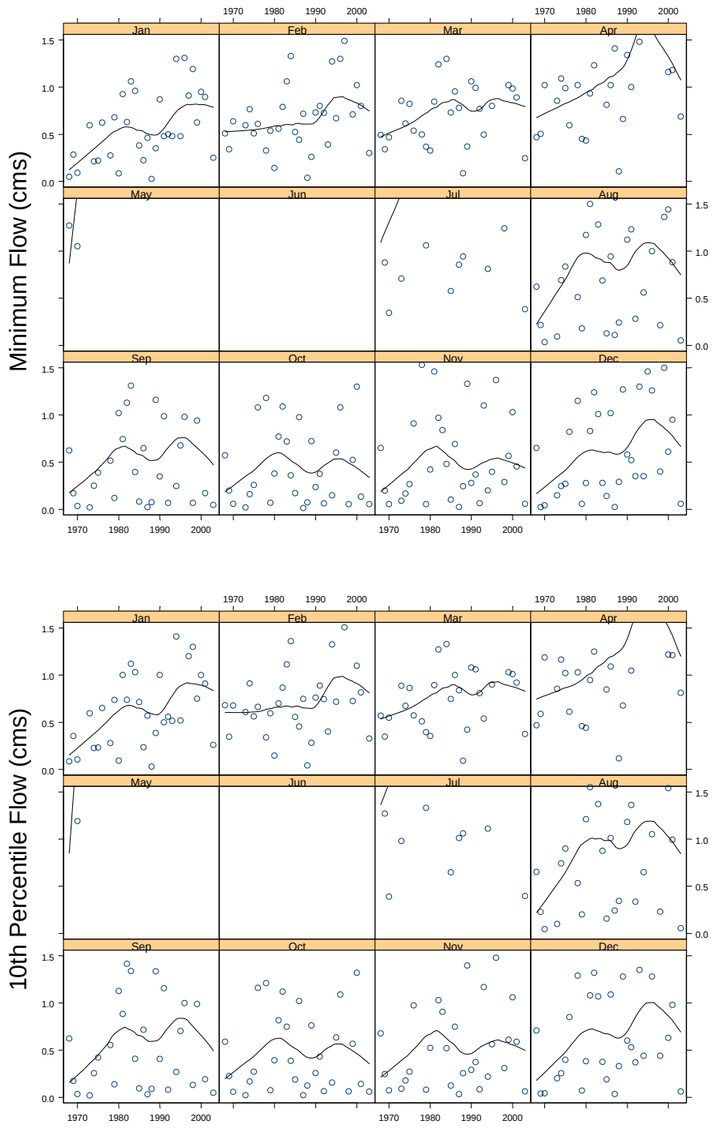


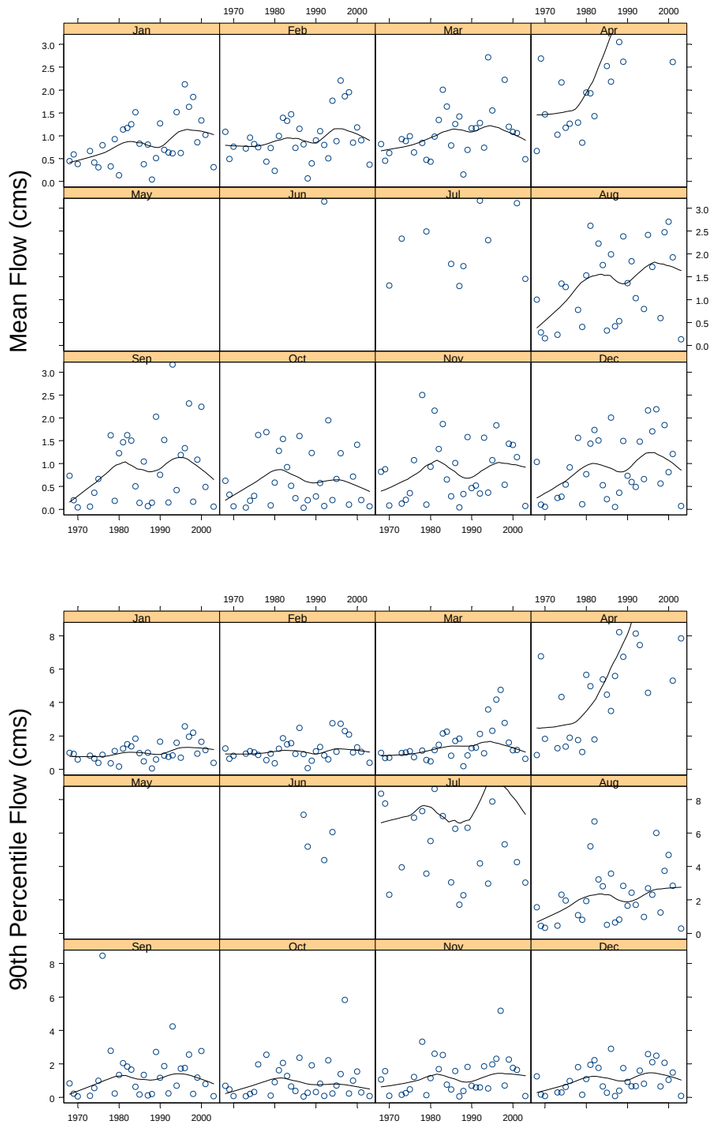


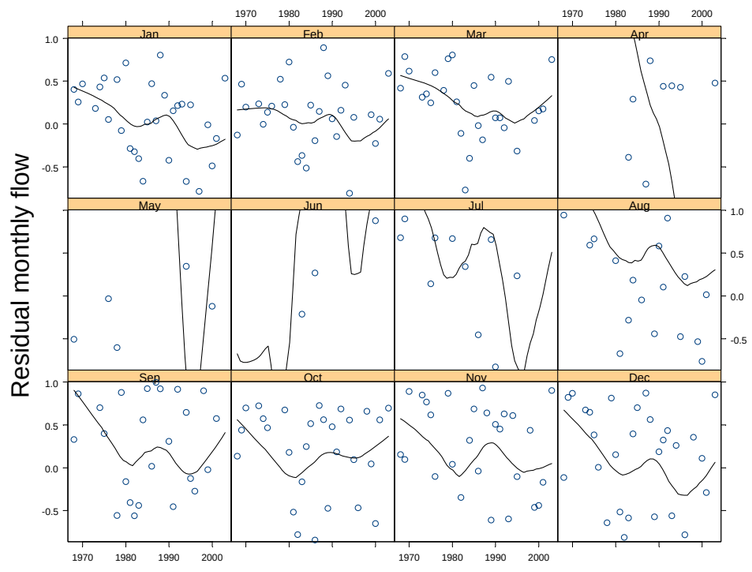
Station Name: Nicola River above Nicola Lake
Station ID: 08LG049
Period of record: 1915-2003
Complete records: 32 years
Drainage area: 1500 km^2
Mean Annual Discharge: 4.2 m^3 sec^{-1}
Runoff: 92.15 L m^{-2} year^{-1}



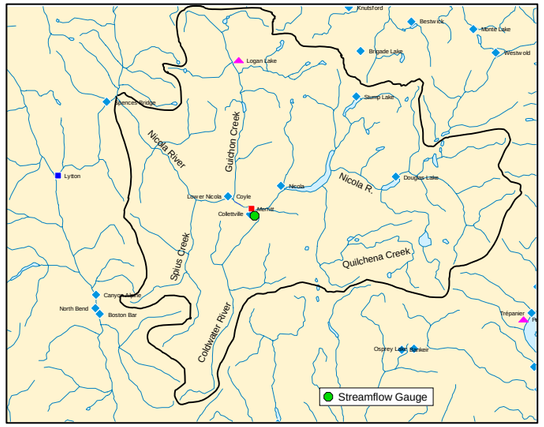






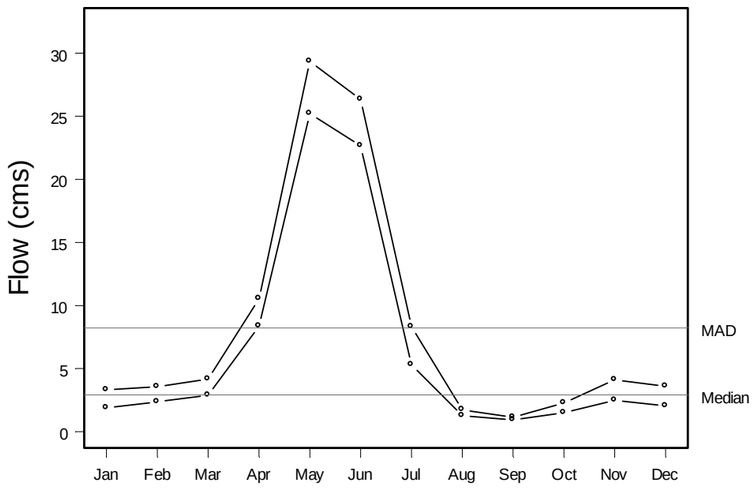


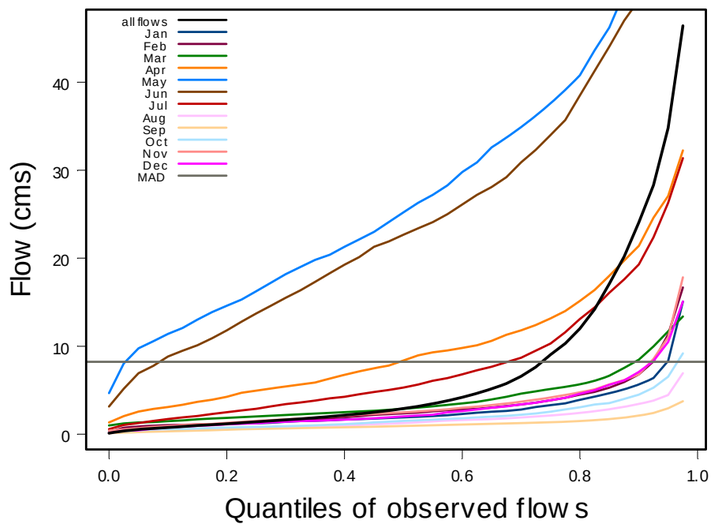
Station Name: Coldwater River at Merritt
Station ID: 08LG010
Period of record: 1913-1995
Complete records: 33 years
Drainage area: 914 km^2
Mean Annual Discharge: 8.2 m^3 sec^{-1}
Runoff: 295.4 L m^{-2} year^{-1}

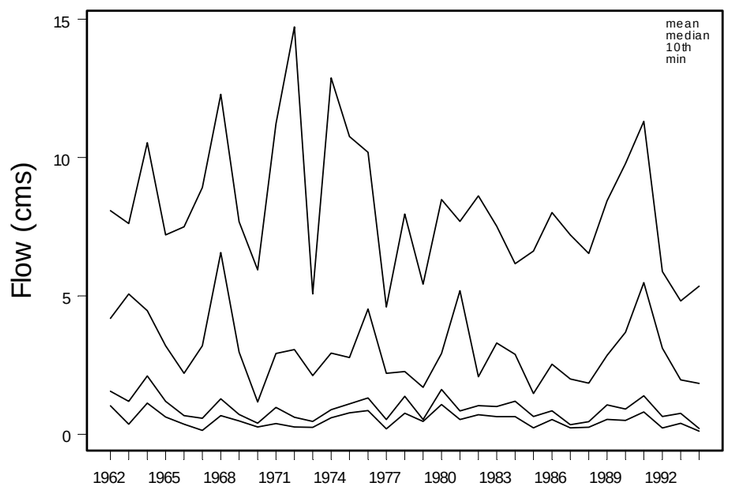


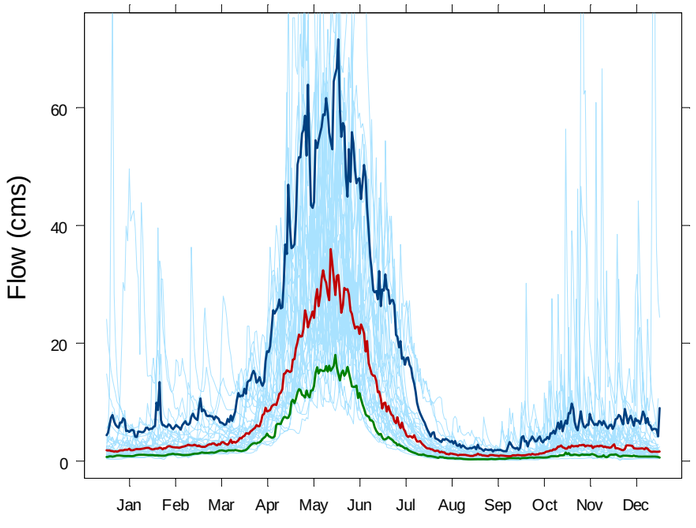
percentiles

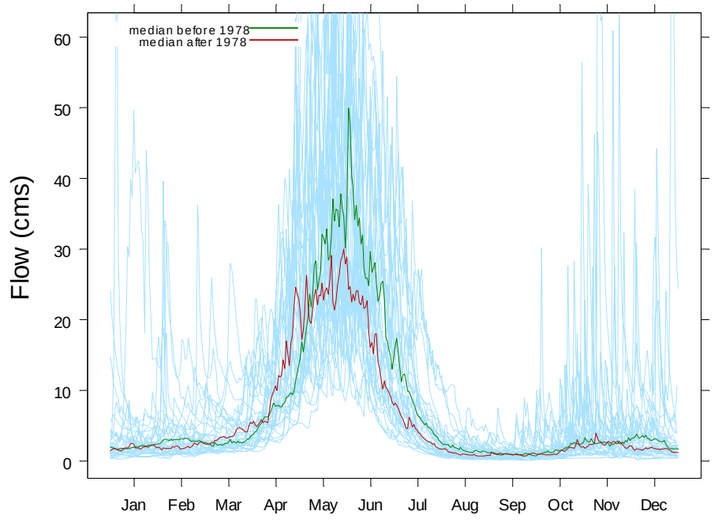
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	3.3	1.9	0.3	81.4	0.8	1.2	1.4	1.7	1.9	2.3	2.8	3.9	5.7	Jan
Feb	3.6	2.4	0.3	39.6	1.0	1.2	1.6	1.9	2.4	2.8	3.4	4.5	6.8	Feb
Mar	4.2	2.9	1.0	28.0	1.5	1.9	2.2	2.5	2.9	3.5	4.6	5.7	8.5	Mar
Apr	10.5	8.4	1.3	62.6	3.1	4.3	5.4	6.7	8.4	9.8	11.8	15.1	21.4	Apr
May	29.3	25.2	4.7	115.0	11.4	14.6	18.2	21.3	25.2	29.8	34.9	40.8	53.2	May
Jun	26.3	22.7	3.2	102.0	8.8	11.8	15.5	19.3	22.7	26.1	30.9	38.5	49.3	Jun
Jul	8.3	5.3	0.6	54.4	1.7	2.5	3.4	4.3	5.3	6.8	8.7	13.1	19.3	Jul
Aug	1.7	1.3	0.2	12.1	0.4	0.6	0.8	1.0	1.3	1.6	1.9	2.4	3.5	Aug
Sep	1.1	0.9	0.1	9.0	0.3	0.5	0.7	0.8	0.9	1.1	1.3	1.5	2.1	Sep
Oct	2.3	1.5	0.1	56.4	0.6	0.8	0.9	1.2	1.5	1.8	2.2	3.1	4.5	Oct
Nov	4.1	2.5	0.4	107.0	0.9	1.3	1.7	2.1	2.5	3.0	3.7	4.8	6.8	Nov
Dec	3.6	2.0	0.1	122.0	0.8	1.1	1.4	1.7	2.0	2.6	3.4	4.6	7.1	Dec
PoR	8.2	2.9	0.1	122.0	0.8	1.2	1.6	2.2	2.9	4.2	6.6	12.0	24.1	PoR

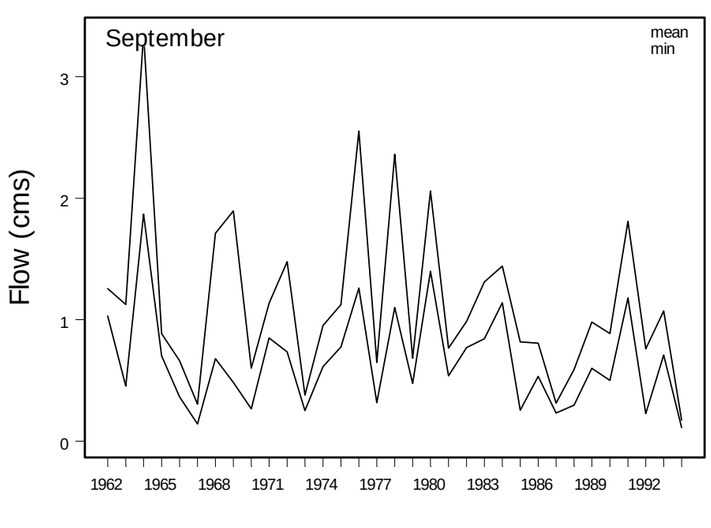




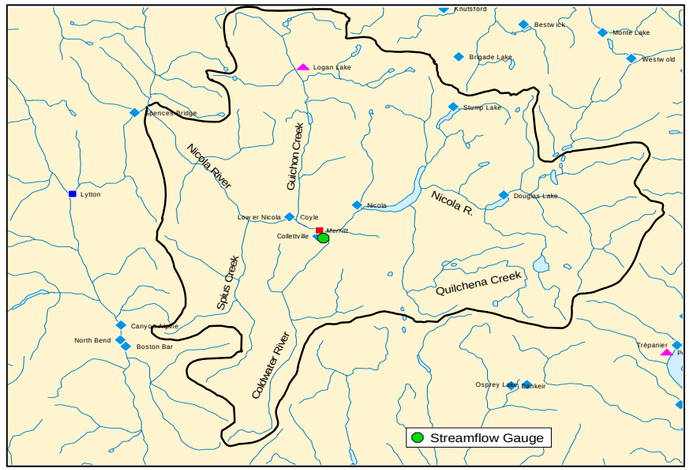


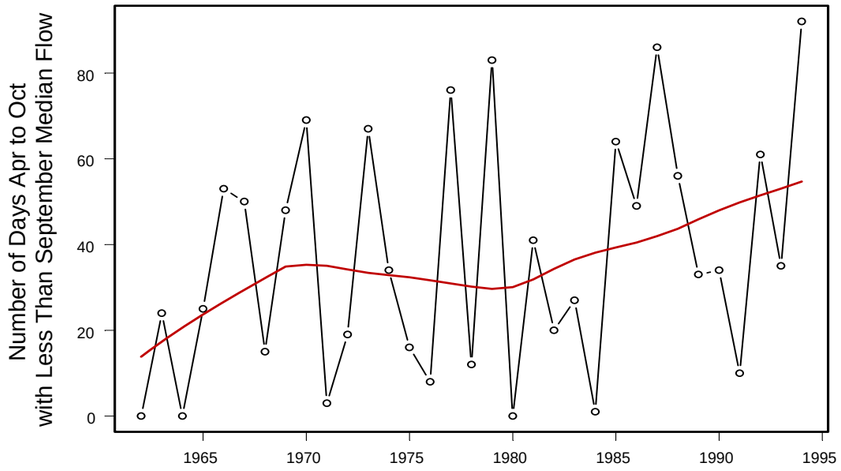


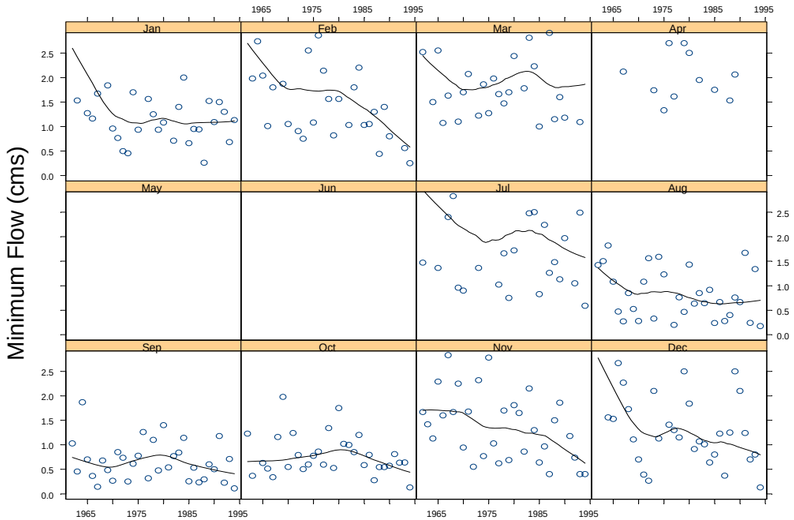


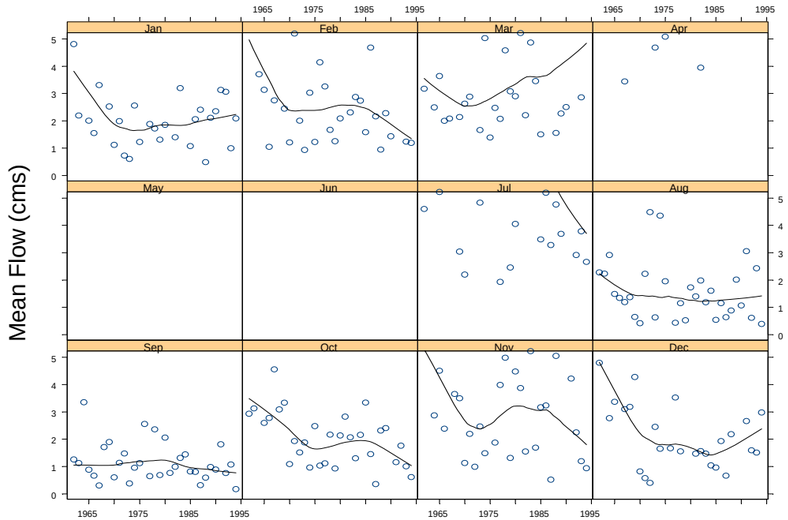


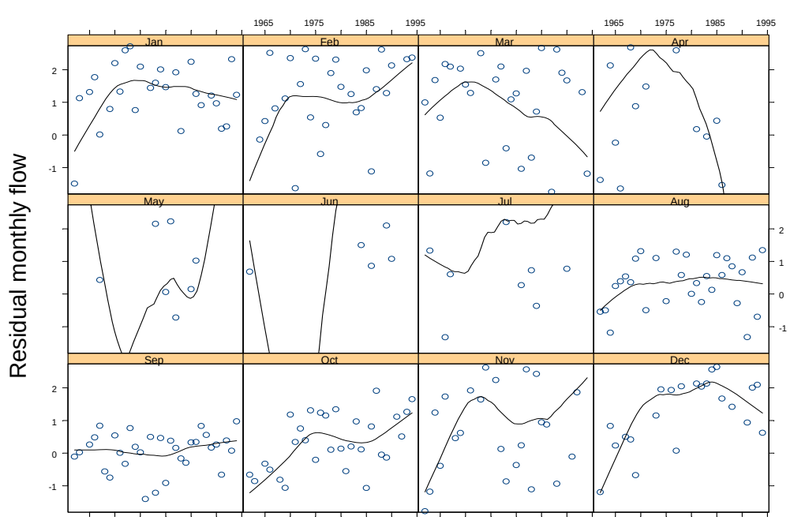
Station Name: Coldwater River at Merritt
Station ID: 08LG010
Period of record: 1913-1995
Complete records: 33 years
Drainage area: 914 km^2
Mean Annual Discharge: 8.2 m^3 sec^{-1}
Runoff: 295.4 L m^{-2} year^{-1}

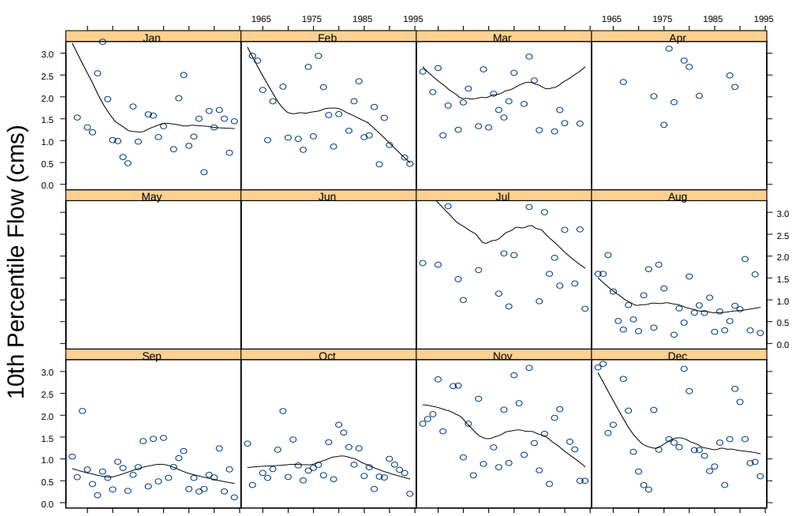


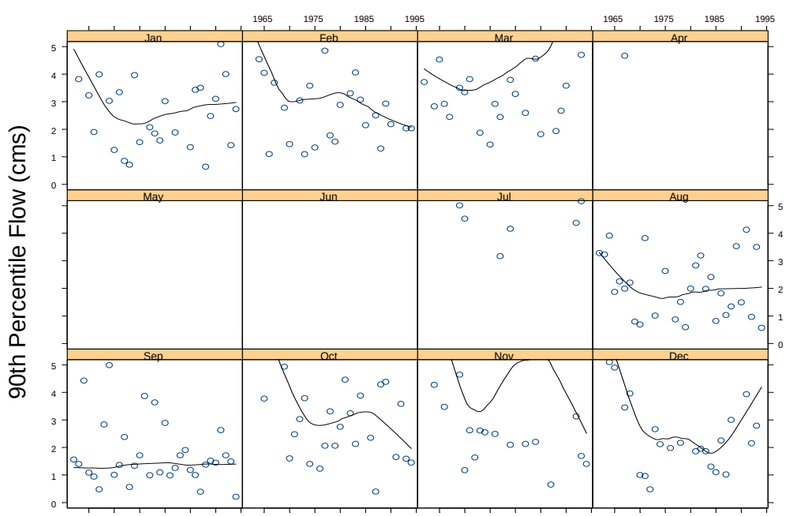




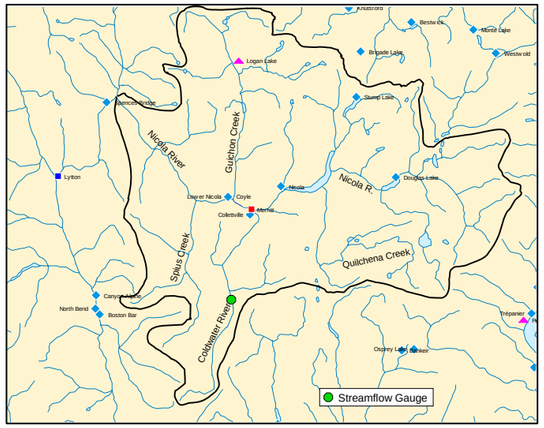






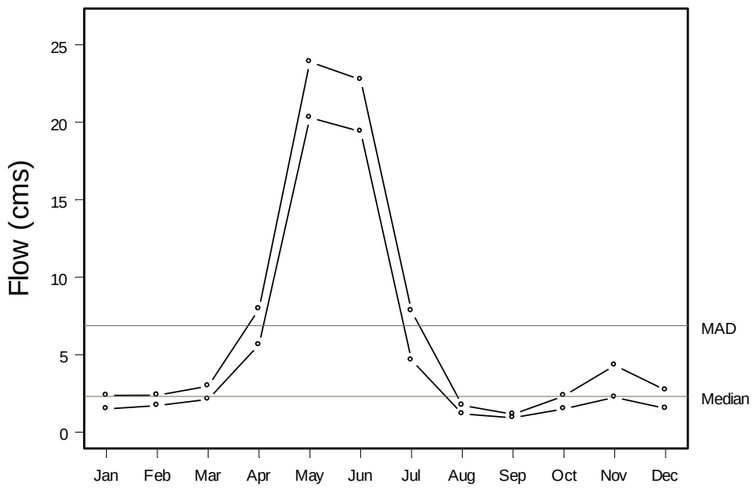


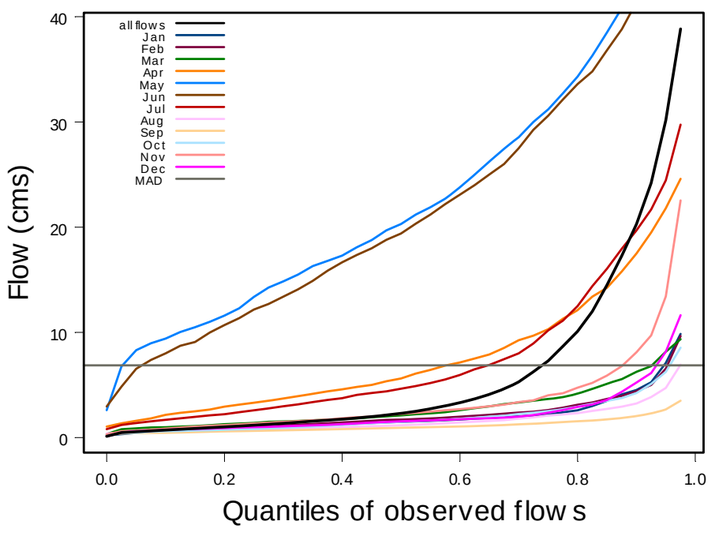
Station Name: Coldwater River at Brookmere
Station ID: 08LG048
Period of record: 1965-2003
Complete records: 36 years
Drainage area: 316 km^2
Mean Annual Discharge: 6.9 m^3 sec^{-1}
Runoff: 715.3 L m^{-2} year^{-1}

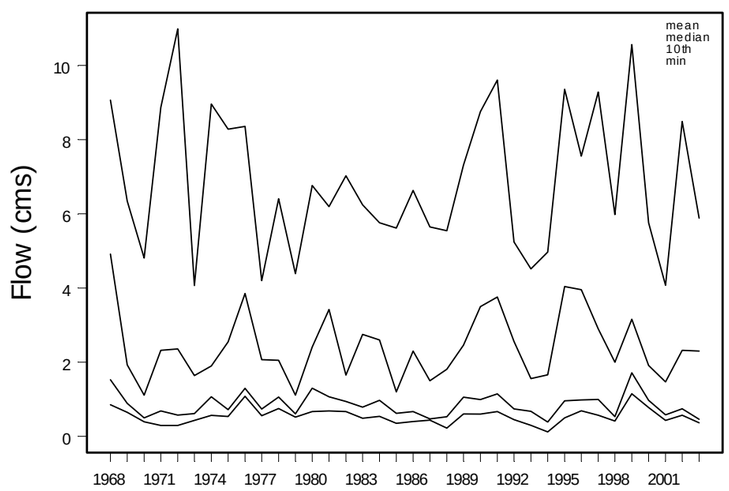


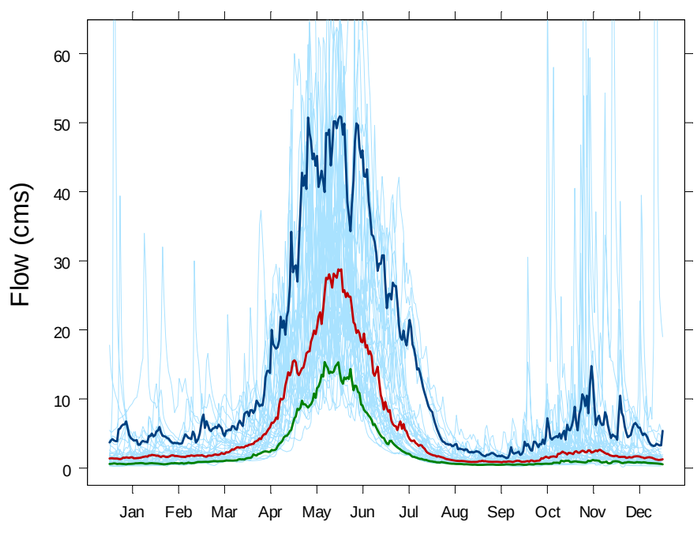
percentiles

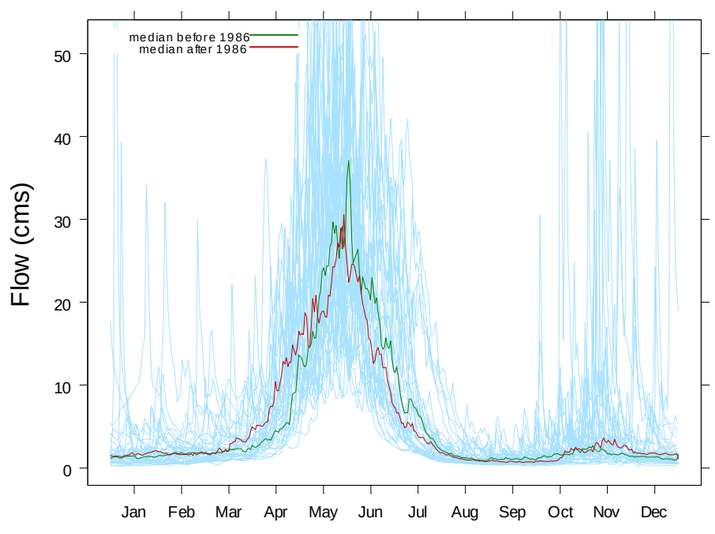
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	2.4	1.5	0.2	96.2	0.6	0.8	1.0	1.3	1.5	1.7	2.0	2.6	4.5	Jan
Feb	2.4	1.7	0.2	32.0	0.7	0.9	1.2	1.5	1.7	2.0	2.4	3.1	4.4	Feb
Mar	3.0	2.1	0.4	22.2	1.0	1.3	1.6	1.8	2.1	2.6	3.4	4.2	6.3	Mar
Apr	7.9	5.6	1.1	46.5	2.2	2.9	3.7	4.6	5.6	7.1	9.3	12.1	17.5	Apr
May	23.9	20.3	2.6	91.2	9.4	11.6	14.9	17.3	20.3	23.8	28.6	34.3	43.8	May
Jun	22.7	19.4	3.0	84.7	8.0	10.7	13.4	16.7	19.4	23.1	27.5	33.6	41.4	Jun
Jul	7.8	4.7	0.8	42.1	1.7	2.2	3.0	3.8	4.7	6.0	8.0	12.5	19.7	Jul
Aug	1.7	1.2	0.4	12.0	0.6	0.7	0.9	1.0	1.2	1.4	1.8	2.3	3.2	Aug
Sep	1.2	0.9	0.2	7.2	0.5	0.6	0.7	0.8	0.9	1.1	1.3	1.6	2.1	Sep
Oct	2.3	1.5	0.3	69.0	0.6	0.7	0.9	1.2	1.5	1.8	2.3	3.0	4.2	Oct
Nov	4.3	2.3	0.3	104.0	0.9	1.2	1.5	1.9	2.3	2.7	3.4	4.7	8.1	Nov
Dec	2.7	1.5	0.1	92.6	0.7	0.9	1.1	1.3	1.5	1.8	2.0	2.9	5.2	Dec
PoR	6.9	2.3	0.1	104.0	0.7	1.0	1.4	1.8	2.3	3.3	5.3	10.1	20.3	PoR

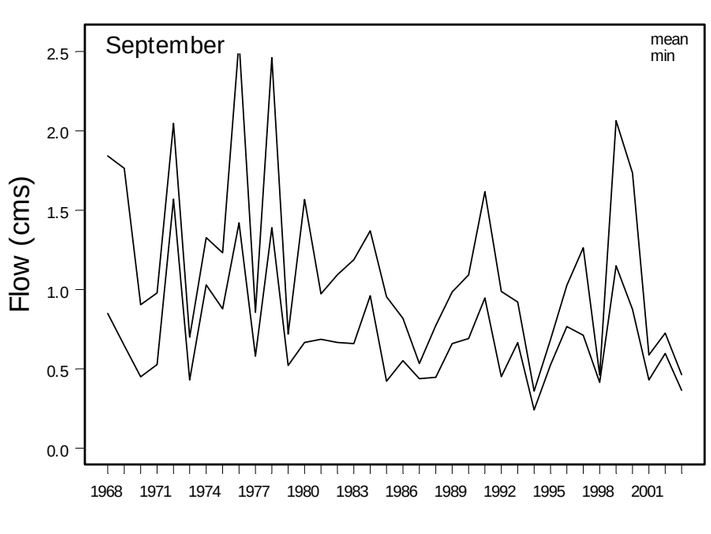




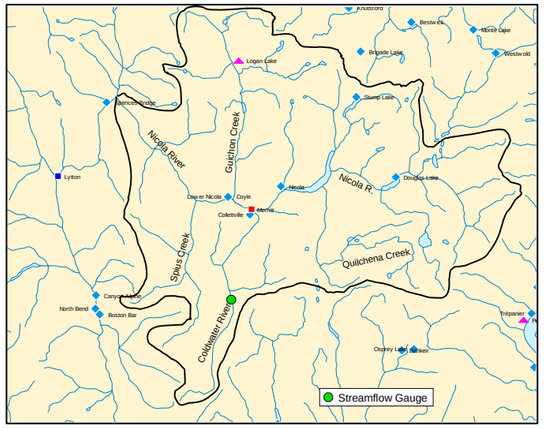


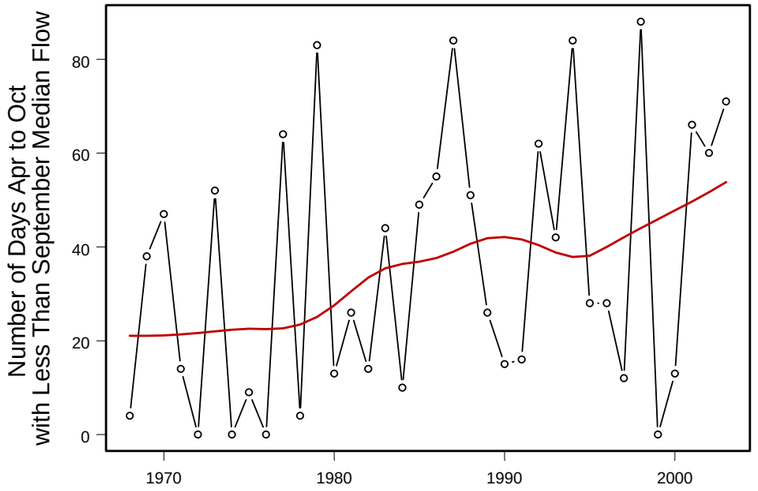


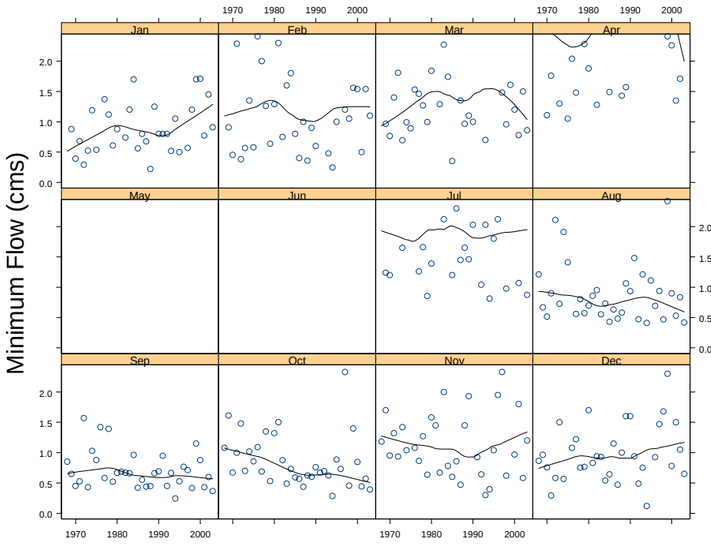


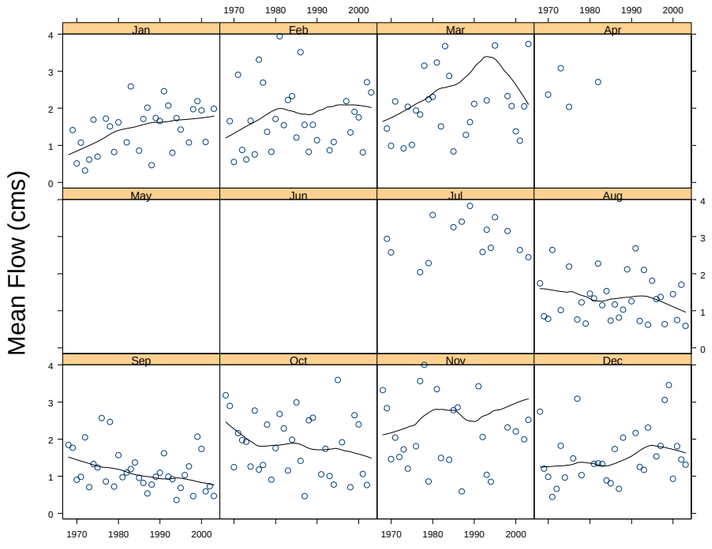


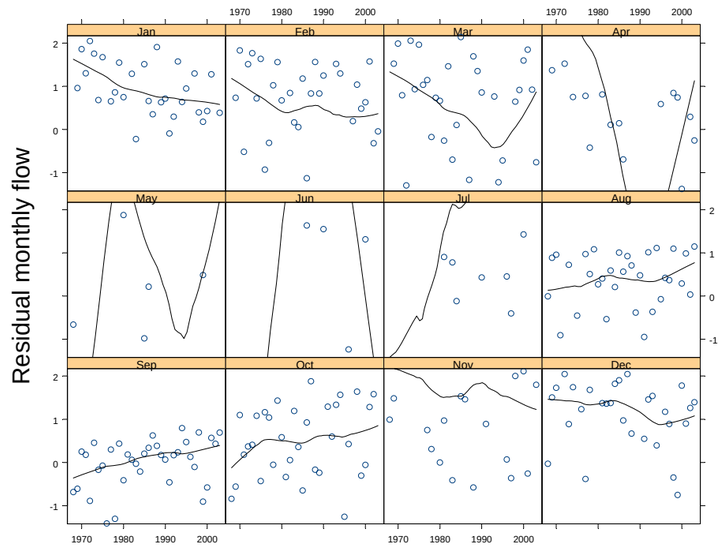
Station Name: Coldwater River at Brookmere
Station ID: 08LG048
Period of record: 1965-2003
Complete records: 36 years
Drainage area: 316 km^2
Mean Annual Discharge: 6.9 m^3 sec^{-1}
Runoff: 715.3 L m^{-2} year^{-1}

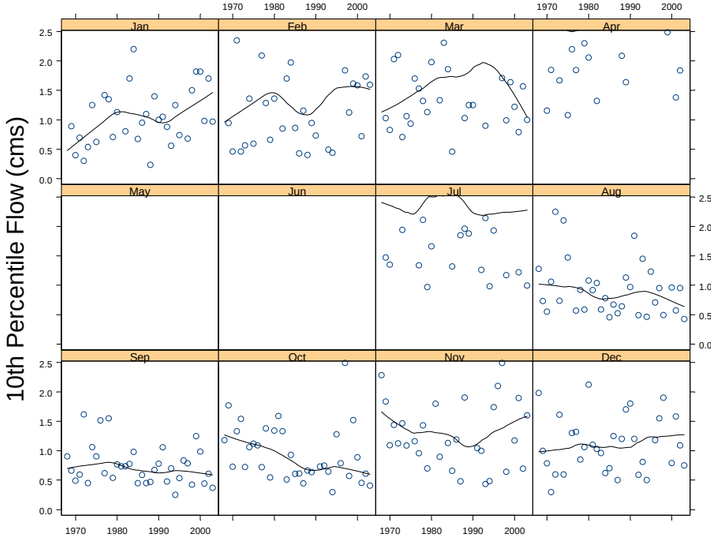


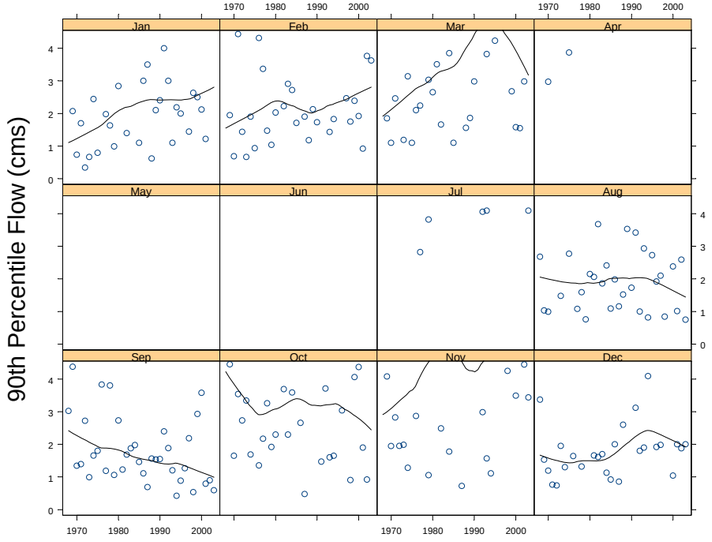




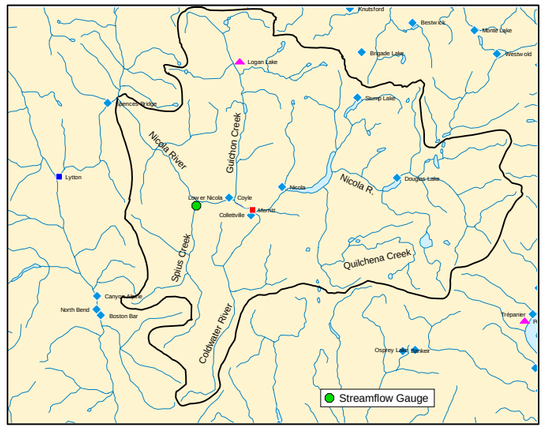






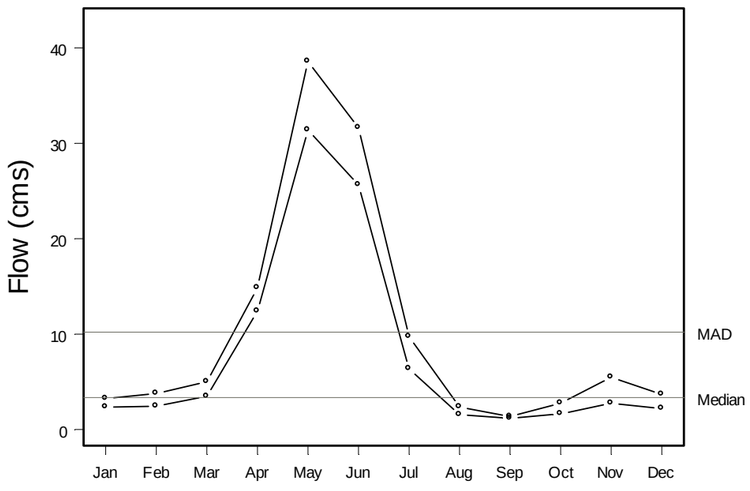


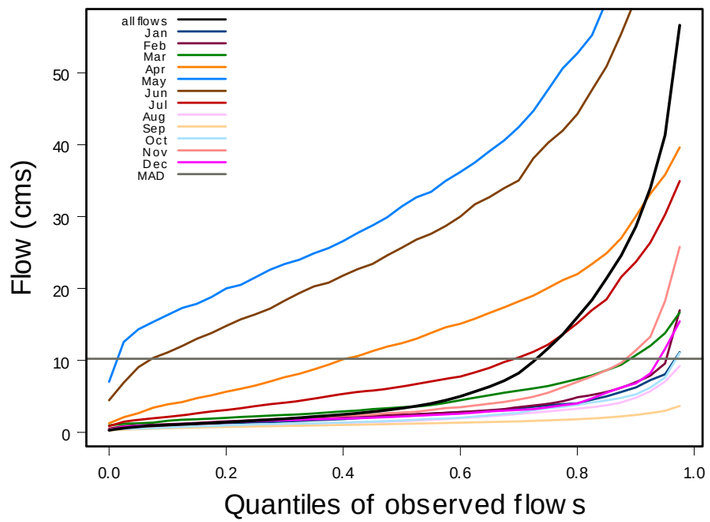
Station Name: Spius Creek near Canford
Station ID: 08LG008
Period of record: 1911-2003
Complete records: 33 years
Drainage area: 780 km^2
Mean Annual Discharge: 10.2 m^3 sec^{-1}
Runoff: 430.9 L m^{-2} year^{-1}

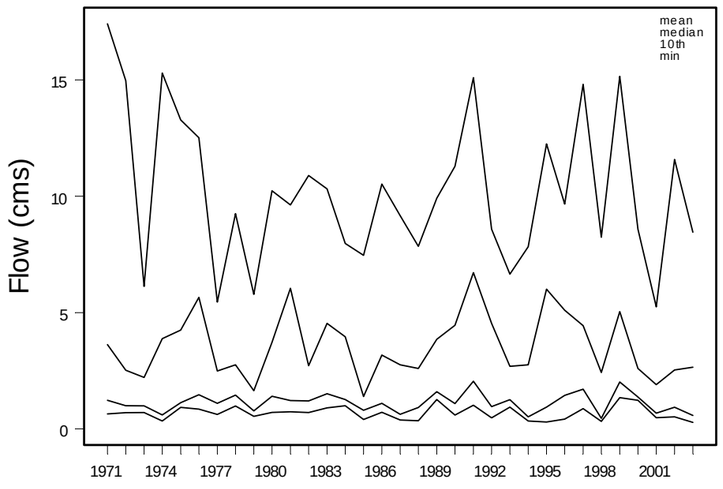


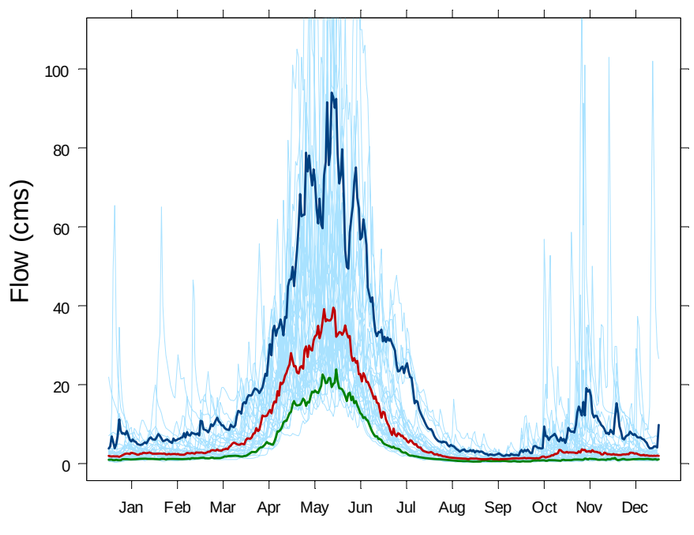
percentiles

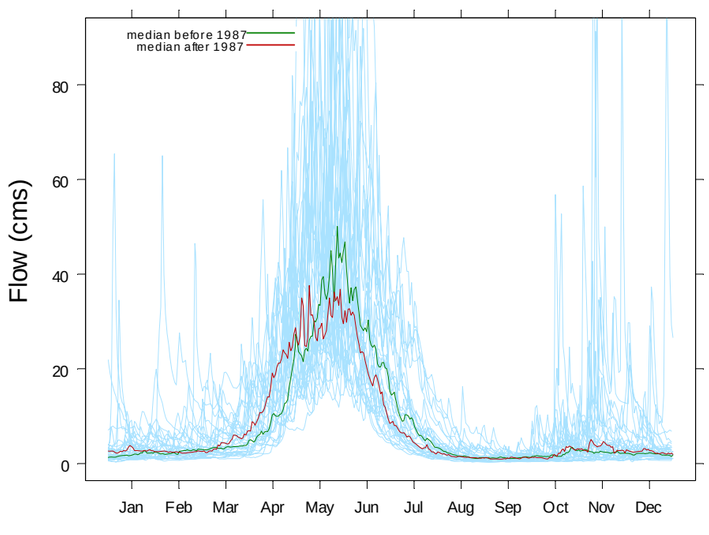
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	3.2	2.4	0.3	65.4	1.0	1.3	1.5	1.8	2.4	2.8	3.3	4.0	6.2	Jan
Feb	3.8	2.5	0.5	65.0	1.1	1.5	1.9	2.2	2.5	2.8	3.5	4.9	7.0	Feb
Mar	5.0	3.5	0.9	25.2	1.6	2.0	2.4	2.9	3.5	4.5	5.8	7.4	10.7	Mar
Apr	14.9	12.4	1.3	81.9	3.9	5.6	7.7	10.2	12.4	15.1	18.2	22.0	30.0	Apr
May	38.6	31.4	7.0	181.0	16.3	20.0	23.4	26.6	31.4	36.2	42.4	52.7	72.3	May
Jun	31.6	25.7	4.5	149.0	11.1	14.8	18.3	21.8	25.7	30.0	35.0	44.3	60.4	Jun
Jul	9.7	6.4	0.9	54.4	2.1	3.1	4.1	5.3	6.4	7.7	10.4	15.2	23.7	Jul
Aug	2.4	1.6	0.3	16.3	0.7	1.0	1.2	1.3	1.6	1.9	2.5	3.3	4.8	Aug
Sep	1.4	1.2	0.3	8.1	0.6	0.8	0.9	1.0	1.2	1.3	1.5	1.8	2.4	Sep
Oct	2.8	1.7	0.3	56.8	0.7	1.0	1.2	1.4	1.7	2.0	2.7	3.8	5.3	Oct
Nov	5.5	2.8	0.4	115.0	1.0	1.4	1.9	2.3	2.8	3.5	4.6	7.0	11.4	Nov
Dec	3.7	2.2	0.3	102.0	1.0	1.4	1.7	1.9	2.2	2.6	3.1	4.0	6.8	Dec
PoR	10.2	3.4	0.3	181.0	1.0	1.4	1.9	2.5	3.4	5.0	8.2	16.0	28.6	PoR

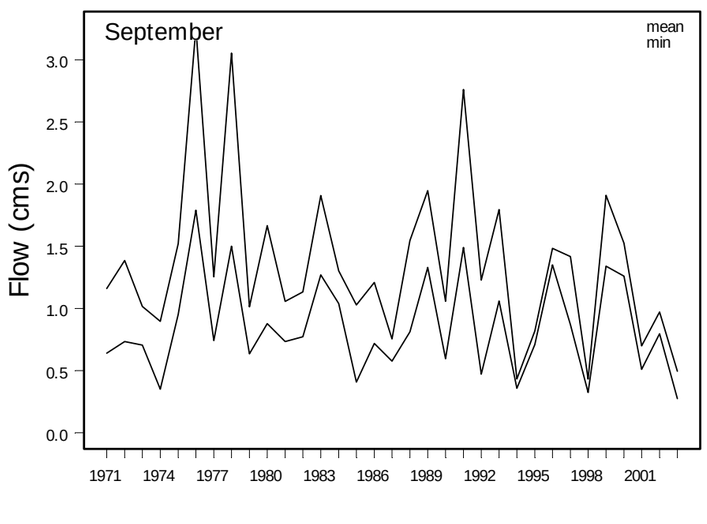




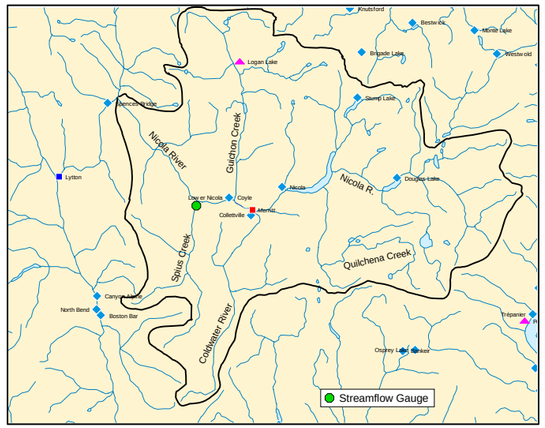


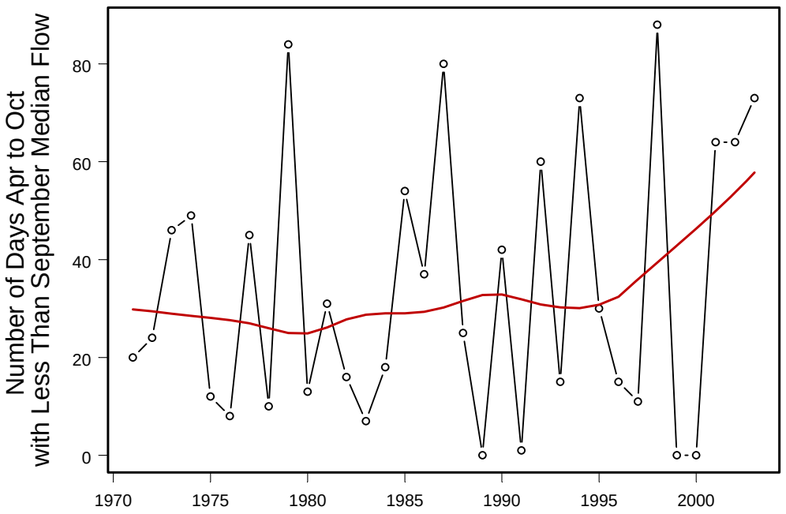


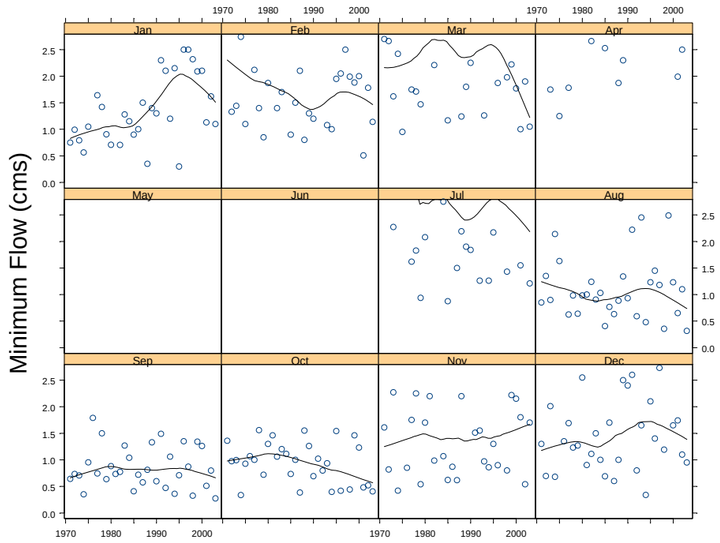


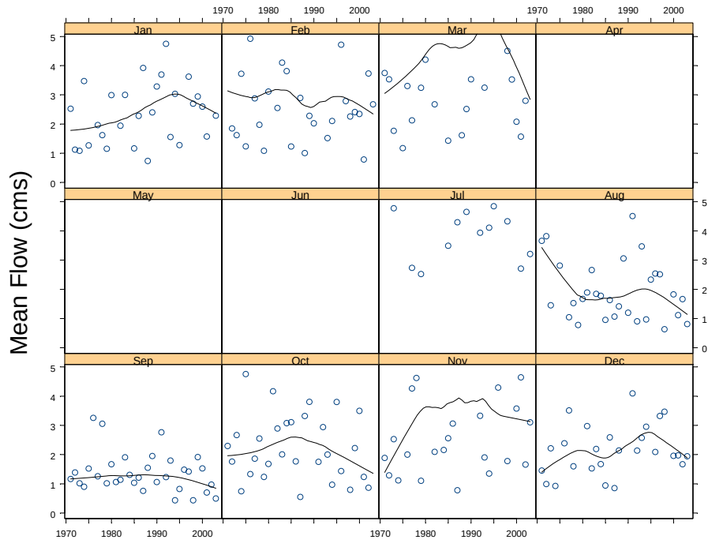


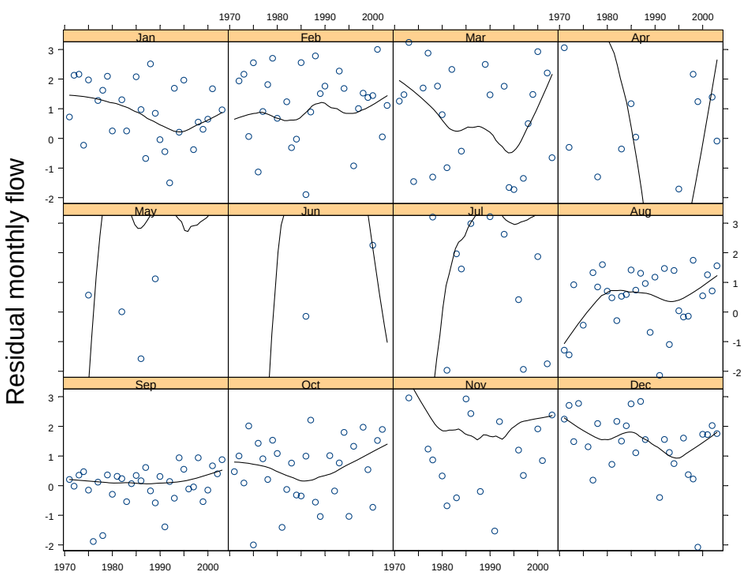
Station Name: Spius Creek near Canford
Station ID: 08LG008
Period of record: 1911-2003
Complete records: 33 years
Drainage area: 780 km^2
Mean Annual Discharge: 10.2 m^3 sec^{-1}
Runoff: 430.9 L m^{-2} year^{-1}

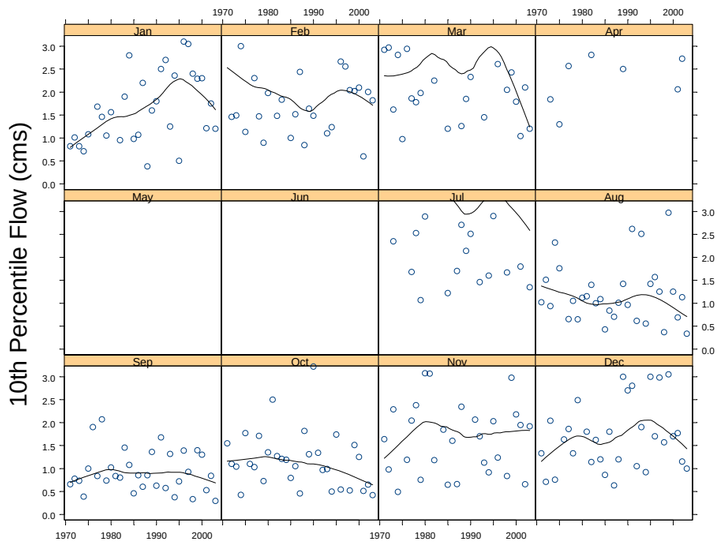


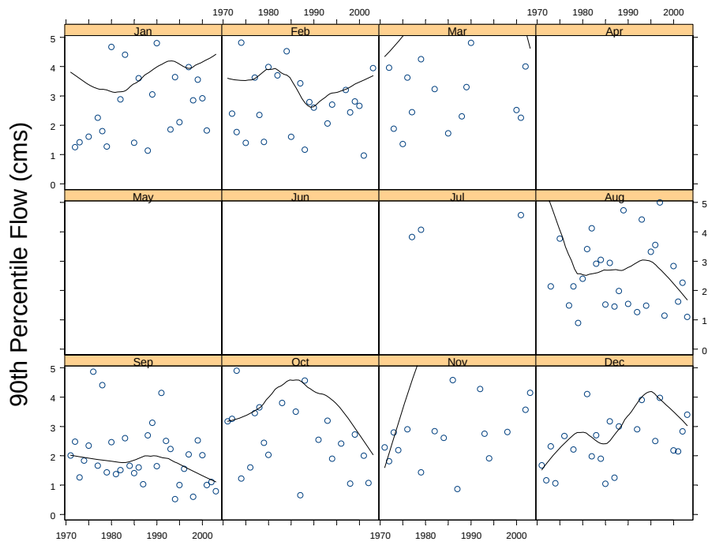




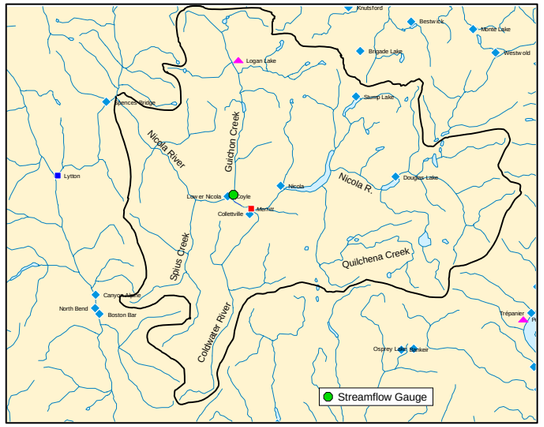




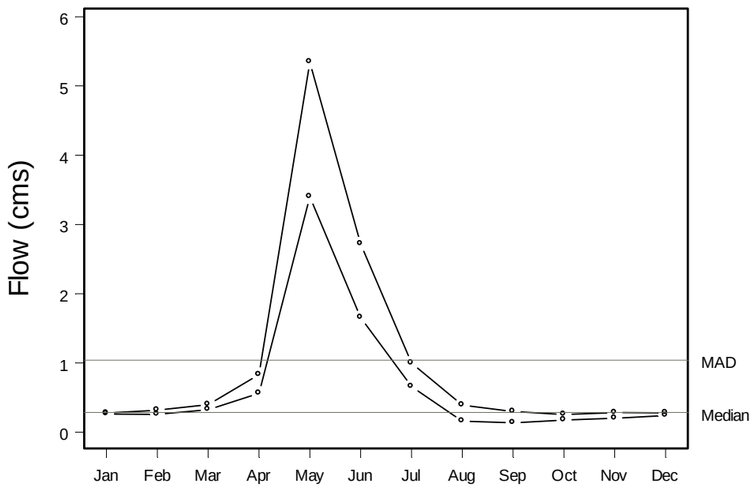


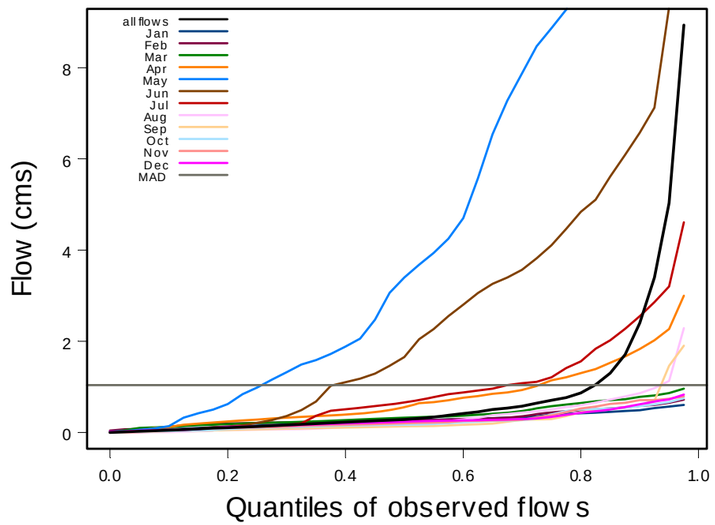


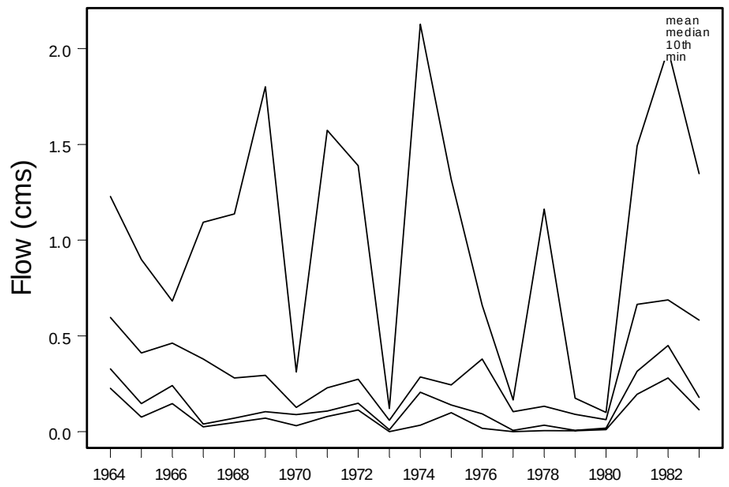
Station Name: Guichon Creek near Lower Nicola
Station ID: 08LG004
Period of record: 1911-1984
Complete records: 20 years
Drainage area: 1230 km^2
Mean Annual Discharge: 1.04 m^3 sec^{-1}
Runoff: 27.76 L m^{-2} year^{-1}

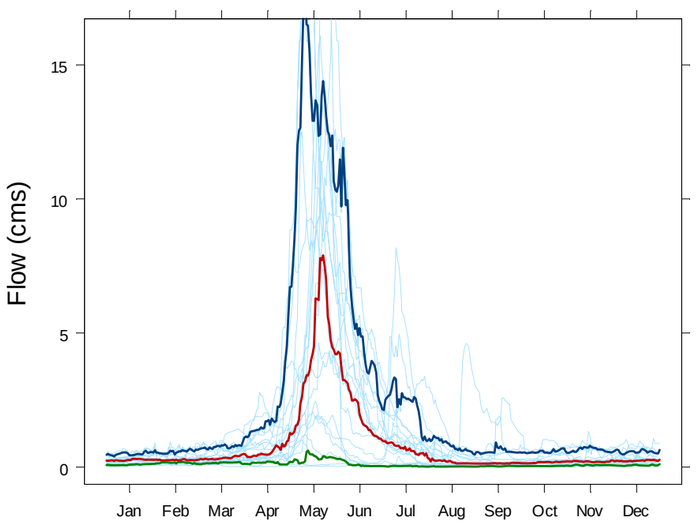


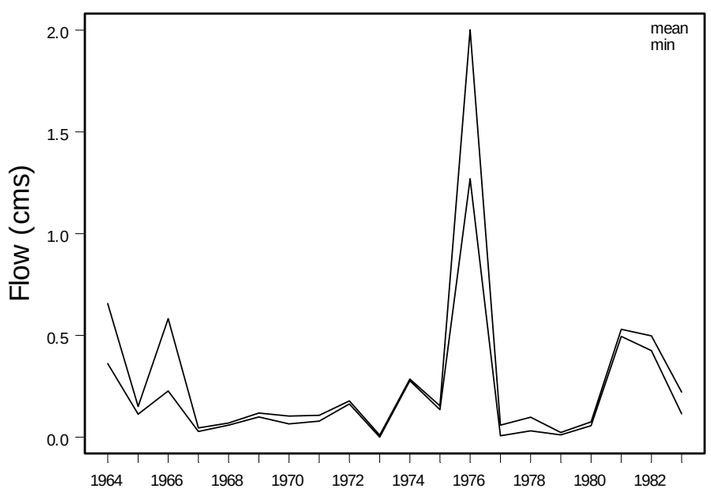
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
					percentiles									
Jan	0.28	0.26	0.02	0.72	0.07	0.13	0.18	0.23	0.26	0.30	0.34	0.43	0.49	Jan
Feb	0.32	0.26	0.04	0.93	0.12	0.20	0.22	0.24	0.26	0.30	0.35	0.49	0.59	Feb
Mar	0.40	0.33	0.01	1.42	0.12	0.18	0.23	0.27	0.33	0.37	0.47	0.65	0.78	Mar
Apr	0.83	0.56	0.01	6.19	0.12	0.24	0.33	0.40	0.56	0.76	0.93	1.30	1.83	Apr
May	5.35	3.40	0.02	26.80	0.14	0.62	1.32	1.88	3.40	4.70	7.87	9.58	13.10	May
Jun	2.72	1.66	0.01	17.00	0.05	0.13	0.36	1.11	1.66	2.80	3.57	4.84	6.58	Jun
Jul	1.00	0.66	0.00	8.18	0.03	0.08	0.16	0.51	0.66	0.88	1.08	1.56	2.55	Jul
Aug	0.39	0.16	0.00	4.59	0.01	0.06	0.07	0.12	0.16	0.29	0.44	0.60	0.86	Aug
Sep	0.30	0.14	0.00	2.97	0.03	0.06	0.09	0.11	0.14	0.17	0.28	0.45	0.60	Sep
Oct	0.26	0.18	0.00	1.20	0.03	0.07	0.11	0.15	0.18	0.23	0.28	0.51	0.58	Oct
Nov	0.28	0.20	0.00	1.33	0.06	0.10	0.13	0.17	0.20	0.25	0.28	0.53	0.71	Nov
Dec	0.28	0.24	0.02	1.07	0.05	0.13	0.16	0.20	0.24	0.27	0.30	0.43	0.62	Dec
PoR	1.04	0.29	0.00	26.80	0.05	0.11	0.17	0.23	0.29	0.42	0.58	0.87	2.40	PoR



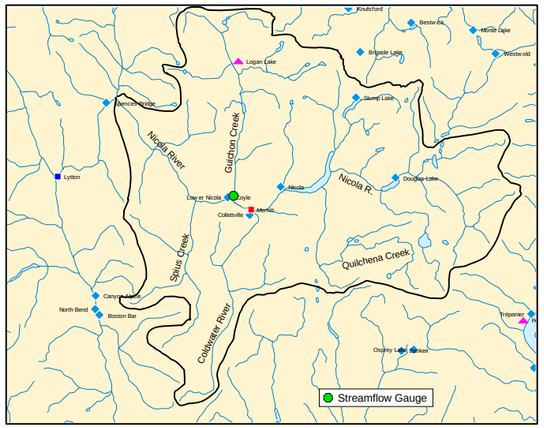


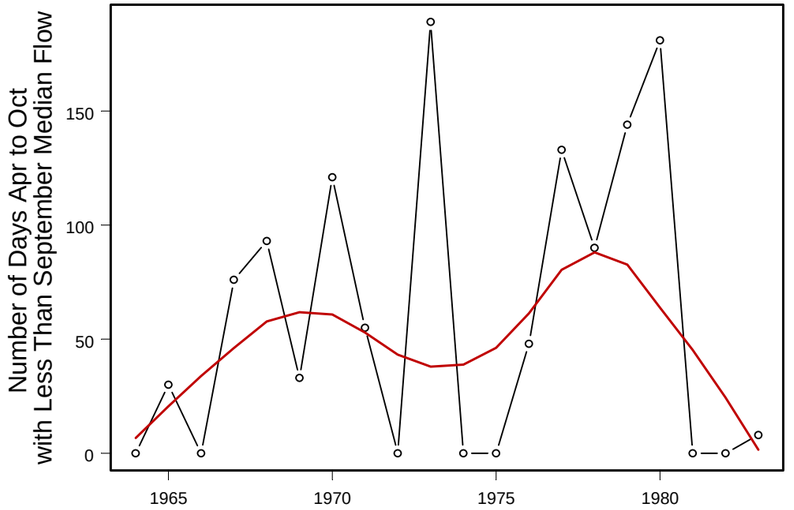


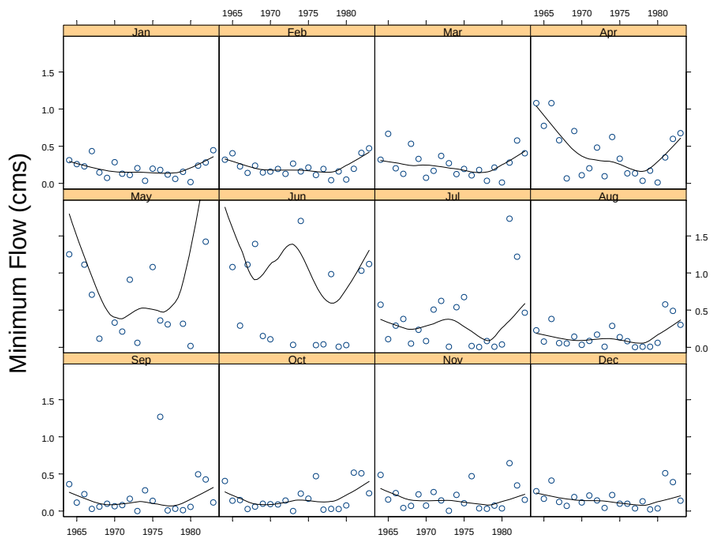


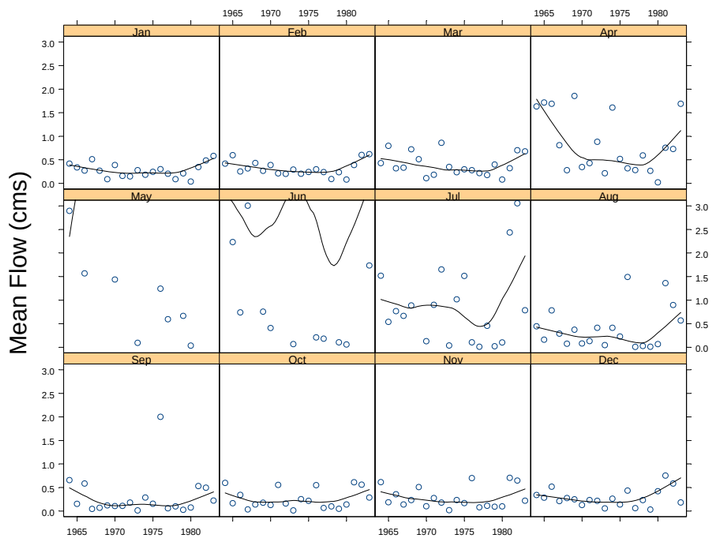


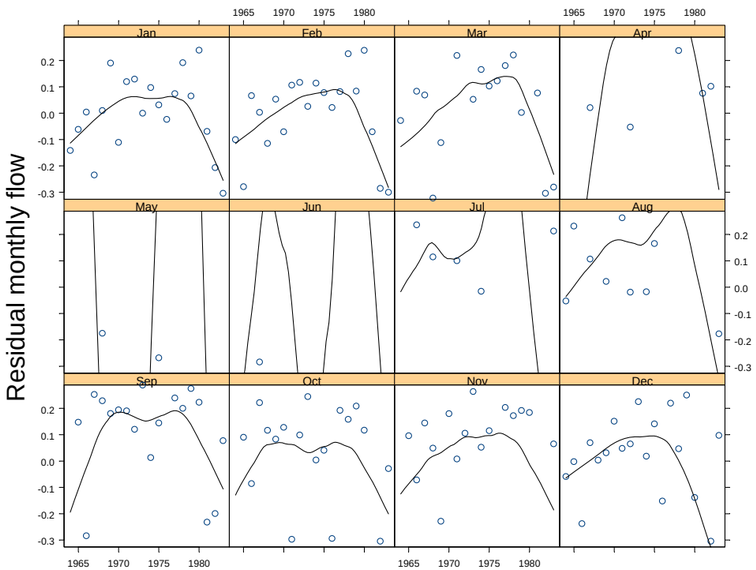
Station Name: Guichon Creek near Lower Nicola
Station ID: 08LG004
Period of record: 1911-1984
Complete records: 20 years
Drainage area: 1230 km^2
Mean Annual Discharge: 1.04 m^3 sec^{-1}
Runoff: 27.76 L m^{-2} year^{-1}

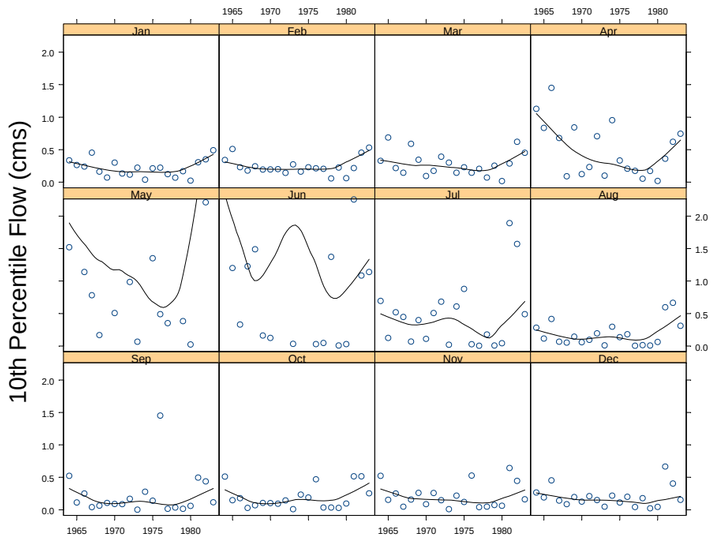


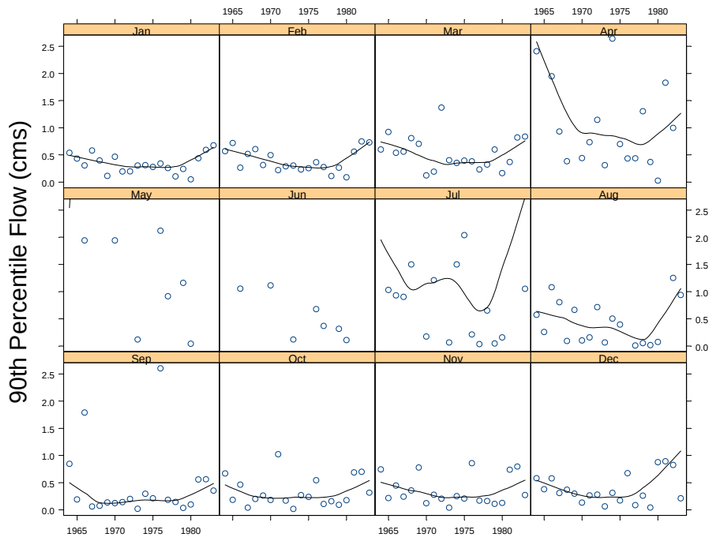




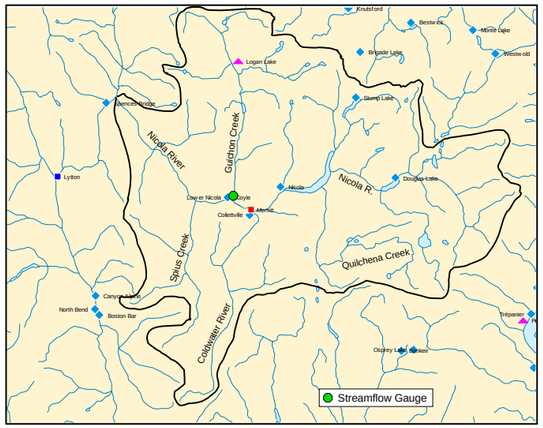




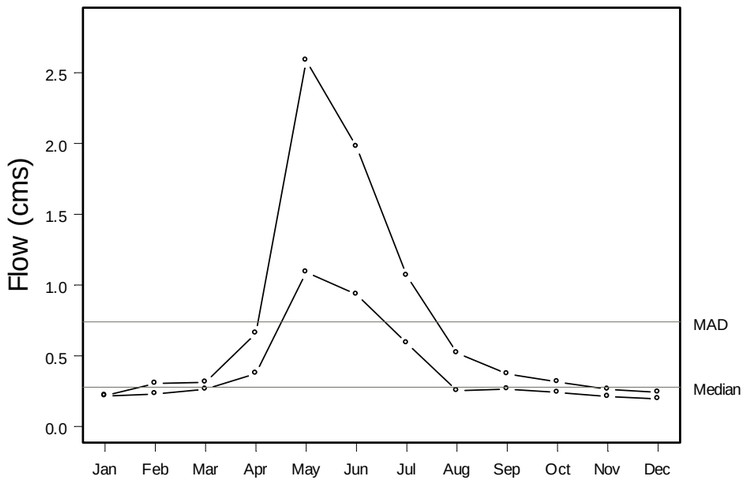


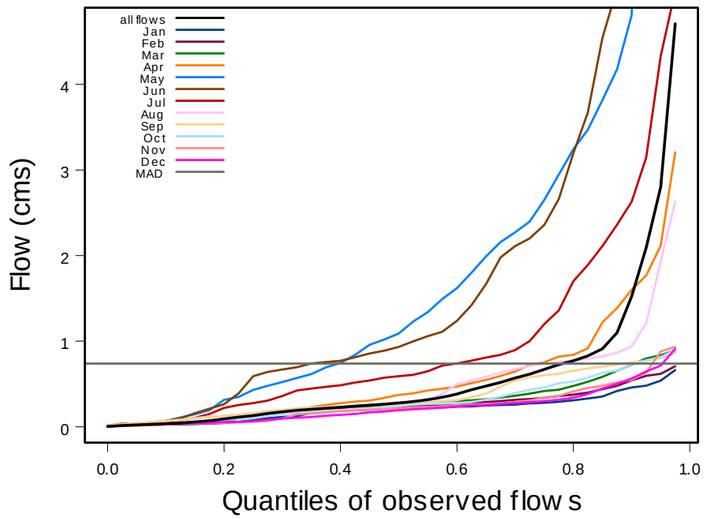


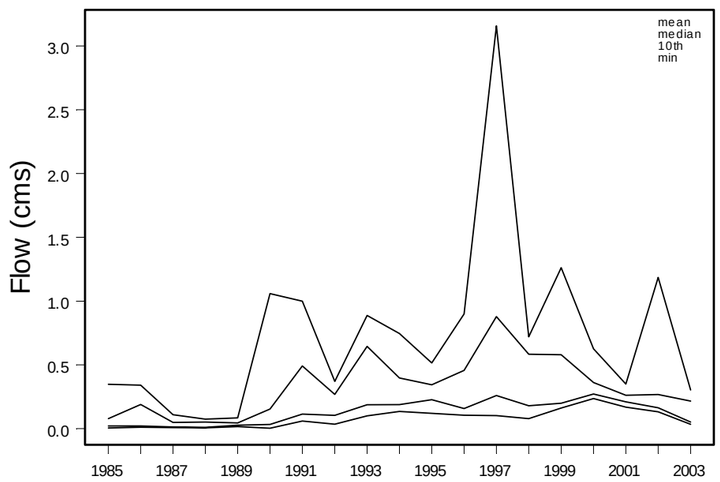
Station Name: Guichon Creek at Mouth
Station ID: 08LG067
Period of record: 1984-2003
Complete records: 19 years
Drainage area: *1230 km²*
Mean Annual Discharge: 0.74 m^3 sec^{-1}
Runoff: 19.74 L m^{-2} $year^{-1}$

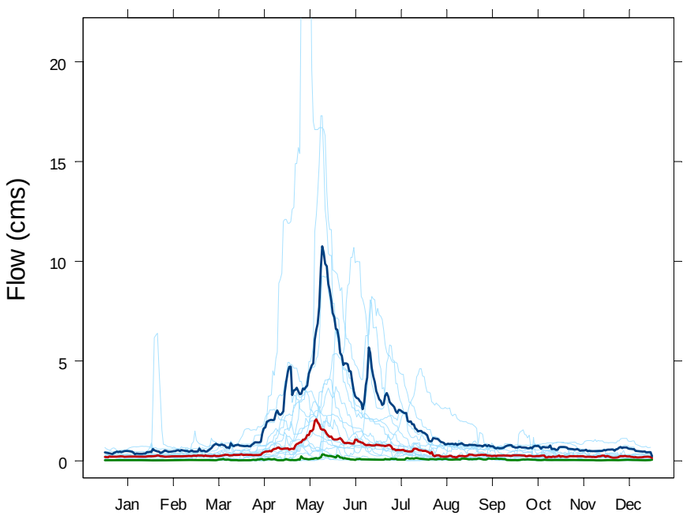


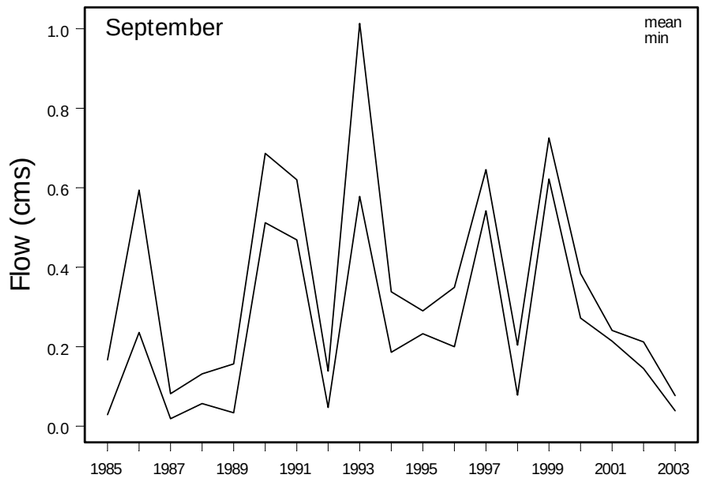
month	mean	median	min	max	10th percentile	20th percentile	30th percentile	40th percentile	50th percentile	60th percentile	70th percentile	80th percentile	90th percentile	month
Jan	0.22	0.22	0.01	0.73	0.03	0.05	0.12	0.19	0.22	0.23	0.26	0.31	0.46	Jan
Feb	0.30	0.23	0.01	6.39	0.03	0.05	0.16	0.21	0.23	0.27	0.32	0.38	0.54	Feb
Mar	0.31	0.26	0.01	1.49	0.03	0.08	0.18	0.23	0.26	0.30	0.36	0.48	0.73	Mar
Apr	0.66	0.37	0.01	12.00	0.03	0.09	0.20	0.28	0.37	0.47	0.65	0.84	1.60	Apr
May	2.59	1.09	0.00	35.60	0.07	0.32	0.52	0.75	1.09	1.62	2.27	3.24	4.81	May
Jun	1.98	0.93	0.02	11.60	0.07	0.26	0.67	0.77	0.93	1.24	2.11	3.19	5.55	Jun
Jul	1.07	0.59	0.01	7.64	0.06	0.22	0.36	0.49	0.59	0.74	0.90	1.70	2.63	Jul
Aug	0.52	0.25	0.01	4.25	0.07	0.13	0.17	0.20	0.25	0.50	0.68	0.78	0.94	Aug
Sep	0.37	0.26	0.02	1.87	0.07	0.13	0.20	0.23	0.26	0.31	0.54	0.66	0.75	Sep
Oct	0.32	0.24	0.01	1.55	0.04	0.08	0.15	0.19	0.24	0.28	0.40	0.53	0.73	Oct
Nov	0.26	0.21	0.01	1.07	0.03	0.05	0.10	0.18	0.21	0.25	0.29	0.42	0.55	Nov
Dec	0.24	0.20	0.01	1.12	0.03	0.05	0.10	0.14	0.20	0.24	0.28	0.34	0.57	Dec
PoR	0.74	0.28	0.00	35.60	0.04	0.09	0.18	0.23	0.28	0.38	0.57	0.77	1.52	PoR



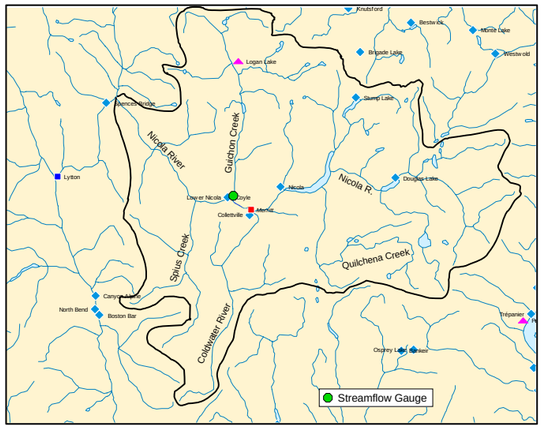


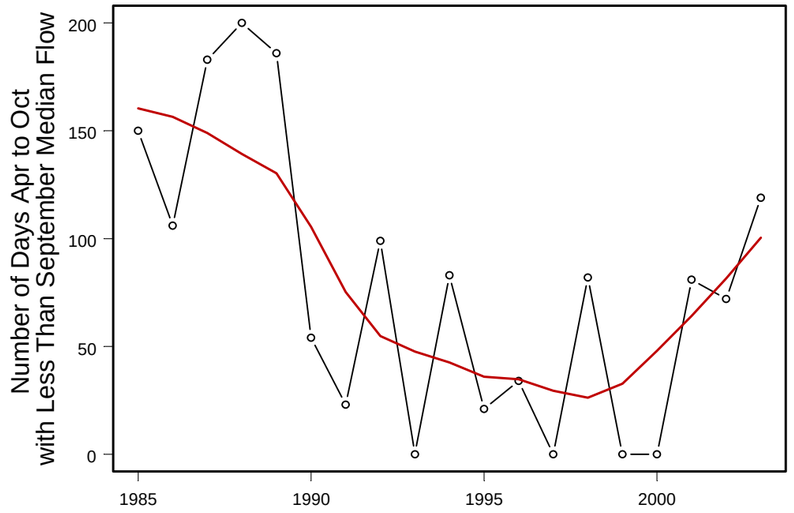


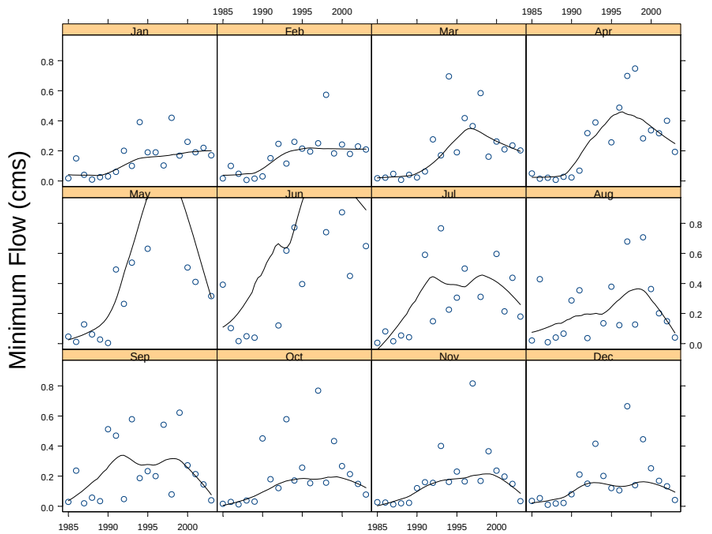


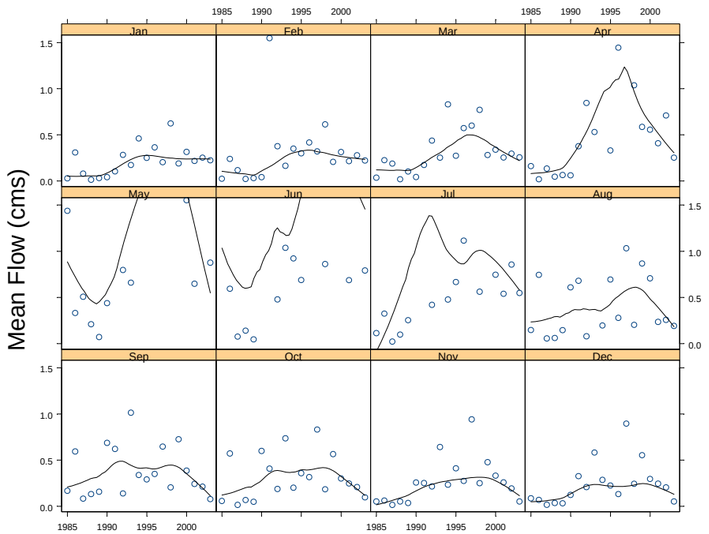


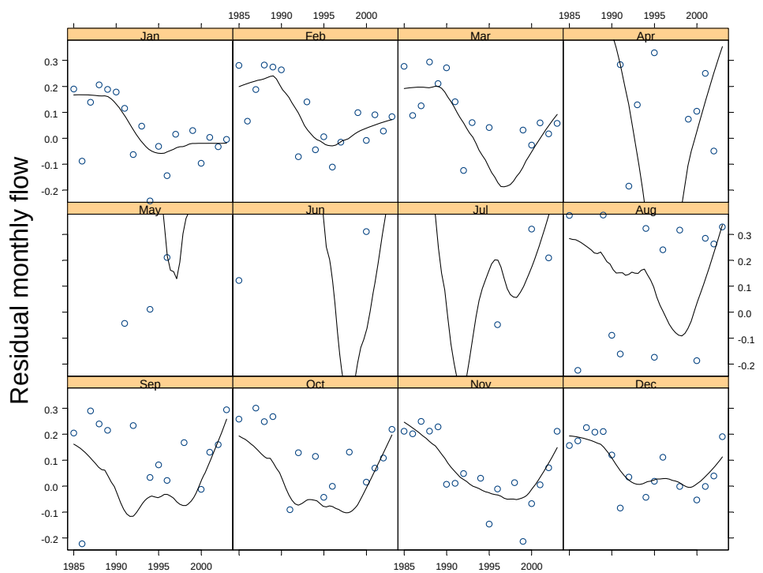
Station Name: Guichon Creek at Mouth
Station ID: 08LG067
Period of record: 1984-2003
Complete records: 19 years
Drainage area: *1230 km²*
Mean Annual Discharge: 0.74 m^3 sec^{-1}
Runoff: 19.74 L m^{-2} $year^{-1}$

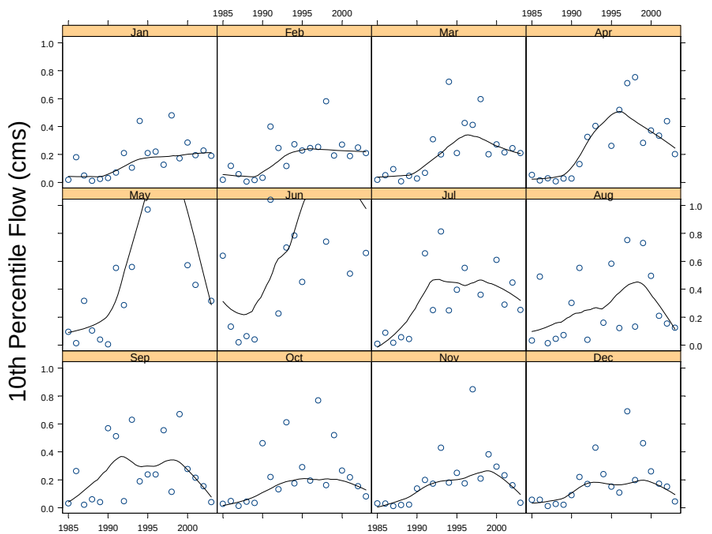


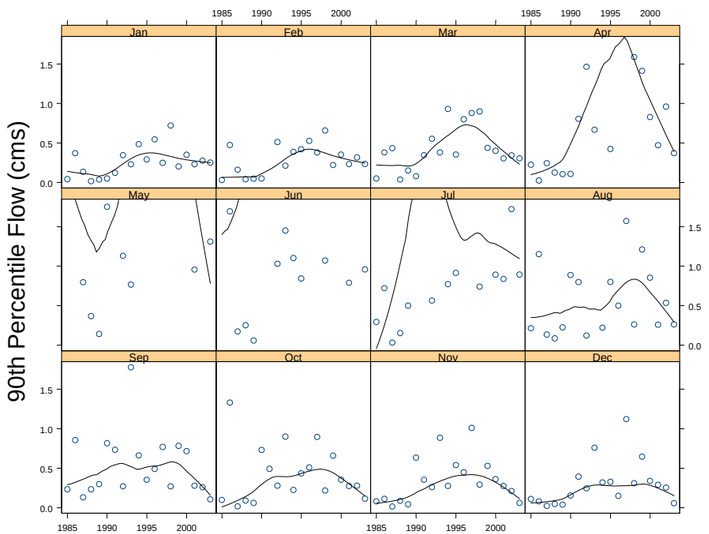




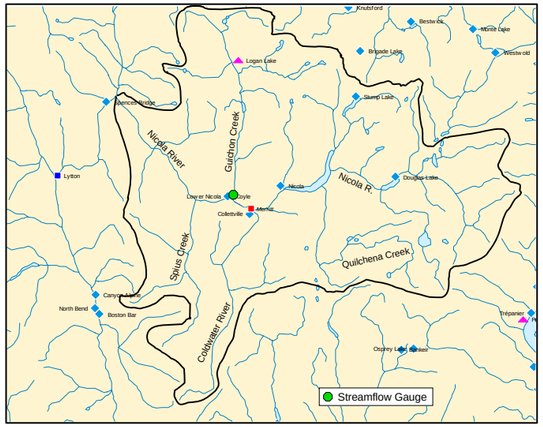




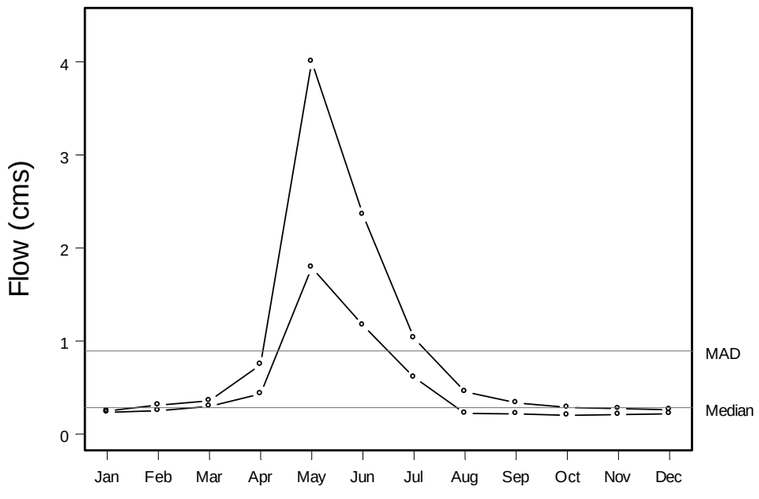


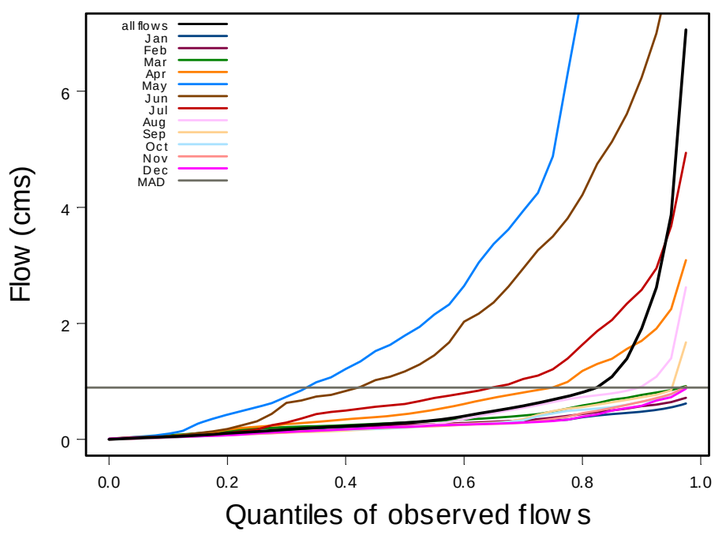


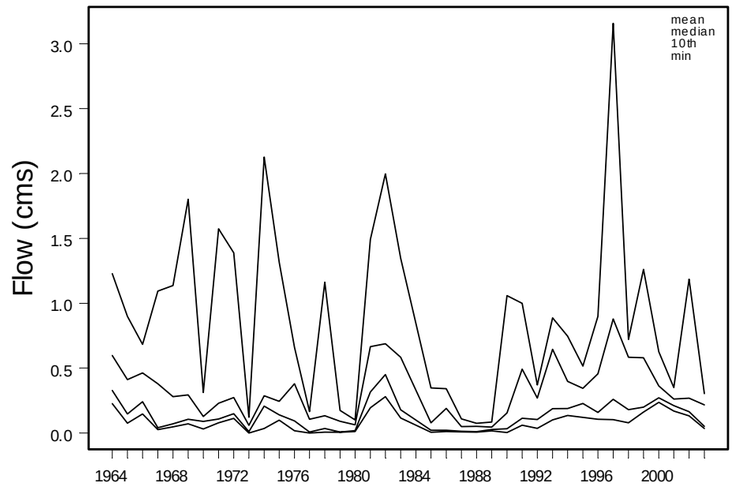
Station Name: Guichon Creek at Mouth combined with Guichon Creek near Lower Nicola
Station ID: 08LG067 + 08LG004
Period of record: 1911-2003
Complete records: 39 years
Drainage area: *1230 km²*
Mean Annual Discharge: 0.89 m^3 sec^{-1}
Runoff: 23.85 L m^{-2} $year^{-1}$

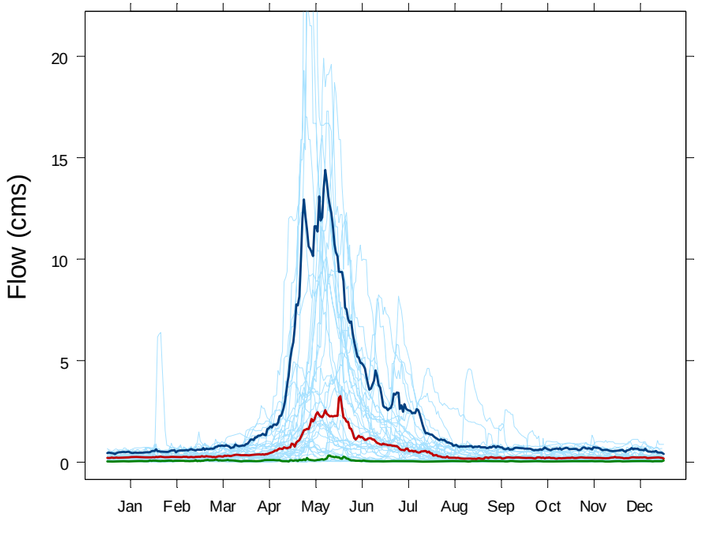


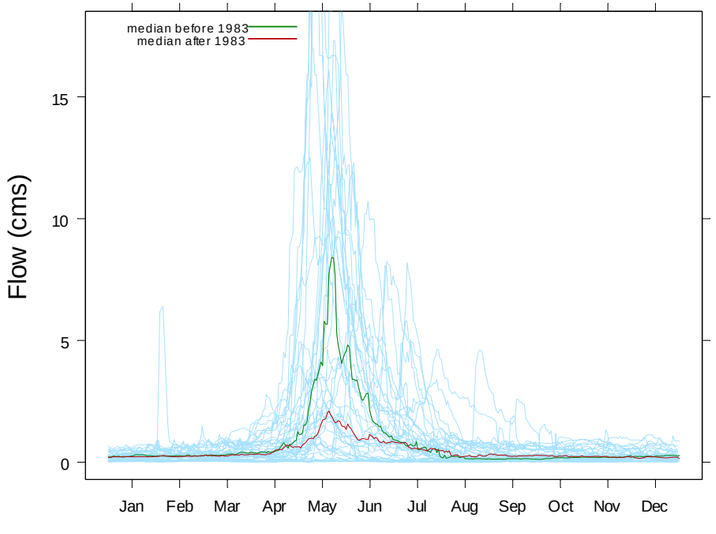
month	mean	median	min	max	percentiles 10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	0.25	0.23	0.01	0.73	0.04	0.10	0.16	0.21	0.23	0.26	0.30	0.38	0.48	Jan
Feb	0.31	0.25	0.01	6.39	0.05	0.15	0.20	0.23	0.25	0.28	0.33	0.44	0.57	Feb
Mar	0.36	0.30	0.01	1.49	0.07	0.14	0.21	0.24	0.30	0.34	0.41	0.58	0.77	Mar
Apr	0.75	0.43	0.01	12.00	0.05	0.17	0.26	0.34	0.43	0.61	0.81	1.18	1.70	Apr
May	4.00	1.79	0.00	35.60	0.10	0.43	0.73	1.21	1.79	2.64	3.94	7.69	11.80	May
Jun	2.36	1.17	0.01	17.00	0.06	0.18	0.63	0.83	1.17	2.03	2.95	4.21	6.24	Jun
Jul	1.03	0.61	0.00	8.18	0.03	0.11	0.29	0.50	0.61	0.80	1.04	1.63	2.58	Jul
Aug	0.45	0.22	0.00	4.59	0.03	0.07	0.12	0.17	0.22	0.35	0.54	0.73	0.91	Aug
Sep	0.33	0.22	0.00	2.97	0.04	0.08	0.11	0.15	0.22	0.27	0.35	0.56	0.72	Sep
Oct	0.29	0.20	0.00	1.55	0.03	0.08	0.13	0.17	0.20	0.26	0.33	0.51	0.65	Oct
Nov	0.27	0.21	0.00	1.33	0.04	0.07	0.12	0.17	0.21	0.25	0.29	0.45	0.65	Nov
Dec	0.26	0.22	0.01	1.12	0.04	0.07	0.13	0.17	0.22	0.25	0.29	0.39	0.58	Dec
PoR	0.89	0.28	0.00	35.60	0.04	0.10	0.17	0.23	0.28	0.40	0.58	0.81	1.91	PoR

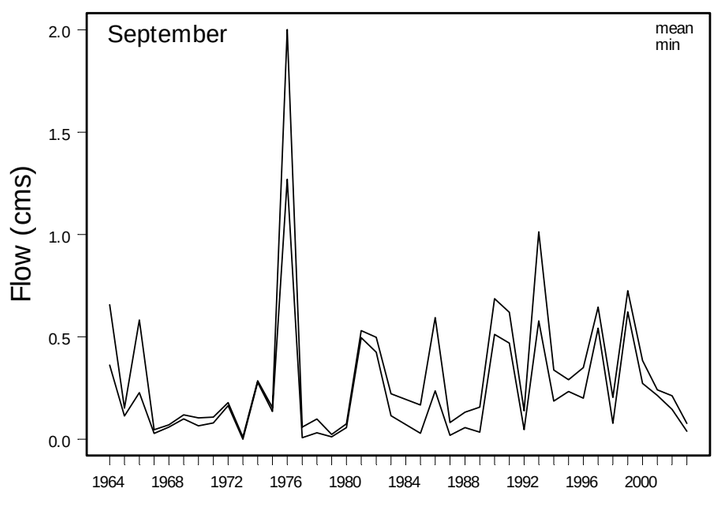




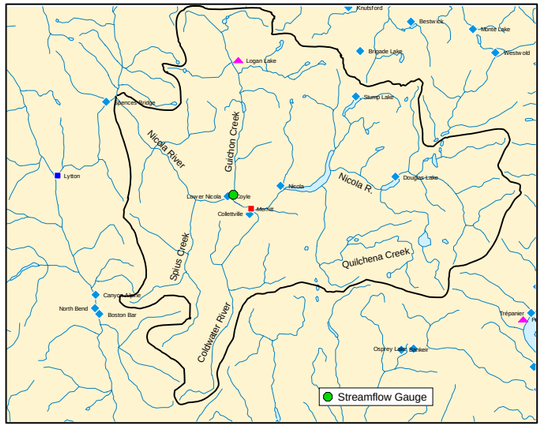


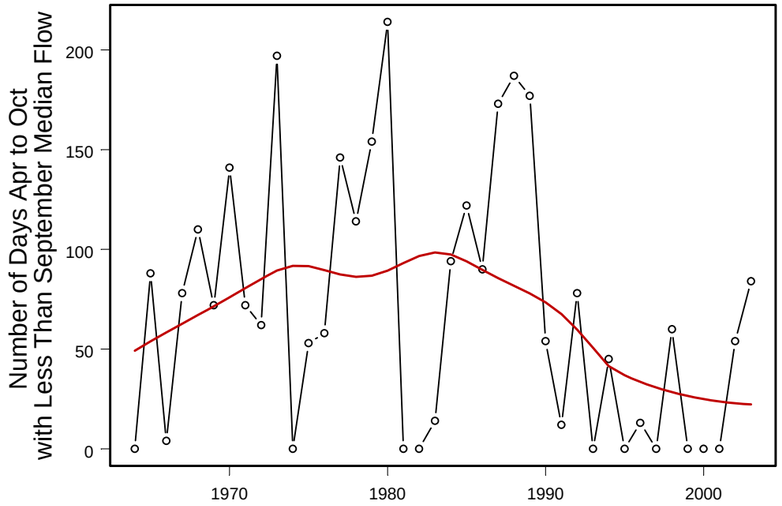


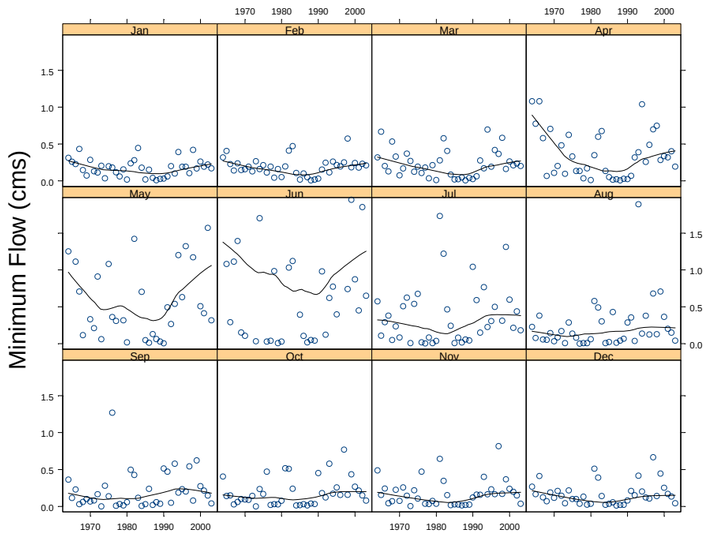


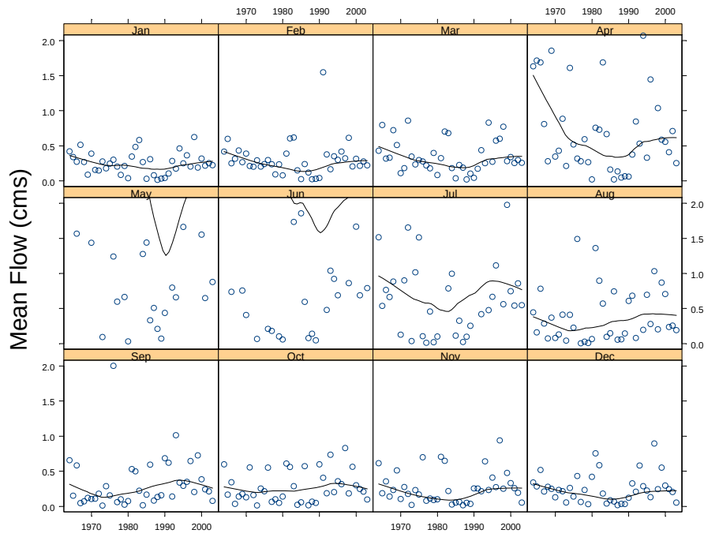


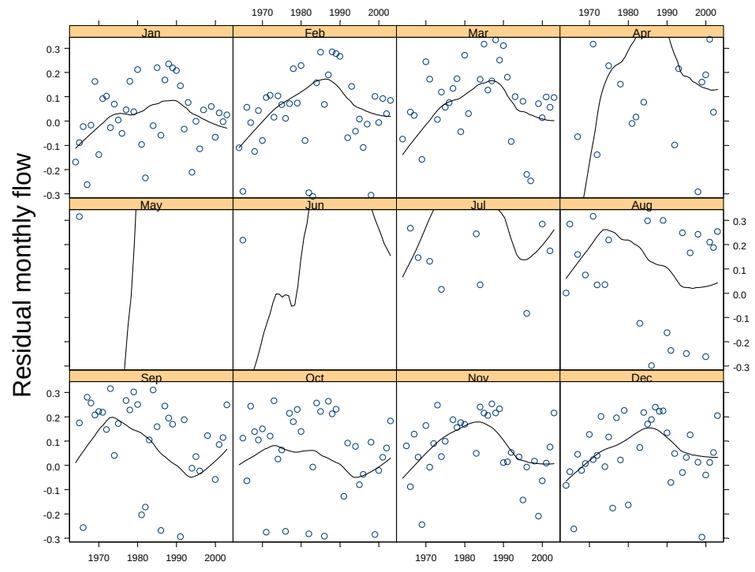
Station Name: Guichon Creek at Mouth combined with Guichon Creek near Lower Nicola
Station ID: 08LG067 + 08LG004
Period of record: 1911-2003
Complete records: 39 years
Drainage area: *1230 km²*
Mean Annual Discharge: 0.89 m^3 sec^{-1}
Runoff: 23.85 L m^{-2} $year^{-1}$

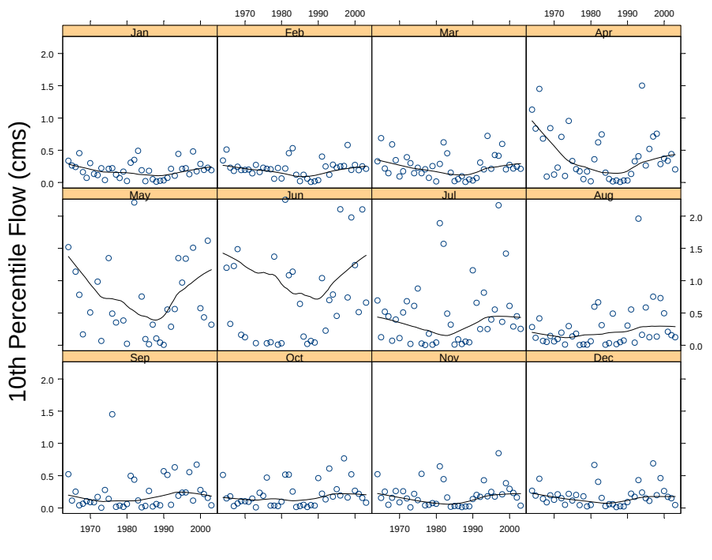


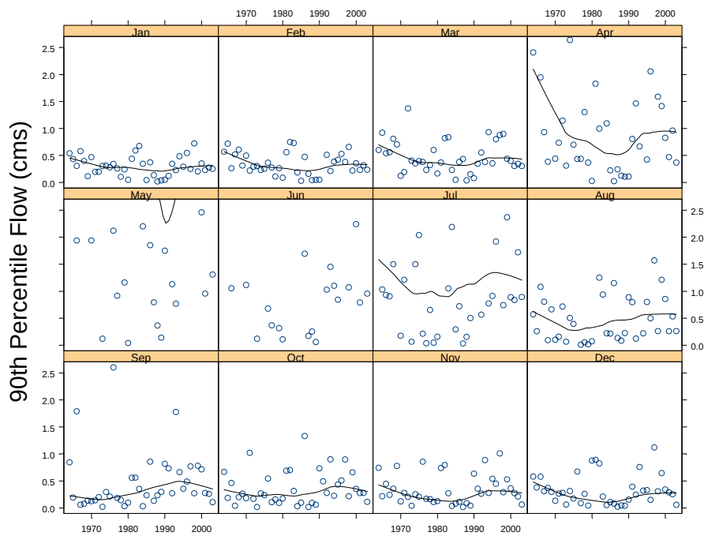




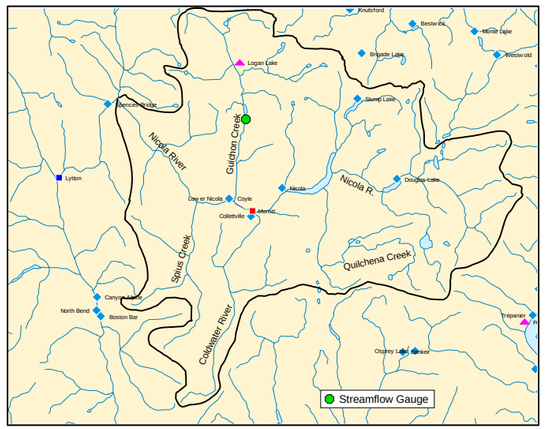






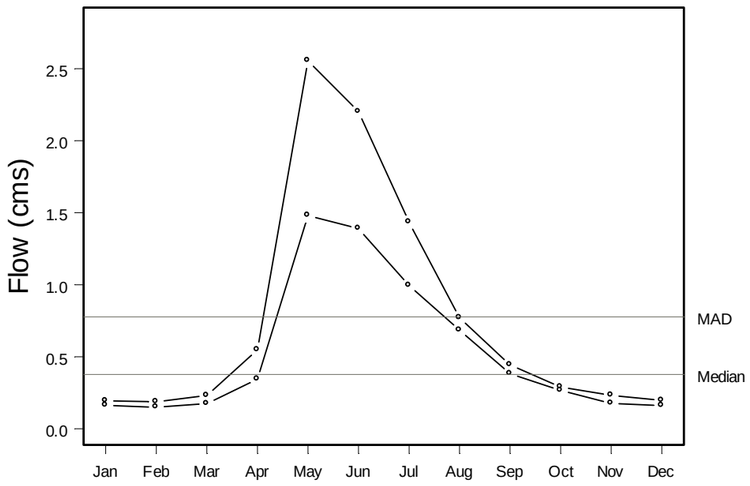


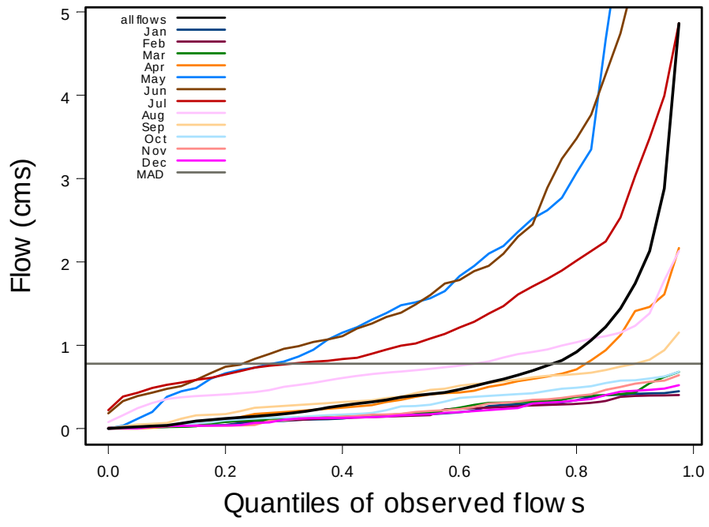
Station Name: Guichon Creek
at outlet of Mamit Lake
Station ID: 08LG041
Period of record: 1936-2003
Complete records: 18 years
Drainage area: 842 km^2
Mean Annual Discharge: 0.8 m^3 sec^{-1}
Runoff: 30.34 L m^{-2} year^{-1}

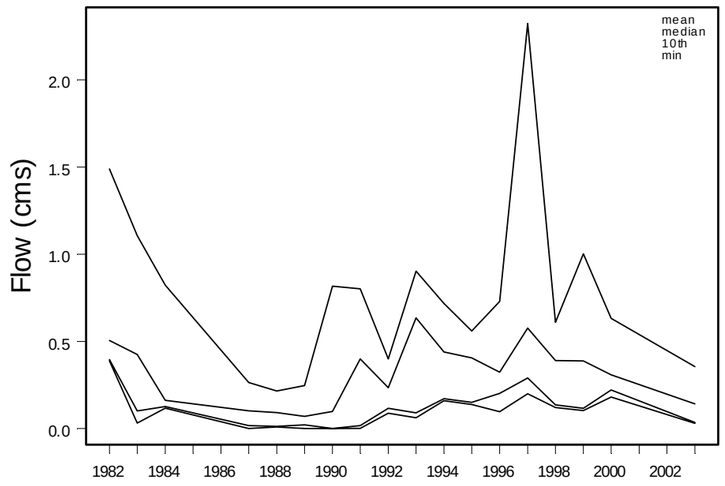


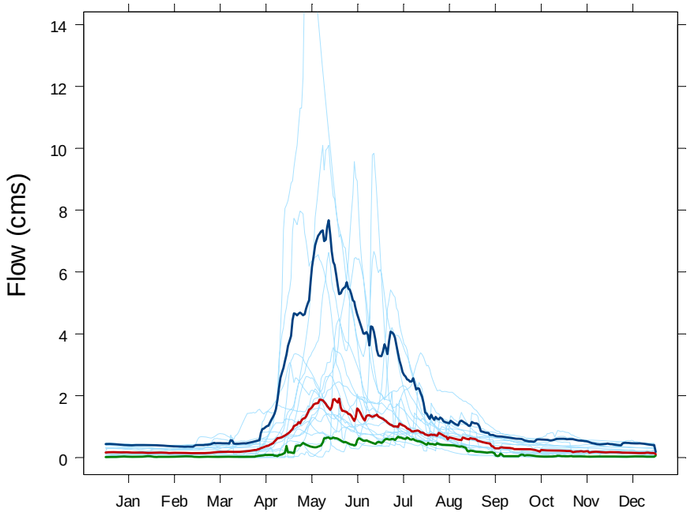
percentiles

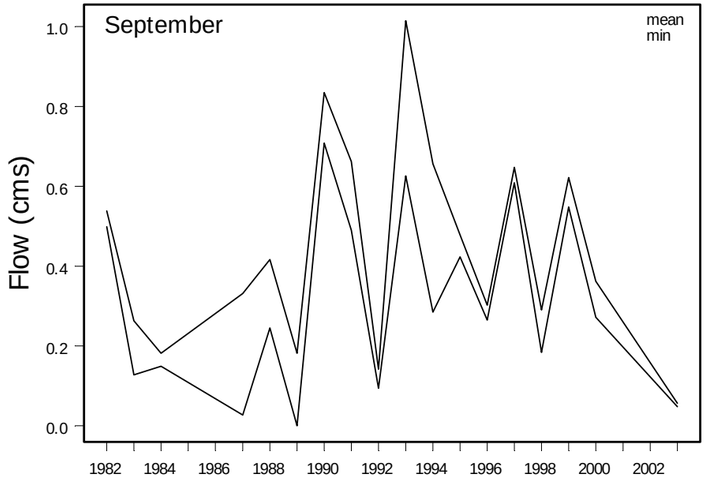
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	0.2	0.2	0.0	0.5	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4	Jan
Feb	0.2	0.2	0.0	0.4	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	Feb
Mar	0.2	0.2	0.0	0.9	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.4	Mar
Apr	0.5	0.3	0.0	8.1	0.0	0.1	0.2	0.3	0.3	0.4	0.6	0.7	1.4	Apr
May	2.6	1.5	0.0	23.1	0.4	0.7	0.8	1.2	1.5	1.8	2.4	3.1	6.6	May
Jun	2.2	1.4	0.2	9.8	0.5	0.7	1.0	1.1	1.4	1.8	2.3	3.5	5.4	Jun
Jul	1.4	1.0	0.2	7.6	0.5	0.6	0.8	0.8	1.0	1.2	1.6	2.0	3.0	Jul
Aug	0.8	0.7	0.1	3.1	0.4	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	Aug
Sep	0.4	0.4	0.0	1.7	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	Sep
Oct	0.3	0.3	0.0	0.9	0.0	0.1	0.1	0.2	0.3	0.4	0.4	0.5	0.6	Oct
Nov	0.2	0.2	0.0	0.8	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	Nov
Dec	0.2	0.2	0.0	0.6	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.5	Dec
PoR	0.8	0.4	0.0	23.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.9	1.7	PoR



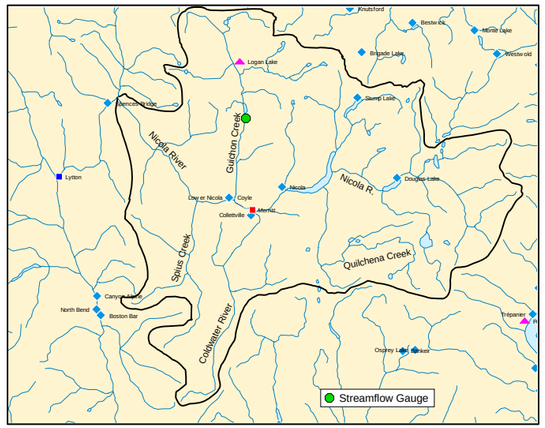


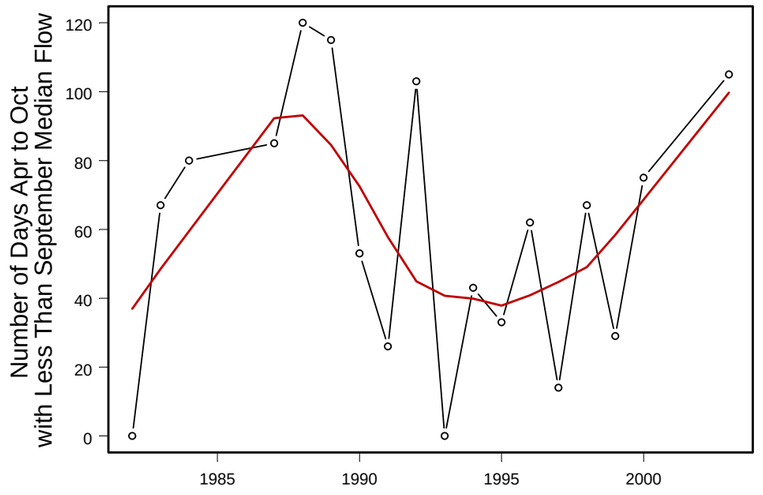


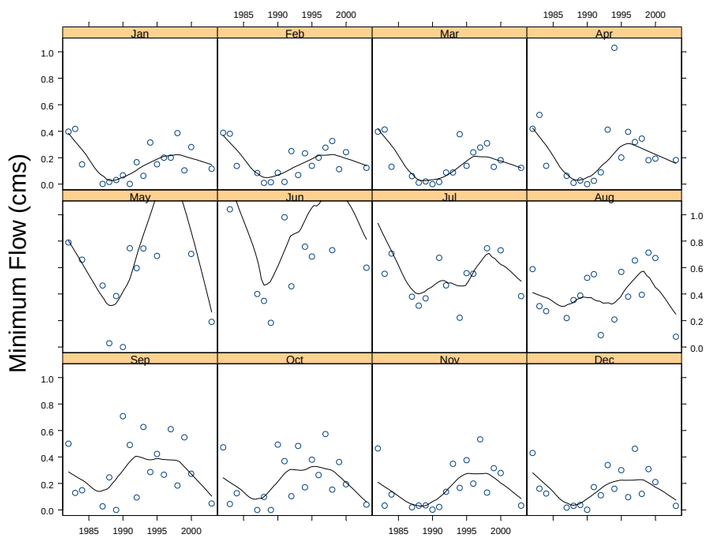


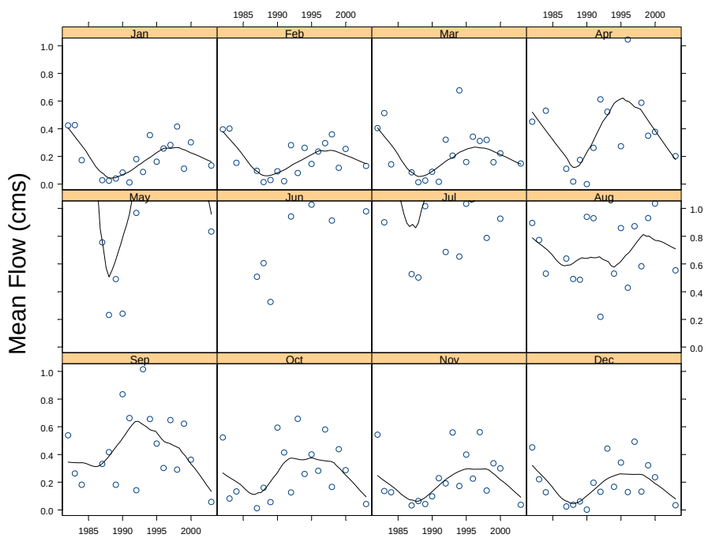


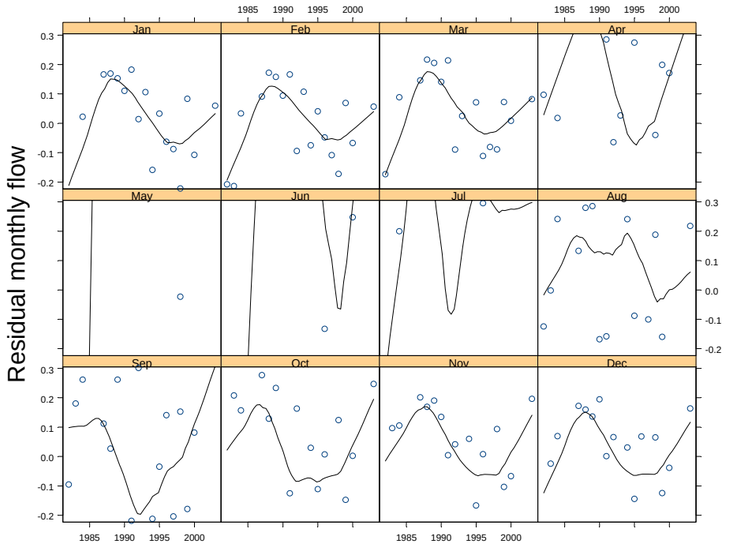
Station Name: Guichon Creek
at outlet of Mamit Lake
Station ID: 08LG041
Period of record: 1936-2003
Complete records: 18 years
Drainage area: 842 km^2
Mean Annual Discharge: 0.8 m^3 sec^{-1}
Runoff: 30.34 L m^{-2} year^{-1}

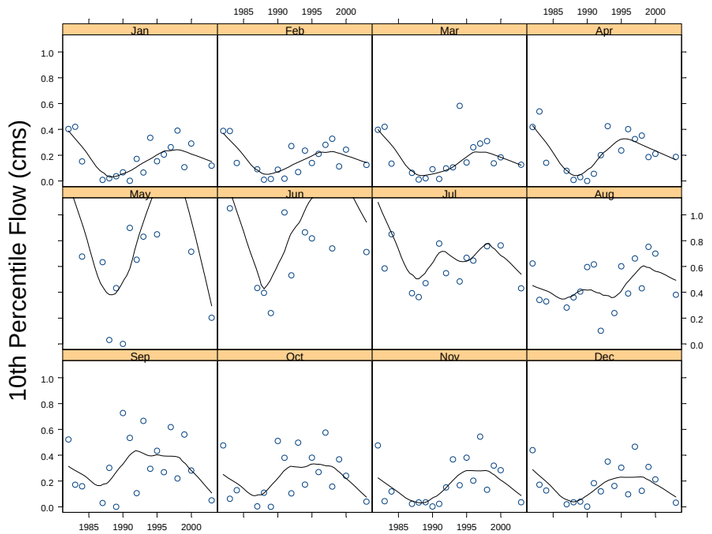


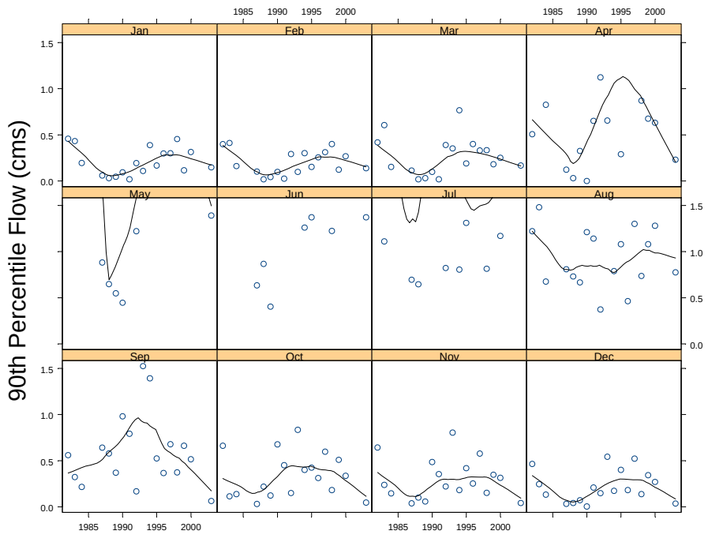




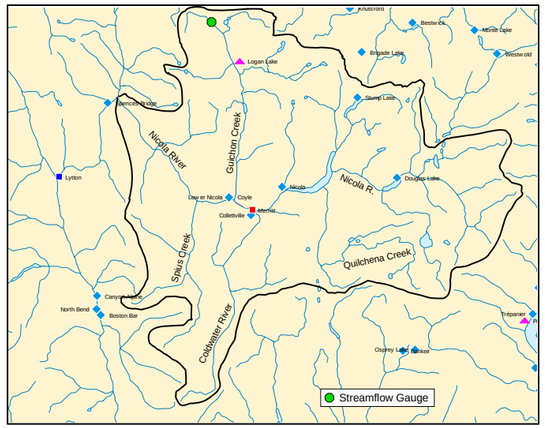






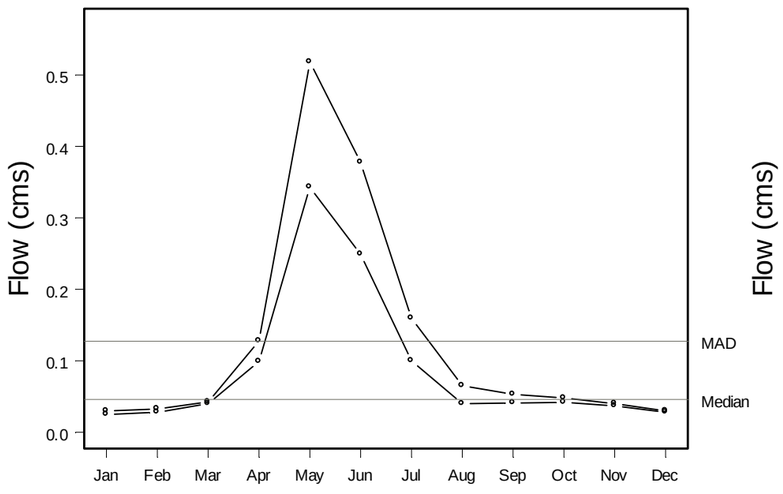


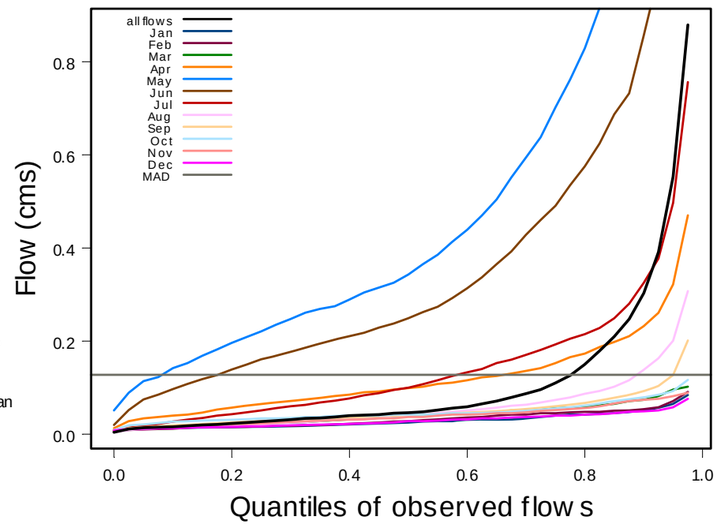
Station Name: Guichon Creek above
Tunkwa Lake Diversion
Station ID: 08LG056
Period of record: 1967-2003
Complete records: 33 years
Drainage area: 78.2 km^2
Mean Annual Discharge: 0.13 m^3 sec^{-1}
Runoff: 53.6 L m^{-2} year^{-1}

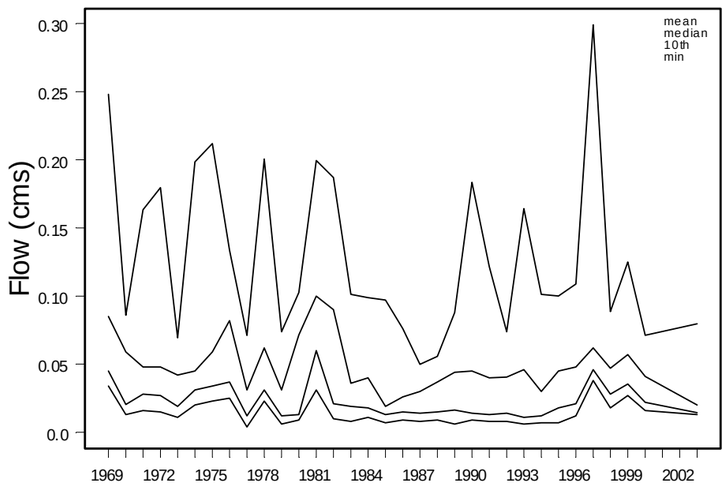


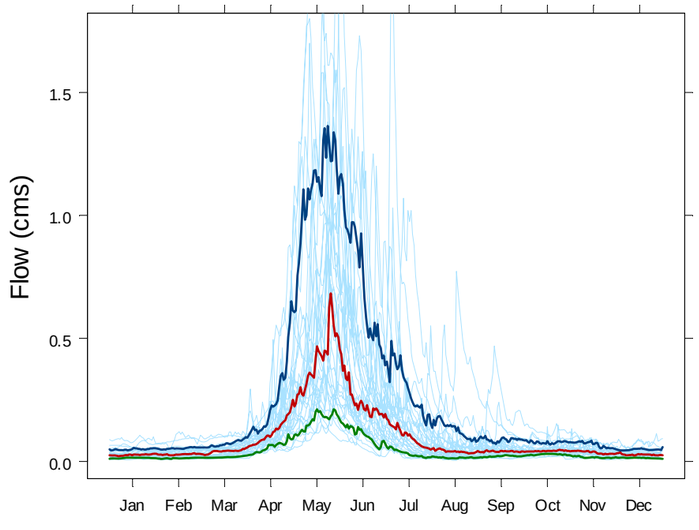
percentiles

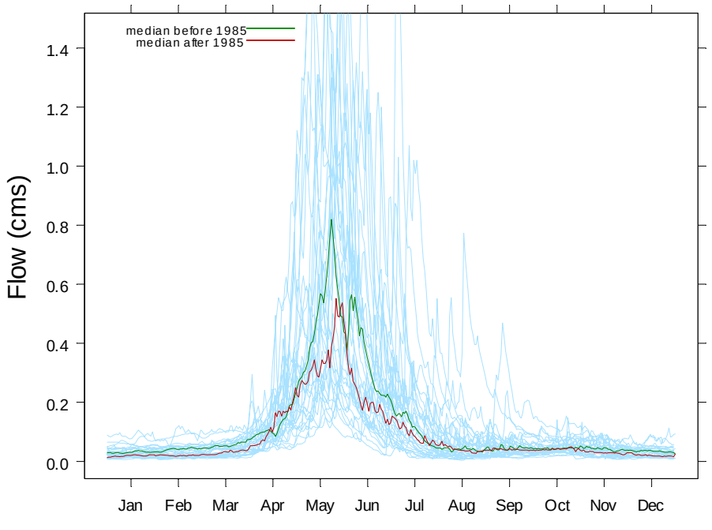
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	0.03	0.03	0.01	0.11	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.05	Jan
Feb	0.03	0.03	0.01	0.12	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.05	0.05	Feb
Mar	0.04	0.04	0.01	0.12	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.07	Mar
Apr	0.13	0.10	0.01	0.88	0.04	0.06	0.07	0.09	0.10	0.12	0.14	0.17	0.23	Apr
May	0.52	0.34	0.05	2.92	0.14	0.20	0.25	0.29	0.34	0.44	0.59	0.83	1.13	May
Jun	0.38	0.25	0.02	2.33	0.10	0.14	0.18	0.21	0.25	0.31	0.43	0.58	0.86	Jun
Jul	0.16	0.10	0.01	2.30	0.03	0.04	0.06	0.08	0.10	0.13	0.17	0.22	0.33	Jul
Aug	0.07	0.04	0.00	0.77	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.09	0.14	Aug
Sep	0.05	0.04	0.01	0.47	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.07	0.09	Sep
Oct	0.05	0.04	0.01	0.16	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.08	Oct
Nov	0.04	0.04	0.01	0.13	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.07	Nov
Dec	0.03	0.03	0.01	0.11	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	Dec
PoR	0.13	0.05	0.00	2.92	0.02	0.02	0.03	0.04	0.05	0.06	0.09	0.15	0.30	PoR

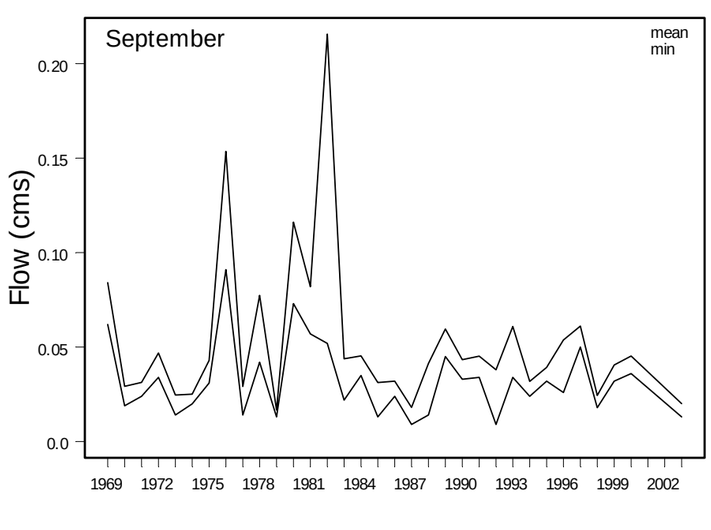




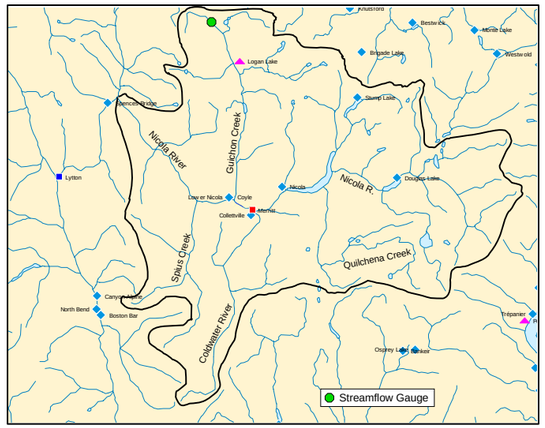


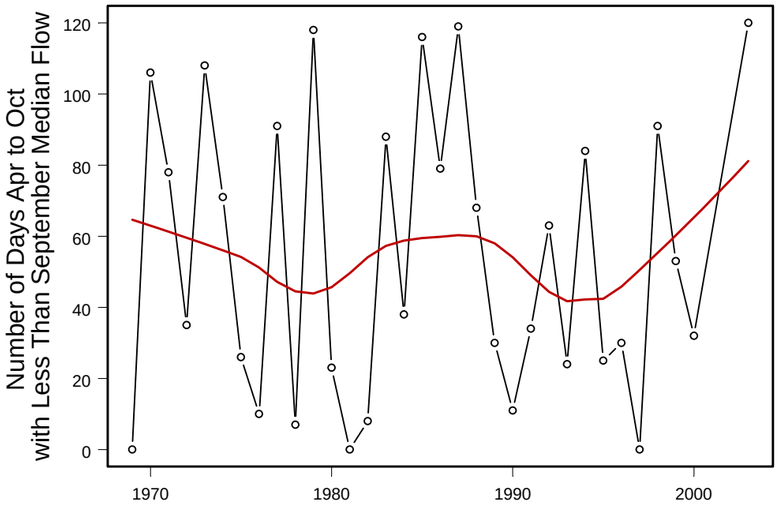


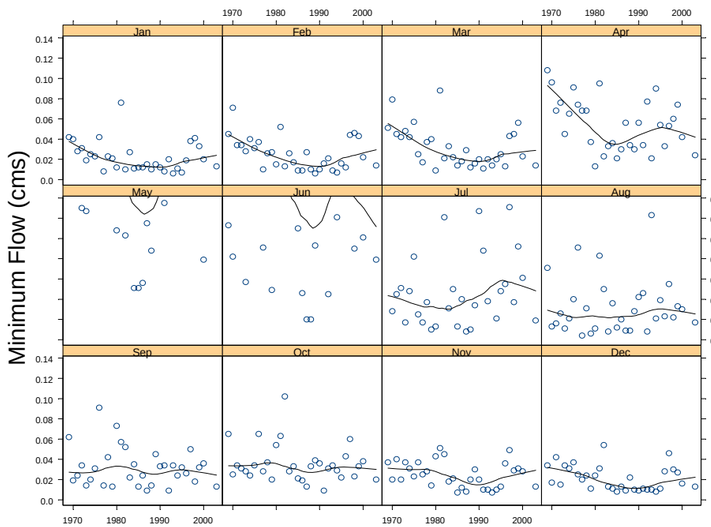


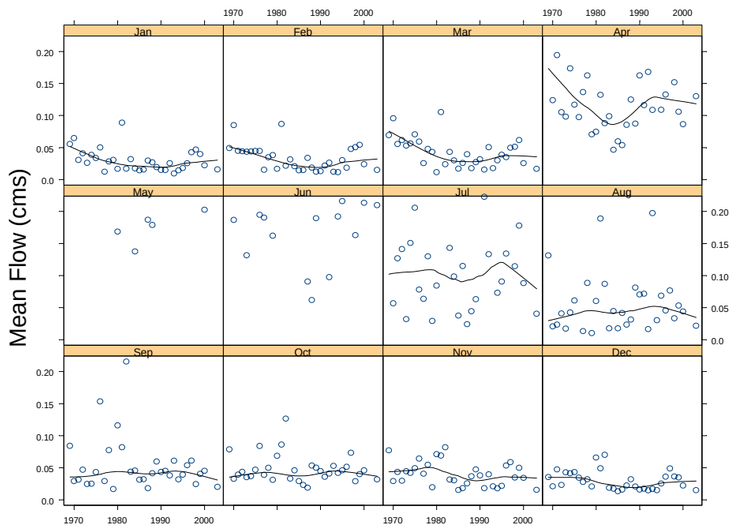


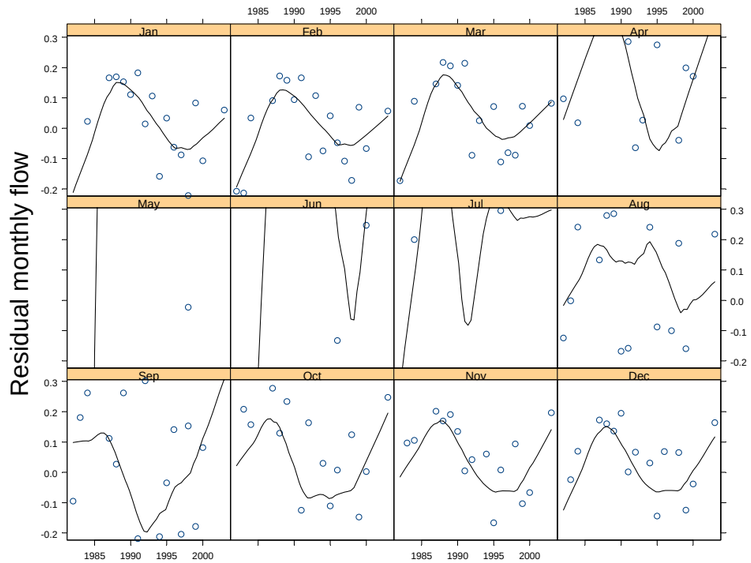
Station Name: Guichon Creek above
Tunkwa Lake Diversion
Station ID: 08LG056
Period of record: 1967-2003
Complete records: 33 years
Drainage area: 78.2 km^2
Mean Annual Discharge: 0.13 m^3 sec^{-1}
Runoff: 53.6 L m^{-2} year^{-1}

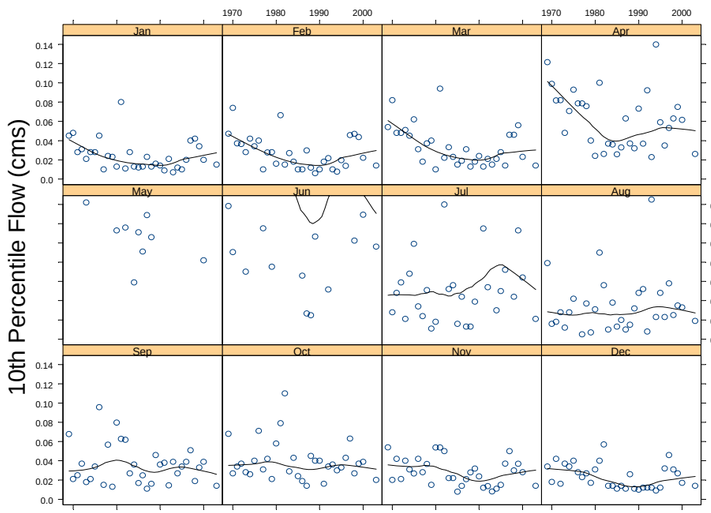


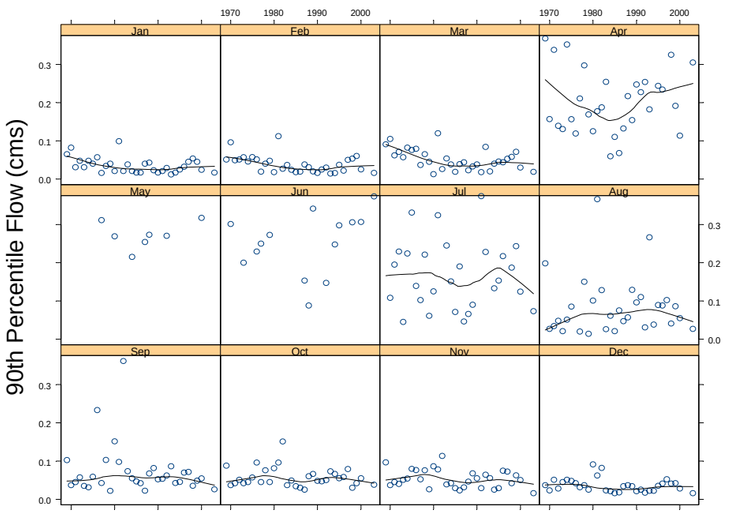




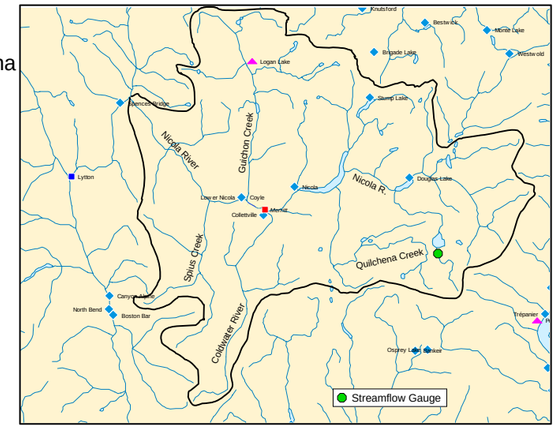




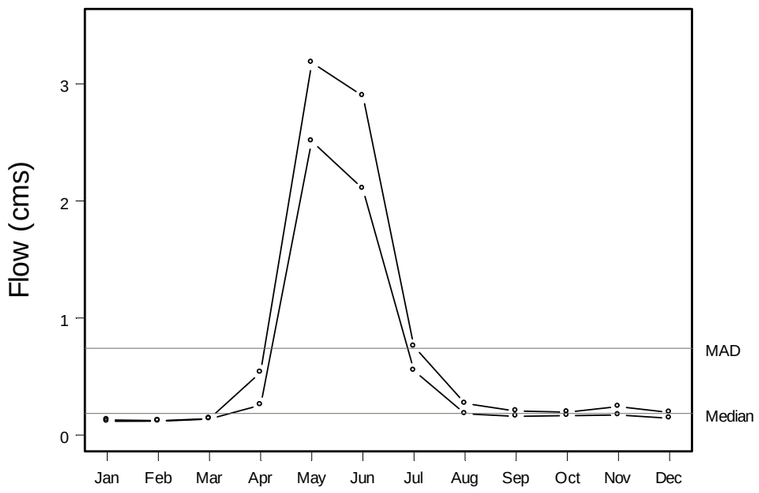


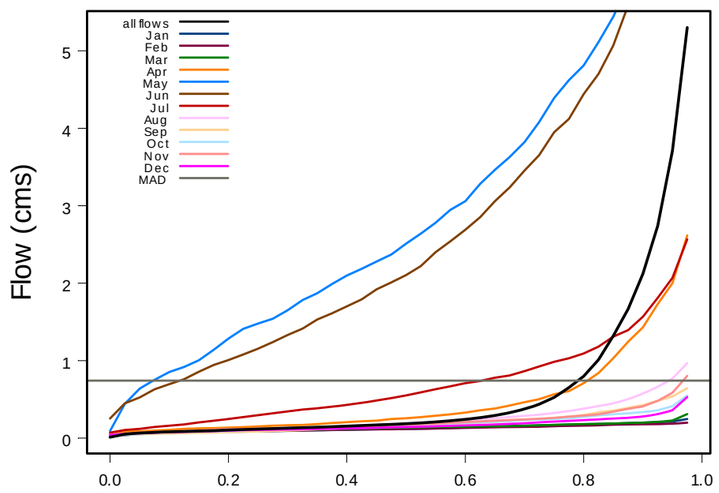


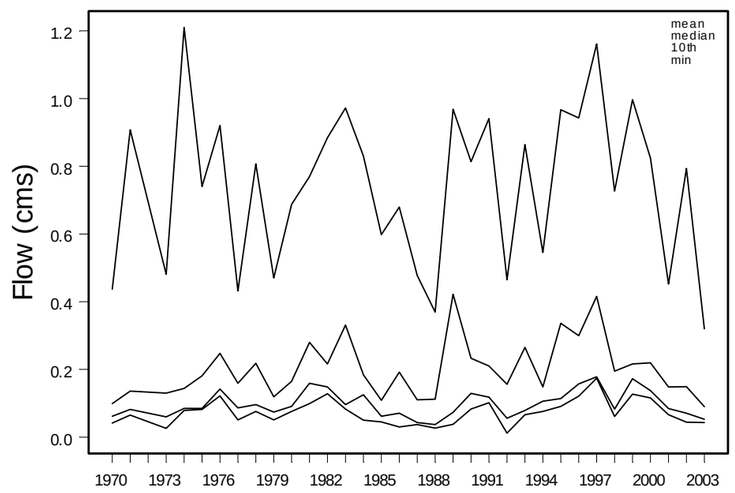
Station Name: Pennask Creek near Quilchena
Station ID: 08LG016
Period of record: 1920-2003
Complete records: 33 years
Drainage area: 87 km^2
Mean Annual Discharge: 0.74 m^3 sec^{-1}
Runoff: 286.6 L m^{-2} year^{-1}

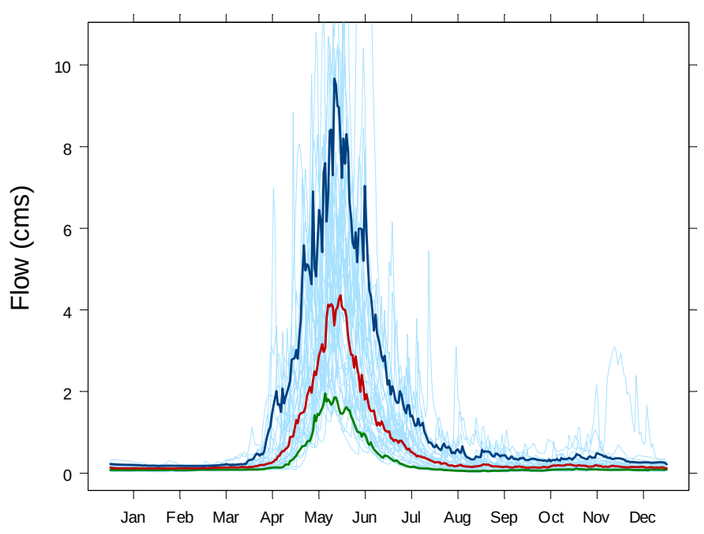


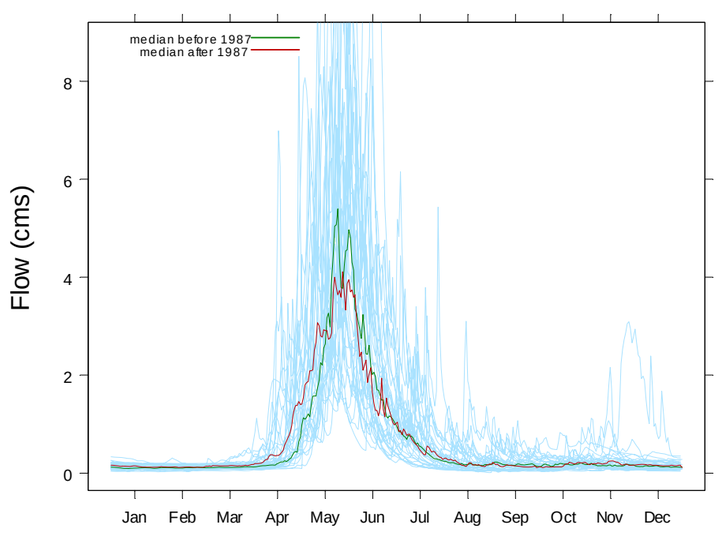
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
					percentiles									
Jan	0.13	0.12	0.03	0.33	0.07	0.08	0.09	0.11	0.12	0.14	0.16	0.18	0.20	Jan
Feb	0.12	0.12	0.03	0.31	0.07	0.09	0.10	0.11	0.12	0.13	0.14	0.16	0.18	Feb
Mar	0.14	0.14	0.05	0.51	0.08	0.09	0.10	0.12	0.14	0.15	0.16	0.18	0.20	Mar
Apr	0.53	0.26	0.06	6.99	0.11	0.14	0.17	0.20	0.26	0.33	0.46	0.71	1.43	Apr
May	3.18	2.51	0.09	12.80	0.85	1.28	1.65	2.10	2.51	3.06	3.82	4.81	6.44	May
Jun	2.90	2.11	0.25	17.70	0.70	1.01	1.33	1.70	2.11	2.69	3.45	4.44	6.01	Jun
Jul	0.76	0.55	0.07	6.15	0.16	0.25	0.34	0.43	0.55	0.71	0.87	1.09	1.57	Jul
Aug	0.27	0.18	0.01	3.10	0.06	0.09	0.12	0.16	0.18	0.23	0.29	0.38	0.58	Aug
Sep	0.20	0.16	0.02	1.15	0.06	0.08	0.10	0.13	0.16	0.19	0.23	0.30	0.43	Sep
Oct	0.19	0.17	0.03	0.93	0.08	0.09	0.12	0.14	0.17	0.20	0.23	0.28	0.34	Oct
Nov	0.24	0.17	0.04	3.09	0.09	0.12	0.13	0.15	0.17	0.21	0.24	0.29	0.41	Nov
Dec	0.19	0.14	0.04	2.94	0.08	0.10	0.11	0.12	0.14	0.16	0.19	0.23	0.28	Dec
PoR	0.74	0.19	0.01	17.70	0.08	0.11	0.13	0.16	0.19	0.24	0.37	0.80	2.12	PoR

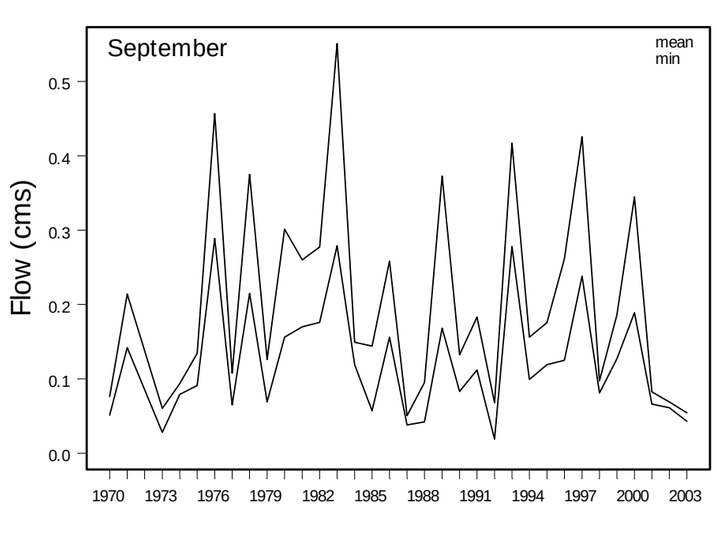




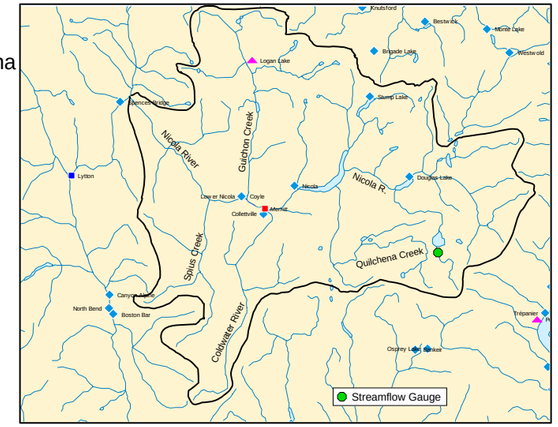


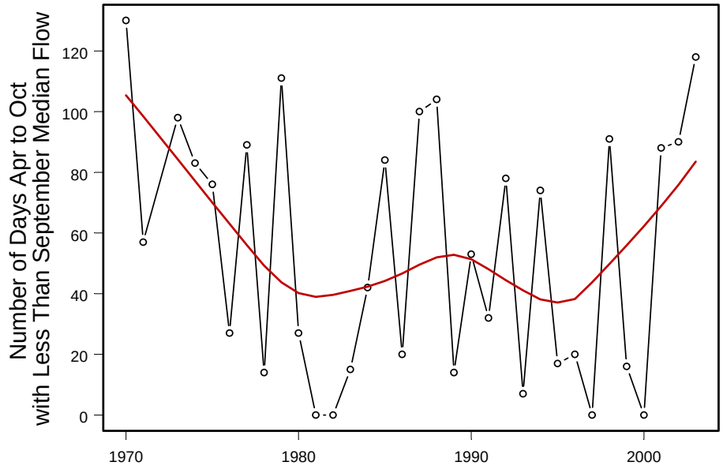


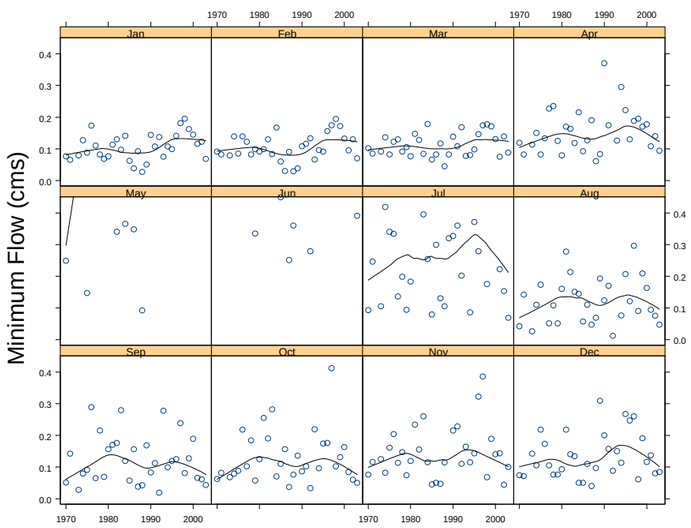


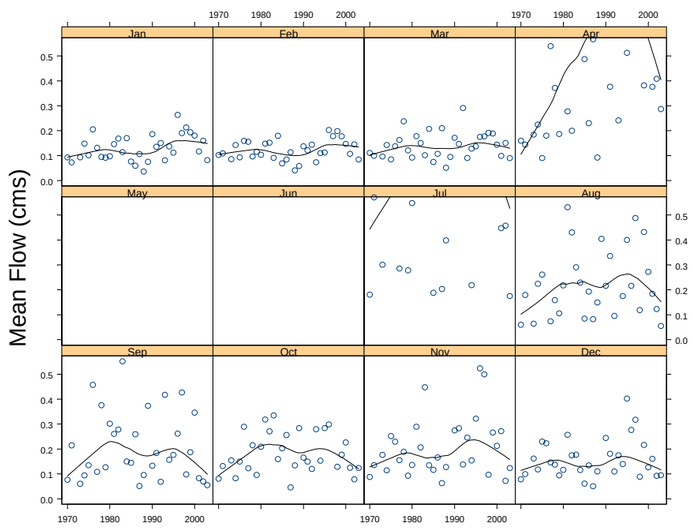


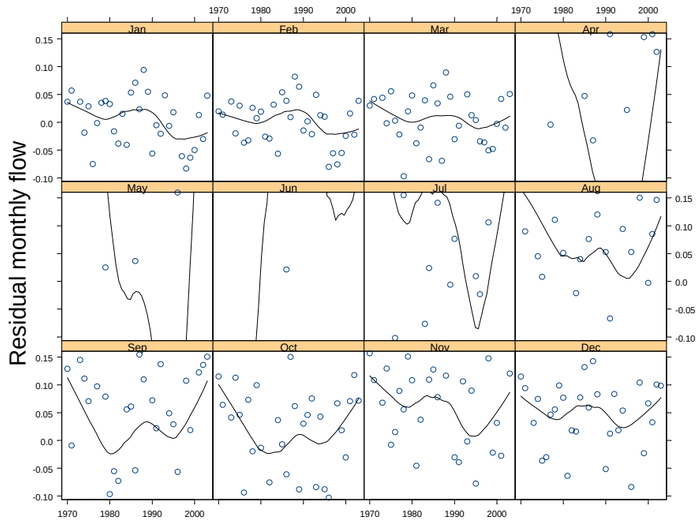
Station Name: Pennask Creek near Quilchena
Station ID: 08LG016
Period of record: 1920-2003
Complete records: 33 years
Drainage area: 87 km^2
Mean Annual Discharge: 0.74 m^3 sec^{-1}
Runoff: 286.6 L m^{-2} year^{-1}

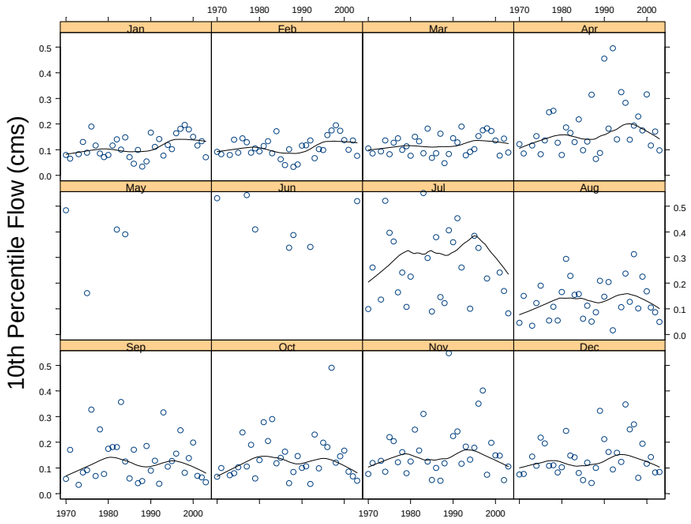


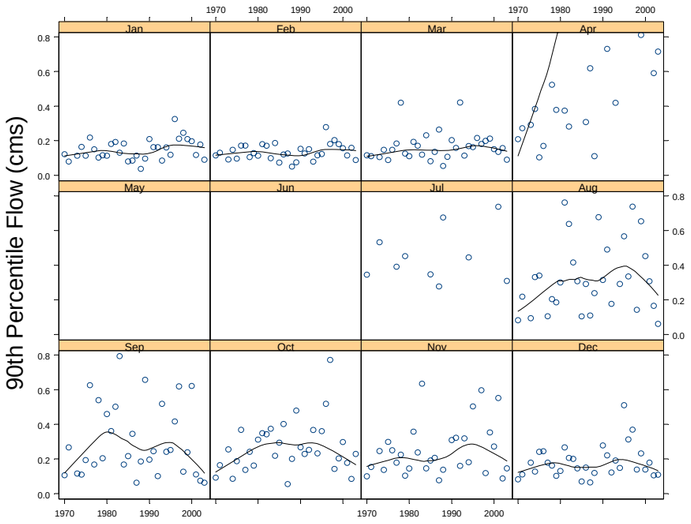




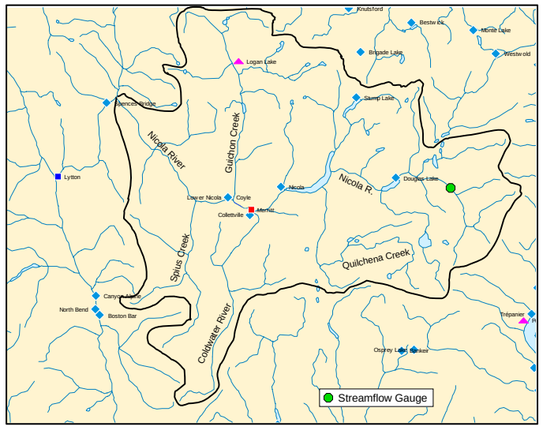






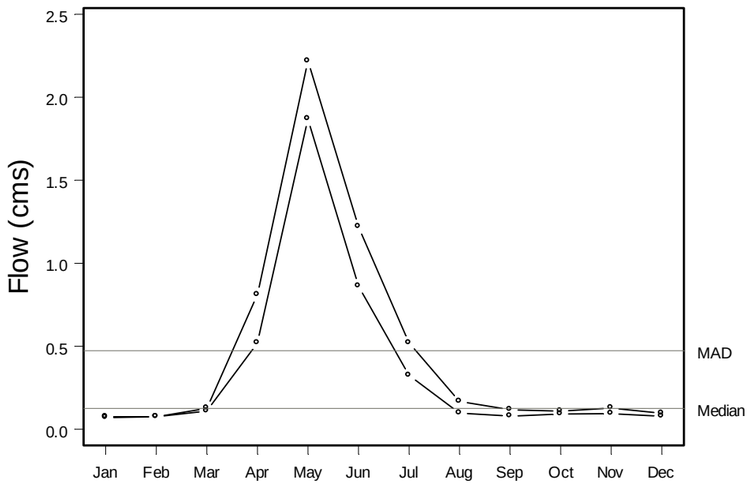


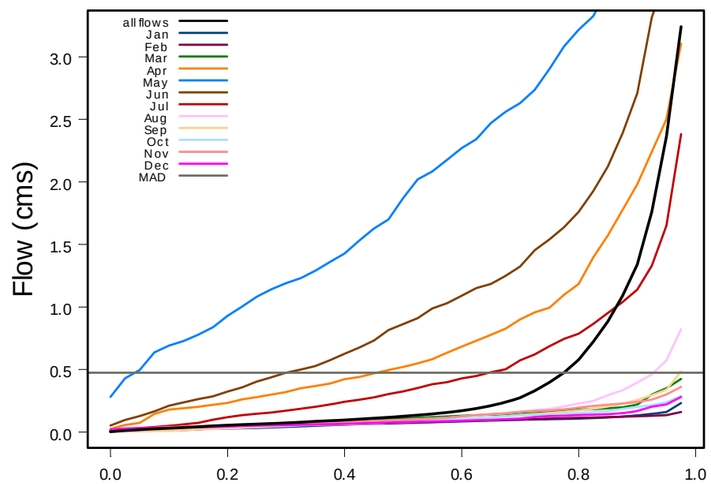
Station Name: Beak Creek at Mouth
Station ID: 08LG064
Period of record: 1982-2001
Complete records: 18 years
Drainage area: 85 km^2
Mean Annual Discharge: 0.47 m^3 sec^{-1}
Runoff: 183.3 L m^{-2} year^{-1}

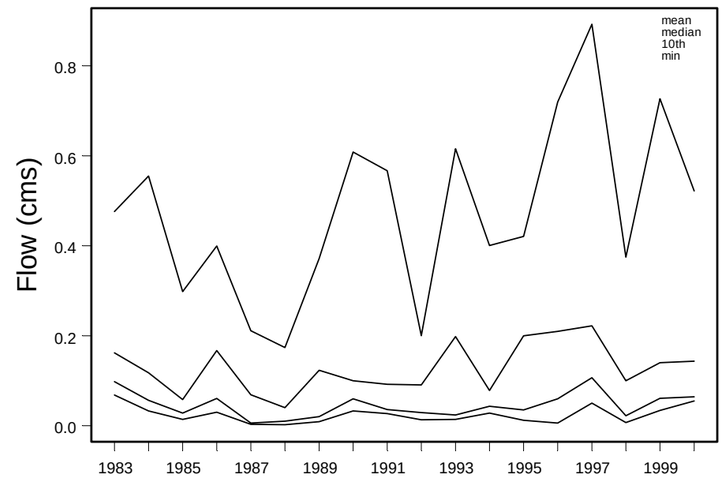


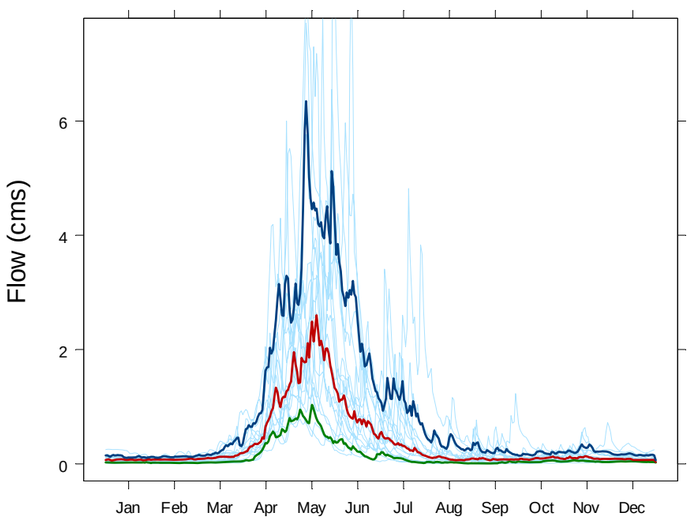
percentiles

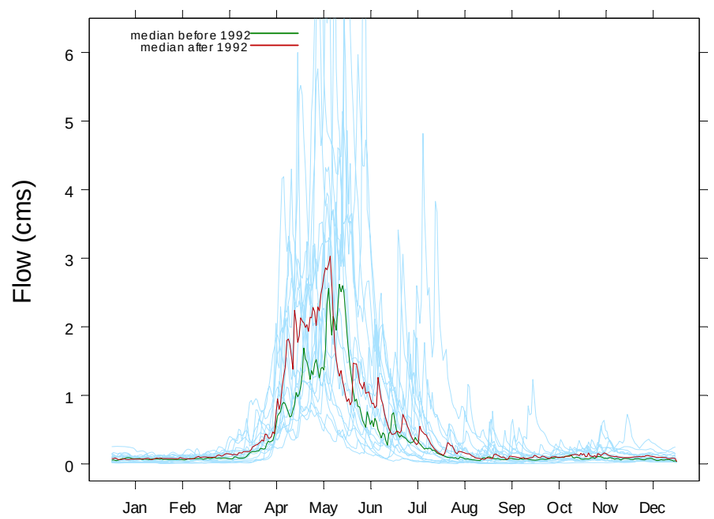
month	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	0.08	0.07	0.01	0.26	0.02	0.03	0.04	0.06	0.07	0.09	0.10	0.11	0.13	Jan
Feb	0.08	0.08	0.01	0.22	0.02	0.04	0.05	0.07	0.08	0.09	0.10	0.11	0.13	Feb
Mar	0.13	0.11	0.01	0.90	0.02	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.22	Mar
Apr	0.81	0.52	0.03	4.30	0.18	0.23	0.32	0.42	0.52	0.68	0.90	1.18	1.98	Apr
May	2.22	1.87	0.28	12.50	0.69	0.93	1.19	1.43	1.87	2.27	2.63	3.22	4.32	May
Jun	1.22	0.86	0.05	8.80	0.21	0.32	0.47	0.63	0.86	1.09	1.32	1.76	2.71	Jun
Jul	0.52	0.32	0.01	4.82	0.05	0.12	0.17	0.24	0.32	0.43	0.57	0.79	1.14	Jul
Aug	0.17	0.10	0.00	2.02	0.02	0.03	0.05	0.07	0.10	0.13	0.16	0.23	0.40	Aug
Sep	0.12	0.08	0.00	1.23	0.01	0.03	0.05	0.06	0.08	0.10	0.14	0.17	0.26	Sep
Oct	0.11	0.09	0.00	0.96	0.03	0.05	0.06	0.08	0.09	0.11	0.13	0.15	0.20	Oct
Nov	0.13	0.09	0.02	0.72	0.04	0.05	0.07	0.08	0.09	0.12	0.16	0.20	0.24	Nov
Dec	0.10	0.08	0.02	0.66	0.03	0.04	0.06	0.07	0.08	0.09	0.11	0.14	0.17	Dec
PoR	0.47	0.13	0.00	12.50	0.03	0.06	0.07	0.10	0.13	0.17	0.27	0.58	1.34	PoR

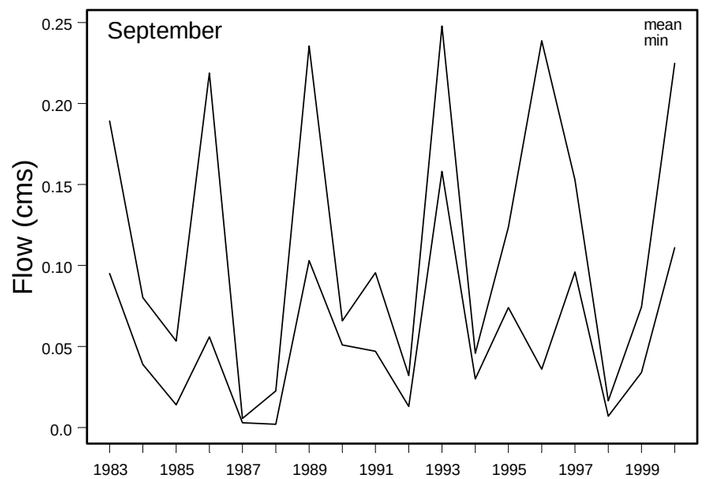




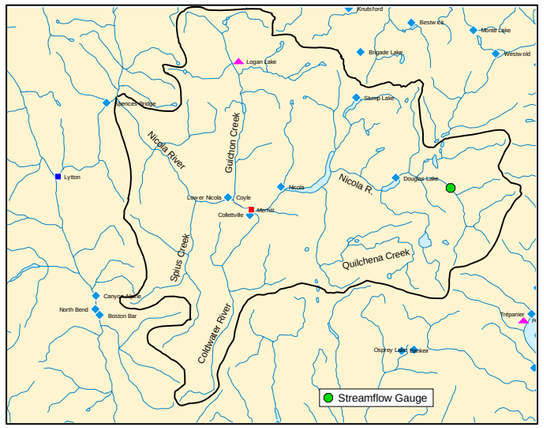


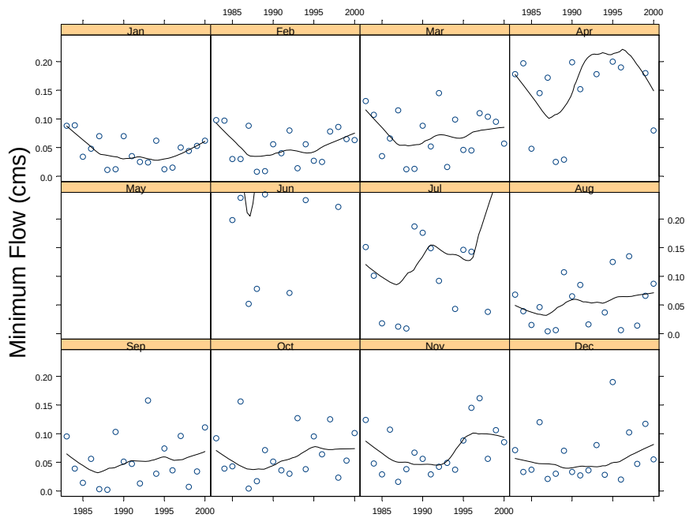


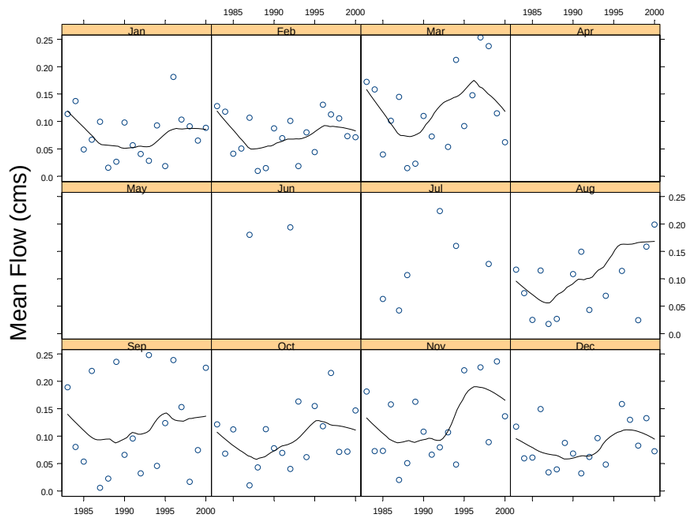


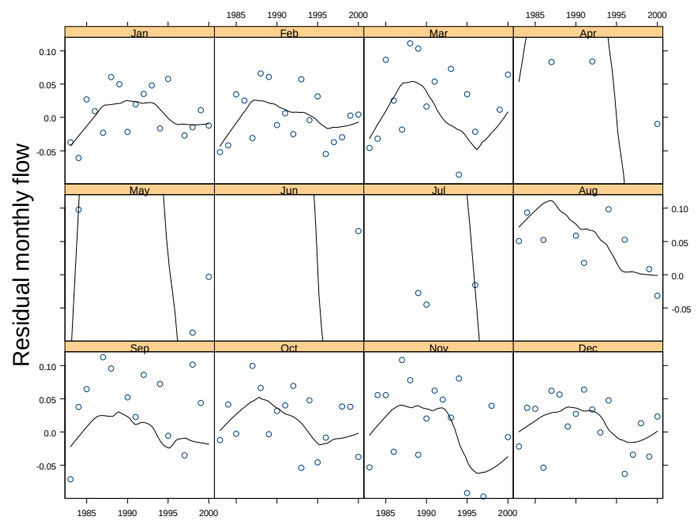


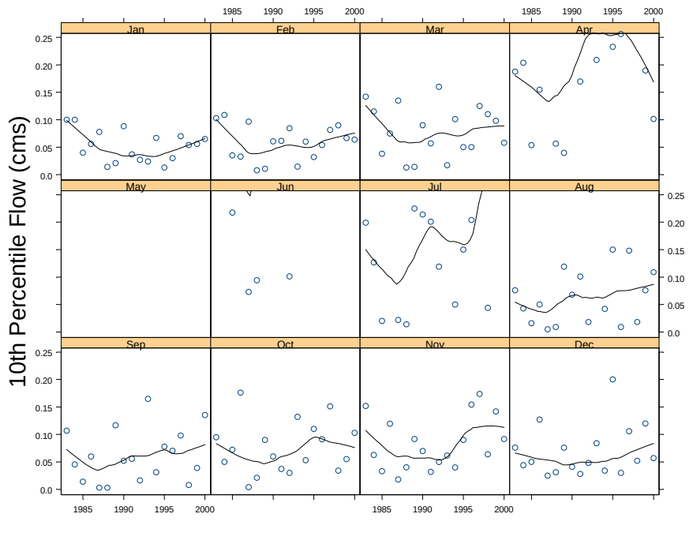
Station Name: Beak Creek at Mouth
Station ID: 08LG064
Period of record: 1982-2001
Complete records: 18 years
Drainage area: 85 km^2
Mean Annual Discharge: 0.47 m^3 sec^{-1}
Runoff: 183.3 L m^{-2} $year^{-1}$

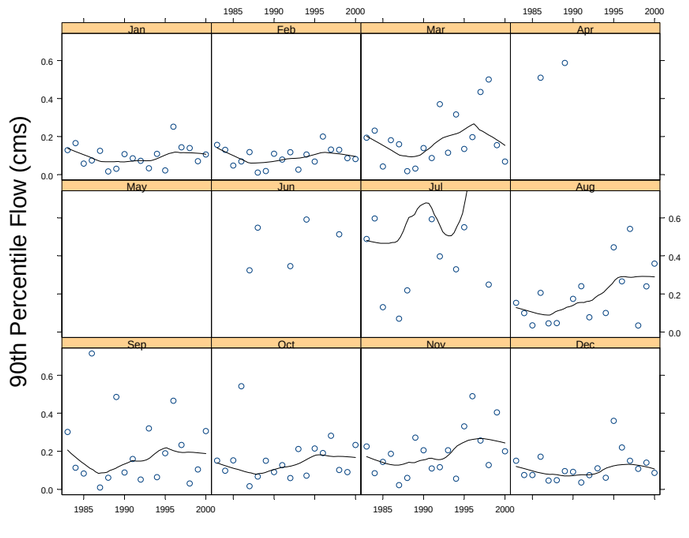




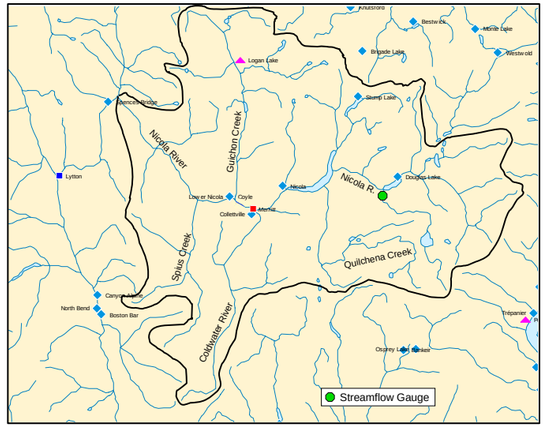




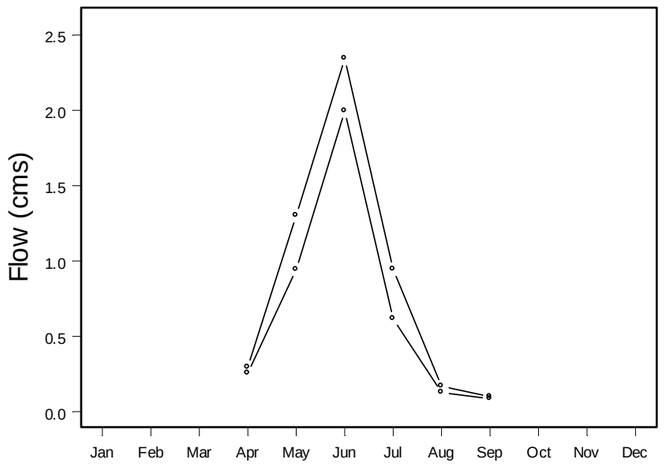


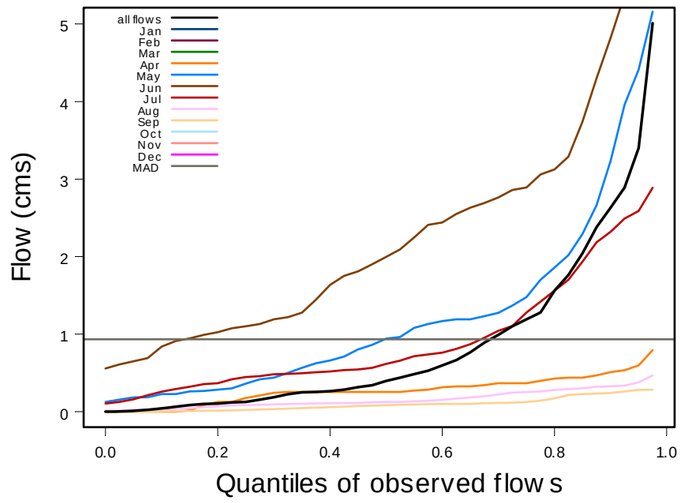


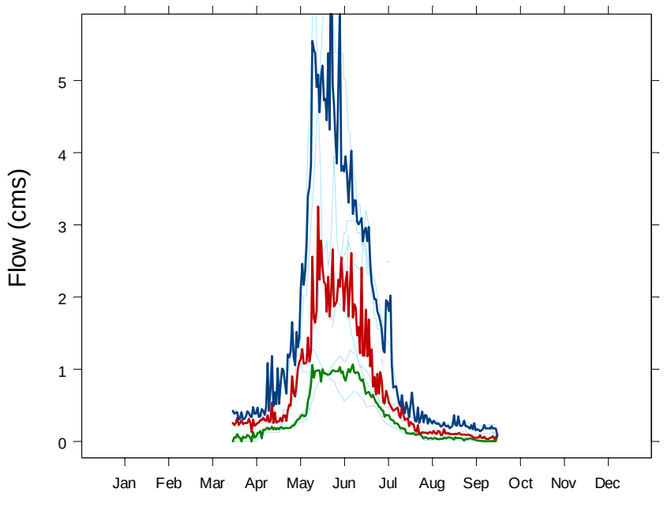
Station Name: Spahomin Creek near Douglas Lake
Station ID: 08LG018
Period of record: 1920-1967
Complete records: 0 years
Drainage area: 233 km^2
Mean Annual Discharge: NA
Runoff: NA

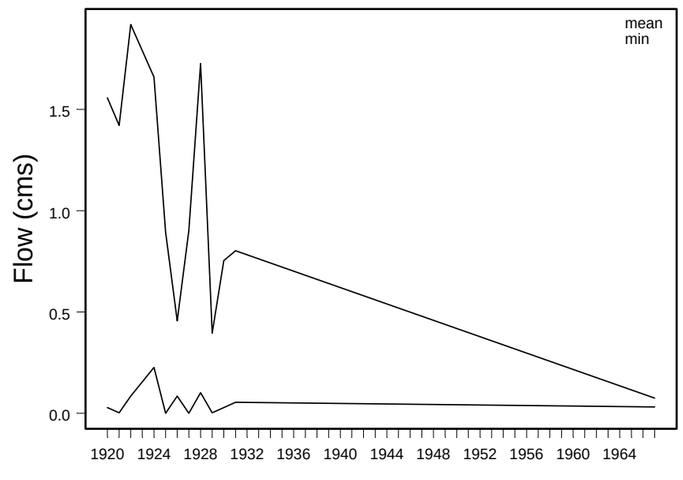


	percentiles													
	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
Jan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Jan
Feb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Feb
Mar	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Mar
Apr	0.294	0.255	0.000	1.730	0.000	0.127	0.242	0.255	0.255	0.314	0.367	0.428	0.510	Apr
May	1.300	0.943	0.127	6.800	0.227	0.283	0.439	0.659	0.943	1.168	1.273	1.858	3.235	May
Jun	2.344	1.995	0.558	9.490	0.838	1.026	1.190	1.634	1.995	2.440	2.762	3.124	4.820	Jun
Jul	0.944	0.616	0.105	3.200	0.259	0.368	0.481	0.519	0.616	0.762	1.042	1.560	2.320	Jul
Aug	0.168	0.127	0.014	0.906	0.025	0.071	0.093	0.109	0.127	0.152	0.222	0.280	0.329	Aug
Sep	0.099	0.085	0.003	0.496	0.003	0.014	0.031	0.057	0.085	0.099	0.113	0.172	0.242	Sep
Oct	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Oct
Nov	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Nov
Dec	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Dec
PoR	0.934	0.396	0.000	9.490	0.042	0.105	0.186	0.265	0.396	0.597	0.991	1.560	2.630	PoR

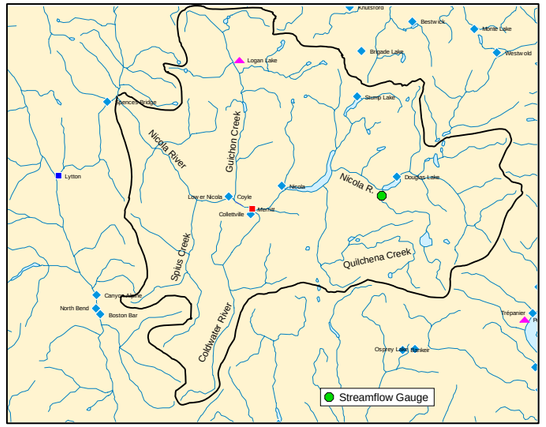




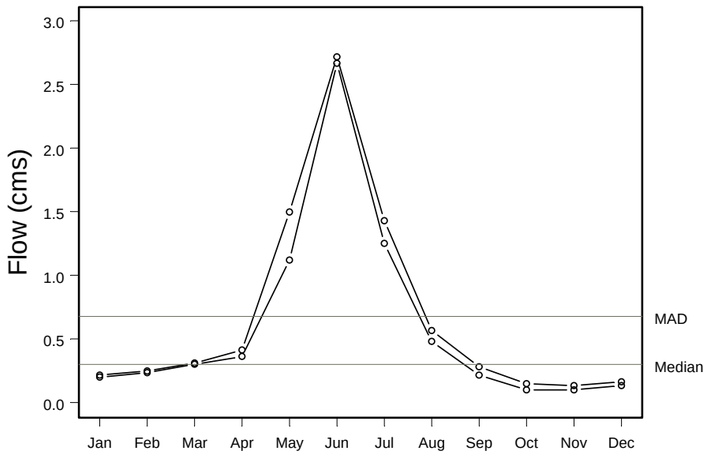


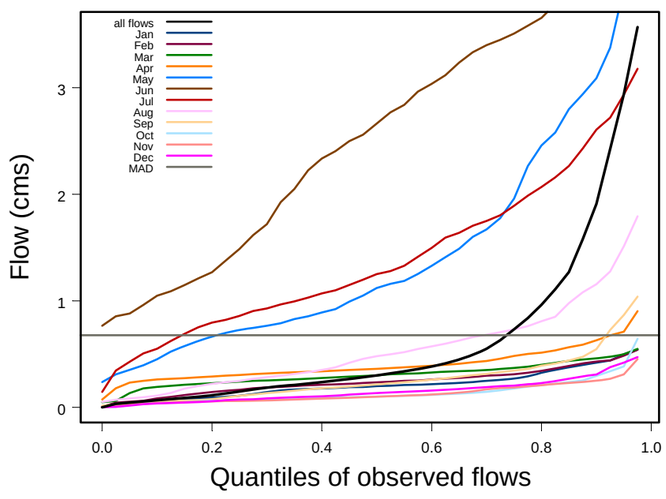


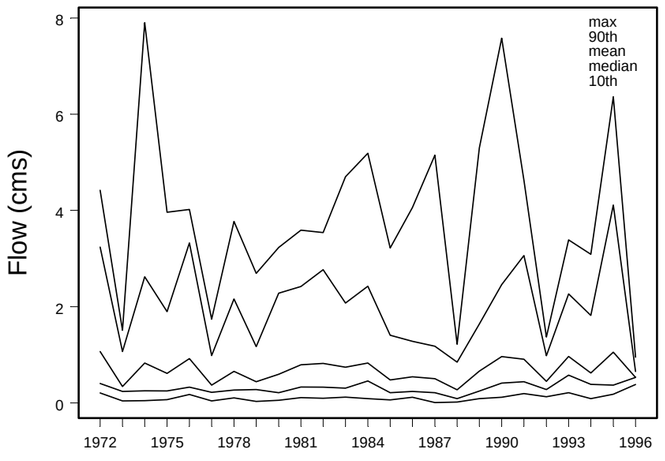
Station Name: Spahomin Creek near the mouth
Station ID: 08LG060
Period of record: 1972-1996
Complete records: 23 years
Drainage area: 241 km^2
Mean Annual Discharge: 0.678 m^3 sec^{-1}
Runoff: 87.4 L m^{-2} year^{-1}

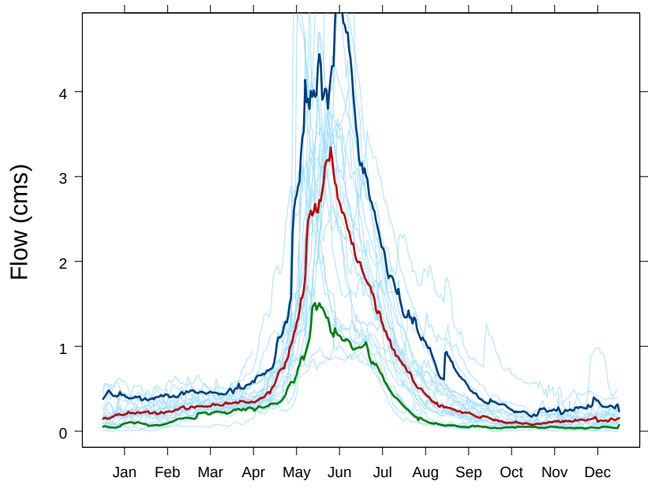


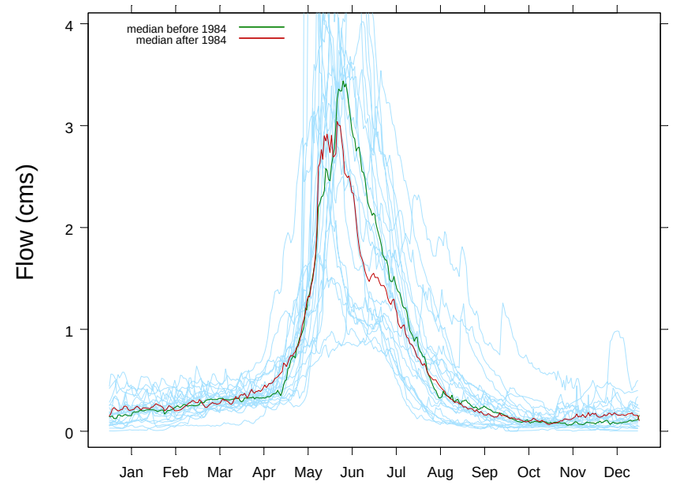
	mean	median	min	max	10th	20th	30th	40th	50th	60th	70th	80th	90th	month
							percentiles							
Jan	0.216	0.200	0.003	0.630	0.057	0.092	0.144	0.178	0.200	0.219	0.250	0.325	0.419	Jan
Feb	0.248	0.235	0.007	0.650	0.085	0.147	0.188	0.212	0.235	0.261	0.297	0.343	0.430	Feb
Mar	0.310	0.301	0.048	0.660	0.194	0.228	0.252	0.277	0.301	0.328	0.352	0.399	0.462	Mar
Apr	0.413	0.362	0.074	1.480	0.263	0.289	0.320	0.340	0.362	0.391	0.436	0.513	0.630	Apr
May	1.497	1.120	0.238	5.350	0.452	0.665	0.767	0.891	1.120	1.330	1.671	2.460	3.090	May
Jun	2.716	2.665	0.767	7.900	1.049	1.268	1.720	2.336	2.665	3.038	3.400	3.656	4.485	Jun
Jul	1.429	1.250	0.146	4.030	0.551	0.795	0.929	1.070	1.250	1.498	1.750	2.070	2.607	Jul
Aug	0.566	0.480	0.051	2.320	0.110	0.221	0.284	0.350	0.480	0.573	0.682	0.810	1.157	Aug
Sep	0.281	0.215	0.016	1.810	0.054	0.078	0.134	0.180	0.215	0.260	0.314	0.391	0.547	Sep
Oct	0.149	0.100	0.000	1.140	0.040	0.062	0.074	0.088	0.100	0.118	0.147	0.210	0.296	Oct
Nov	0.133	0.100	0.001	0.589	0.040	0.057	0.065	0.082	0.100	0.120	0.170	0.207	0.249	Nov
Dec	0.163	0.134	0.003	0.985	0.037	0.057	0.085	0.105	0.134	0.158	0.190	0.227	0.308	Dec
PoR	0.678	0.300	0.000	7.900	0.067	0.113	0.185	0.238	0.300	0.383	0.550	0.963	1.910	PoR

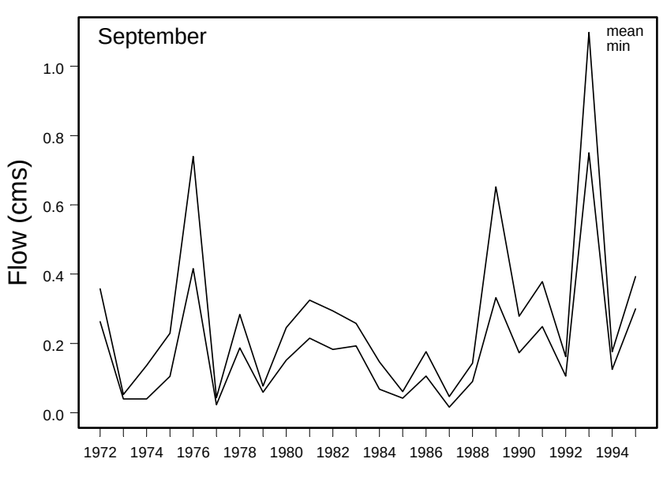












Station Name: Spahomin Creek near the mouth
Station ID: 08LG060
Period of record: 1972-1996
Complete records: 23 years
Drainage area: 241 km^2
Mean Annual Discharge: 0.678
Runoff: 87.4L m-2 year-1