



PRAIRIE PROVINCES WATER BOARD

Report #175

Response to the 2011 Pesticide Excursions
in
Transboundary Rivers in the Prairie Provinces of Canada

Prepared for the Prairie Provinces Water Board
By the Committee on Water Quality

February 2016

**Response to the 2011 Pesticide Excursions in Transboundary
Rivers in the Prairie Provinces of Canada**

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Introduction

Pesticides are substances or agents used to eliminate various unwanted pests (Goldsborough and Crumpton, 1998; Yao *et al.*, 2006). Several types of pesticides exist, including, but not limited to, herbicides, insecticides, and fungicides, which target plants, insects, and fungi, respectively (Goldsborough and Crumpton, 1998). More than half of all pesticide use in Canada can be attributed to Alberta, Saskatchewan, and Manitoba—known collectively as the Prairie Provinces (Waite *et al.*, 2005; Environment Canada, 2011). Herbicides account for the majority of pesticides used in the Prairie Provinces (Waite *et al.*, 2004; Tuduri *et al.*, 2006; Environment Canada, 2011; Messing *et al.*, 2011). For instance, in Alberta, 76.4% of pesticide active ingredients sold in or shipped into the province in 1998 were herbicides (Environment Canada, 2011). In Manitoba, herbicides composed 84.9% of pesticides used from 2001 to 2003 (Environment Canada, 2011).

A large portion of the Prairie Provinces is located within the Prairie Pothole Region of North America, a region that encompasses many productive wetland ecosystems (Messing *et al.*, 2011; Messing *et al.*, 2013). The prairie wetlands serve as a critical habitat for various flora and fauna (Donald *et al.*, 1999; Messing *et al.*, 2011; Messing *et al.*, 2013). This includes 50–80% of North America's ducks, as well as other North American waterfowl, which use the prairie wetlands as their breeding grounds (Goldsborough and Crumpton, 1998; Donald *et al.*, 1999; Messing *et al.*, 2011; Messing *et al.*, 2013). Other fauna include amphibians, insects, and crustaceans, some of which are unique to the prairie wetlands (Donald *et al.*, 1999).

The Prairie Pothole Region is also predominantly comprised of agricultural land (Donald *et al.*, 2000). Therefore the wetlands in the Prairie Pothole Region are surrounded by land that regularly receives direct inputs of pesticides (Goldsborough and Crumpton, 1998; Degenhardt *et al.*, 2011). For this reason, the prairie rivers and wetlands are highly susceptible to pesticide contamination (Degenhardt *et al.*, 2011). Pesticides may enter surface waters as a result of overland runoff (Donald *et al.*, 2000; Messing *et al.*, 2011) or wet and dry atmospheric deposition (Donald *et al.*, 2000; Waite *et al.*, 2005; Yao *et al.*, 2006; Messing *et al.*, 2011). Pesticides enter the atmosphere via gas exchange between air and water (Messing *et al.*, 2011), application drift (Yao *et al.*, 2006; Degenhardt *et al.*, 2011; Messing *et al.*, 2013), volatilization following application (Yoa *et al.*, 2006; Messing *et al.*, 2013), and on wind-eroded soil (Donald *et al.*, 2000; Waite *et al.*, 2005; Yao *et al.*, 2006). Pesticide contamination in surface waters can have a detrimental effect on aquatic flora and fauna (University of Iowa, 1993) so understanding and managing their risk to aquatic life and effect for other water uses is a priority.

Background

The Prairie Provinces Water Board (PPWB) has a mandate to foster and facilitate interprovincial water quality management among the parties and to encourage the protection and restoration of the aquatic environment. The PPWB has an active water quality program that includes long-term water quality monitoring at the transboundary rivers. The Committee on Water Quality (COWQ), a standing committee to the PPWB, annually reviews water quality monitoring results to interprovincial water quality objectives. As part of this annual reporting, the COWQ reports on adherence rates to these interprovincial objectives and highlights excursions to the objectives. In 2015, the water quality objectives for the transboundary rivers were reviewed and updated. The water quality objectives were developed to protect different water uses including the protection of aquatic life, agricultural uses, recreation and aesthetics, source water treatability, and fish consumption. Following the review of the interprovincial water quality objectives, and as an approach to address excursions to the water quality objectives, the COWQ developed the Response to Excursion Process (REP) for PPWB.

The REP is a series of steps and guidelines that are to be executed following observation of any excursion. The purpose of the REP is to develop an appropriate course of action in response to water quality excursions. Steps outlined in the REP include (1) determining, based on an observed water quality excursion, whether there is sufficient concern for further examination, (2) evaluating conditions relating to the observed excursion, (3) determining, based on evaluation of conditions, whether further examination is required and, if so, determining the scope of the examination and whom is responsible for conducting such examination, and (4) developing any reasonable recommendations to related government(s).

As the first step of the REP, if an excursion to a water quality objective is observed, it must be determined whether or not there is sufficient concern for further examination. To evaluate the REP for the PPWB, the COWQ selected pesticides as a group of parameters to assess the process.

The PPWB water quality monitoring program, which is carried out by Environment Canada, includes twelve rivers and incorporates three groups of pesticides; the acid herbicides, neutral herbicides, and organochlorines. Monitoring is completed monthly and on an annual basis for the Assiniboine and Carrot rivers, while sampling for the remaining ten rivers is completed on a rotational basis. Of the rivers that are sampled on a rotational basis 2 to 3 are sampled each year eight times a year (February, April, May, June, July, August, October and December) providing a four year return frequency for most PPWB rivers. The rotational sampling strategy for pesticides was developed and implemented in 2006. Sampling of pesticides was switched to rotational sampling from annual sampling at these sites as a result of a long data record, where most data points were below the analytical detection limits. The analytical detection limits have improved over time with changes to the analytical methodologies. In 2013, the COWQ recommended additional sampling of the acid herbicides on

two rivers (Battle and South Saskatchewan rivers) due to a number of detections in these two rivers. In 2015 the COWQ also recommended additional sampling on the Saskatchewan and Qu'Appelle rivers for acid herbicides.

In 2014, an internal report and literature review on pesticide excursions was conducted by the COWQ (Committee on Water Quality, 2014). The review included all pesticide data up until the end of 2013, and concluded there was sufficient evidence to warrant further examination of pesticides in the transboundary rivers.

The internal review of pesticide data concluded that, out of the three groups of pesticides currently monitored by PPWB, the acid herbicides had the greatest proportion of excursions and were therefore of greatest priority for follow-up. When reviewing pesticide excursions by category from 1991 to 2013, the review found that excursion frequency in the acid herbicide group greatly exceeded those in the organochlorine pesticide and neutral herbicide groups. Of the acid herbicides, 2-methyl-4-chloro phenoxy acetic acid (MCPA) and dicamba, had the most frequent excursions. The interprovincial water quality objective for MCPA is 0.025 µg/L and for dicamba is 0.006 µg/L. The objective for both these acid herbicides was set for the protection of agricultural uses, specifically irrigation.

When focusing on excursions among pesticides within the acid herbicide group from 2000 to 2013, analytical detection limits prior to 2000 were generally too high to detect the herbicides, COWQ found that MCPA and dicamba were the only two pesticides that exceeded their 2015 objectives. Of the 12 transboundary rivers that are monitored for pesticides, eight had excursions of MCPA, dicamba or both. The percentage of excursions for these eight rivers from 2000 to 2013 was approximately 20% for MCPA and 11% for dicamba. However, the review did not indicate annual excursion rates by river for either MCPA or dicamba.

The pesticide review also found that pesticide detection frequencies were highest in the months of March, April, June, July, and August. Although the report provided total pesticide detection frequency per month, it did not summarize the individual pesticide detection frequency per month, nor did it indicate individual pesticide excursion frequency per month. Thus, it remains to be determined which months exhibited the greatest exceedance rates, and which pesticides were exceeding objectives.

Finally, the pesticide data review did not address the type of objective being exceeded by each pesticide. If an objective is exceeded outside the relevant season for the use objective, then it may not be cause for concern. However, for example, if a Protection of Agriculture (Irrigation) objective is exceeded in one of the months in which irrigation occurs, then it may warrant further investigation.

The purpose of this report was to use the PPWB REP to develop a response to 2011 pesticide excursions in the transboundary rivers. The internal review of pesticide data for the transboundary sites completed the REP up to the evaluation step. Therefore, this report will

begin where the COWQ's internal review (May 2014) left off, with evaluation of the conditions related to excursions. It should be noted that although this report focused on excursions observed in 2011, the response was developed based on pending 2015 water quality objectives. It should also be noted that pesticides were chosen as the parameter for this response due to their anthropogenic nature.

Methods

This report used the PPWB REP (Figure 1) to develop a response to 2011 pesticide excursions. As a first step, pesticide excursions in 2011 were reviewed, and based on the number of excursions it was determined that further examination was warranted. Once it was determined that further review of the data was warranted it was then determined which of the pesticides exceeded the interprovincial water quality objectives and the river in which those exceedances occurred. Conditions related to the excursions were then evaluated.

This follow-up report is based on 2011 data compared to 2015 objectives. In 2011, MCPA exceeded its objective in four different rivers, while dicamba exceeded its objective in one river. Given these excursion frequencies, previous MCPA and dicamba data were reviewed to provide greater context to understand typical excursion frequencies and evaluated to determine if there are patterns in their concentrations. This review only includes data since 2000 because prior to 2000, detection limits were meaningfully greater. MCPA and dicamba data for all other PPWB rivers were reviewed to determine excursion frequency and patterns. This is especially important since most of the rivers are sampled for pesticides on a four year rotational basis. Data pertaining to the remaining fourteen monitored pesticides were also reviewed to determine if there have been excursions of other pesticide between 2000 and 2013.

All MCPA and dicamba data were used to determine annual exceedance rates for those two pesticides in all rivers that exhibited excursions between 2000 and 2013. Monthly excursion frequencies were also determined for both MCPA and dicamba to ascertain if seasonal trends were present.

Daily discharge data were obtained from Environment Canada's historical hydrometric database. Scattergraphs were created using SigmaPlot. Scattergraphs were constructed for each sampling year dating back to 2000, and for each river that exhibited at least one MCPA and/or dicamba excursion between 2000 and 2013. Each graph shows pesticide concentration and flow over time. This was done to allow visual examination of potential pesticide concentration-flow rate relationships.

The results of the completed evaluation were then used to assess whether further examination was required. The scope of further examination, and the responsible party, was also recommended. These recommendations are summarized for reporting to the PPWB and its jurisdictions.

Results

Analysis of pesticide data revealed excursions of MCPA and dicamba in 2011 at all four PPWB stations monitored. MCPA exceeded its objective in 33% (2/6), 13% (1/8), 50% (6/12), and 9% (1/11) of the samples in Battle, Red Deer (near Bindloss), Assiniboine, and Carrot rivers, respectively (Tables 1, 2, 4, and 5). Dicamba exceeded the objective in 13% (1/8) of samples in Red Deer River near Bindloss but was below the objective value for the other three rivers (Table 9). The four rivers that exhibited pesticide excursions in 2011 also had excursions of both MCPA and dicamba in other years (Tables 1, 2, 4, 5, and 9, Appendices A-D). MCPA in the Battle River was sampled in three years and exceeded the objective at a frequency of 43%, 33%, and 25% in 2007, 2011 and 2013, respectively (Table 1). Red Deer River near Bindloss was only sampled in 2007 and 2011 for pesticides and had an MCPA excursions rate of 13% in each year (Table 2). The Assiniboine and Carrot rivers had pesticide data collected for all years between 2000 and 2013. MCPA excursions occurred in the Assiniboine at least once in each year, with a maximum excursion frequency of 50% in 2011 (Table 4). The Carrot River exhibited MCPA excursions in 9 of the 14 sampling years (Table 5). The excursion frequency for MCPA in five of the fourteen years was greater than 17% with a maximum of 36% in 2012.

The focus of this report is to understand pesticide excursion frequency and associated patterns so examining excursions in years other than 2011 provides context of excursion rates. MCPA excursions were also found to have occurred in the South Saskatchewan and Qu'Appelle rivers. Data from other years for these two rivers found that MCPA exceeded its objective in the Saskatchewan River 13% (2006), 30% (2010) and 0% (2013) of the time. In the Qu'Appelle River MCPA exceeded its objective once in 2008 and 8 times (100%) in 2012 (Table 6).

Analysis of dicamba data from rivers not sampled for pesticides in 2011 the Battle, North Saskatchewan, South Saskatchewan, Assiniboine, Carrot, Qu'Appelle, and Saskatchewan rivers found some excursions occurred between 2000 and 2013. In the Battle River, dicamba exceeded the objective 14% (1/7) of the time in 2007 but did not exceed in either 2011 or 2013 (Table 7). In the North Saskatchewan River, one of two sampling years exhibited excursions in 10% (2010) of samples while there were no excursions in 2006 (Table 8). In the South Saskatchewan River, dicamba exceeded its objectives in all three sampling years, in 50% (2006), 20% (2010), and 25% (2013) of samples taken (Table 10). In the Assiniboine River exceedences were observed in eight out of fourteen sampling years (Table 11). In five of those eight years, the objective was exceeded in more than two samples. In the Carrot River, exceedences were observed in six out of fourteen sampling years (Table 12). Four of those six years exhibited excursions in more than 2 samples. Interestingly, for the Assiniboine and Carrot rivers, there were no dicamba excursions in the most recent years, 2010-2013. In the Qu'Appelle River, dicamba exceeded its objective in 75% of samples in 2012 but had no excursions in 2008 (Table 13). In the Saskatchewan River, dicamba exceeded in 33% of the samples in 2000, with no excursions in the six years samples were collected between 2001 and 2012 (Table 14).

The only pesticide other than MCPA and dicamba that exhibited excursions between 2000 and 2013 was endosulfan. Endosulfan is an organochlorine pesticide and has a low absolute objective value (3 ng/L). There were three endosulfan excursions from 2000 to 2013, one each on the Battle, Assiniboine and Carrot rivers. All three endosulfan excursions occurred in 2007.

The majority of excursions among all rivers and dates (2000 to 2013) occurred in July, followed by June, then August (Figure 2). Of the four rivers that exhibited MCPA excursions in 2011, all four had the most excursions in July (Figures 3, 4, 6, and 7), although the Battle River had an equal number of excursions in June (100%).

The majority of dicamba excursions in all rivers between 2000 and 2013 occurred in July, although the frequency of excursions in July was substantially lower than MCPA and the overall frequency distribution was flatter compared to MCPA (Figure 9). July exhibited the most excursions in the Battle, North Saskatchewan, Red Deer (Bindloss) and Assiniboine rivers (Figures 10, 11, and 14), although the Red Deer River had equal excursion rates in April, June, July and August. July was not the month with the most frequent excursions for the South Saskatchewan, Carrot, Qu'Appelle, and Saskatchewan rivers (Figures 12, 13, and 15-17). On the South Saskatchewan River, July had the fewest excursions. In the Qu'Appelle River, July had no excursions.

The MCPA-Flow scattergraphs (Appendix B) illustrate that MCPA excursions sometimes co-occur with peak flows (Figures 21, 22, and 33), but not always (Figures 23-25). Many of the graphs also illustrate higher MCPA concentrations between 20 and 40 ng/L through April and May, which coincide with large increases in flow (Figures 18, 26-28, and 31). The impact of flow on pesticide concentrations in these rivers is unclear, given inflows can increase pesticide concentrations because inflows carry pesticides into the rivers, but if inflow concentrations are low they could dilute the in-river concentrations. In addition, timing of monitoring, pesticide applications, deposition, irrigation return flow, runoff, sediments and environmental pesticide half-life can all affect measured concentrations.

The scattergraphs presenting dicamba and daily flow rates (Appendix D) indicate some trends similar to those presented by the MCPA graphs. Many of the dicamba graphs illustrate pesticide detections between the beginning of July and the end of October at concentrations between 8 and 22 ng/L. While some of the graphs illustrate increased dicamba concentrations corresponding with increases in flow (Figures 35, 36, and 42) others do not (Figures 38, 39, 41, and 43).

Discussion

The consistency and frequency of MCPA excursions indicate that annual MCPA excursions are persistent in a number of the PPWB rivers including the Battle, Red Deer (Bindloss), South Saskatchewan, Assiniboine, Carrot, and Qu'Appelle rivers. The MCPA

excursion data for the rivers exhibiting excursions between 2000 and 2013 suggests that there are a sufficient number of excursions to warrant further examination as identified in the steps in REP flow chart. The majority of sampling years in the Battle, Red Deer (Bindloss), South Saskatchewan, Assiniboine, Carrot, and Qu'Appelle rivers exhibit excursions in over 10% of samples. For instance, in the Battle River, MCPA exceeded its objectives in all three sampling years over 25% of the time. The Assiniboine River exhibited excursions for 14 consecutive years. Moreover, only two of those years had excursions rates of less than 10%. In some of the most recent years, from 2008 to 2012, excursions in Assiniboine River occurred in over a quarter of the samples.

The dicamba excursion data for the rivers exhibiting excursions between 2000 and 2013 also indicated a sufficient number of excursions that, as with MCPA, justifies further examination as a decision point within the REP. The Red Deer River near Bindloss exhibited dicamba excursions in more than 10% of samples in both years it was sampled. The South Saskatchewan River had excursions in 20% or more of samples in each of the three sampling years. Although the Qu'Appelle River did not exhibit any excursions in 2008, in 2012 all eight samples exceeded the objective suggesting that further sampling should be conducted to better assess the year to year variability and typical frequency of excursions.

The analysis did not indicate sufficient concern for further examination of conditions related to endosulfan excursions. Only three endosulfan excursions occurred between 2000 and 2013, all of which took place in February and March of 2007, each in a different river. Although all three excursions occurred within two to three weeks of each other, they occurred in three different rivers (Battle, Assiniboine, and Carrot rivers). The chronological proximity of the three excursions may be explained by increased use of endosulfan in the year preceding the excursions, although this is unknown. Endosulfan does enter the aquatic environment through spray drift, long range atmospheric transport or leaching and runoff from terrestrial applications.

The MCPA and dicamba monthly excursion frequency graphs illustrate patterns in the excursions. Annual MCPA and dicamba excursions were most frequently observed in June, July and August for MCPA. This is significant because, for both MCPA and dicamba, the objectives that were exceeded were for the protection of agriculture uses, specifically irrigation. The MCPA irrigation objective of 25 ng/L is from a study of effects on lettuce; with recommended guidelines for cereals, tame hay and pasture at 160 ng/L. The dicamba objective of 6 ng/L is based on recommended irrigation guidelines for crops other than cereals, tame hays and pasture (600 ng/L) and legumes (60 ng/L). Because the excursions occurred during the summer months, when irrigation is most likely to occur, the excursions are of greater cause for concern than if they occurred, for example, during the winter. Both MCPA and dicamba also have Protection of Aquatic Life objectives, which are 2.6 µg/L and 10 µg/L respectively, but these objectives were not exceeded at any point between 2000 and 2013.

Although no known data exist on specific timing of pesticide application during these years farmers conventionally apply herbicides once a year, between May and the first week of July (Donald *et al.*, 2000). Donald *et al.* (2000) explain that, as a result, wetlands receiving runoff from agricultural fields generally exhibit highest pesticide concentrations from late June to early July. This is consistent with some of the findings of this report. For instance, in the Assiniboine River in 2009 (Figure 28), a small MCPA excursion (roughly 30 ng/L) is observed in mid-April; this excursion overlaps with an increase in flow. Given the time of year, this can most likely be explained by snowmelt run-off. However, a second, much larger MCPA excursion is observed in mid-July. Unlike the first excursion, there is no increase in flow rate to explain the second excursion. Therefore, it is possible that the second excursion was mainly caused by another process such as wet and/or dry atmospheric deposition following pesticide application.

Dicamba displayed seasonal increases in excursion frequency similar to those of MCPA. However, the increases displayed by dicamba usually occur between the beginning of July and the end of October. Although dicamba does not spike at the time of year predicted by Donald *et al.* (2000), the increases may still be a result of pesticide application at this time. The difference in response within the river, for example, may be related to longer transport times. However, the actual cause and transporting path will require further investigation to find out.

Conclusions and Recommendations

This report provides information as part of the REP to develop a response to 2011 pesticide excursions. Specifically, this review provides the second step in the process by summarizing, in greater detail, the frequency of excursions from all the sites with pesticide data in 2011 and comparing these to excursion frequency over a longer time period.

Although all pesticide data from 1991 onwards were reviewed, pesticide excursions that occurred in 2011 were the initial focus of this report. This review was undertaken as part of the response to the excursions observed in 2011 and to ascertain if excursions to pesticides (dicamba and MCPA) warranted further evaluation. Exceedance and flow rate scattergraphs, tables presenting annual exceedance rates, and column graphs presenting monthly excursion rates were constructed to assess potential relationships.

Key findings and recommendations developed for this stage of investigation are as follows.

2011 Excursions - key findings

- (1) Battle River: of the six samples collected there were two MCPA excursions in 2011 (Figure 19). One excursion occurred June 21, the other July 13. Figure 19 does not suggest a correlation between flow and increases in pesticide. For this reason, and because these two excursions occur between mid-June and mid-July, it is assumed that

the 2011 MCPA excursions in Battle River are a result of pesticides applied between May and the first week of July.

- (2) Red Deer River near Bindloss: of the eight samples collected there was one MCPA excursion in 2011 (Figure 20), which occurred during the first week of July. There does appear to have been an above-average flow rate during that time. Figure 20 indicates a higher flow rate at the beginning of June, but the corresponding MCPA concentration is less than 5 ng/L. This suggests that pesticide concentration fluctuates independently of flow rate, or could potentially be influenced by the effect of dilution. However, the July excursion is assumed to be due to May-July pesticide application.
- (3) Assiniboine River: of the twelve samples collected there were six MCPA excursions in 2011 (Figure 29). The first three excursions occurred in January, February, and March, occurring prior to spring runoff. Flow rate during these first three excursions, although it remained below $20\text{m}^3/\text{s}$, was greater compared to the flow rate at the end of 2011, during November and December. It was a wet autumn in 2010, so this would have potentially increased the groundwater input to base flow through the early part of 2011. The last three excursions of 2011, which occurred in July, August, and September, are greater and coincide with the irrigation season. The last three excursions do not appear to coincide with any rise in flow rate.
- (4) Carrot River: of the eleven samples collected there was one MCPA excursion in 2011 (Figure 32). Like the other 2011 MCPA excursions, this one occurred during the summer, in mid-July, and does not appear to coincide with flow rate. Therefore, the Carrot River MCPA excursion is assumed to be a result of pesticides applied between May and July.
- (5) One dicamba excursion occurred in the Red Deer River near Bindloss during the first week of July (Figure 34). Similar to the MCPA excursion that occurred in Red Deer River near Bindloss in 2011, this excursion corresponds with above-average flow rates for this time of year, but is not believed to be caused by increased flow, which occurred in April, May, and June. Therefore, the 2011 dicamba excursion in Red Deer River near Bindloss is assumed to be a result of late spring/early summer pesticide application.

Given that the 2011 excursions (i.e., four sites with at least one MCPA excursion and one site with one dicamba excursion) occurred in rivers along both the Alberta-Saskatchewan and Saskatchewan-Manitoba borders, the following recommendations may be applied.

Recommendations

- (1) The PPWB should notify each jurisdiction about the regular occurrence of acid herbicide (MCPA and Dicamba) excursions to the interprovincial water quality objectives. The PPWB should request feedback from each of the jurisdictions on the awareness of the pesticide concerns and any actions/programs that are being undertaken within the jurisdictions to address this issue.
- (2) It is also recommended that PPWB request any additional, available pesticide data and potential impacts from the Alberta, Saskatchewan, and Manitoba provincial jurisdictions

to expand the current data set and increase insight on pesticide prevalence and impacts in surface water on the prairies. In this case, the provincial jurisdictions should compile and review their data and report back to the PPWB.

- (3) Annual monitoring in the Assiniboine and Carrot rivers should be maintained, but acid herbicide monitoring should be increased for the rivers that most frequently exhibit pesticide excursions. This includes the Battle, Red Deer (Bindloss), South Saskatchewan, Saskatchewan and Qu'Appelle rivers. The non-acid herbicide groups should continue to be monitored according to current protocol.

PPWB Response to Excursion Process

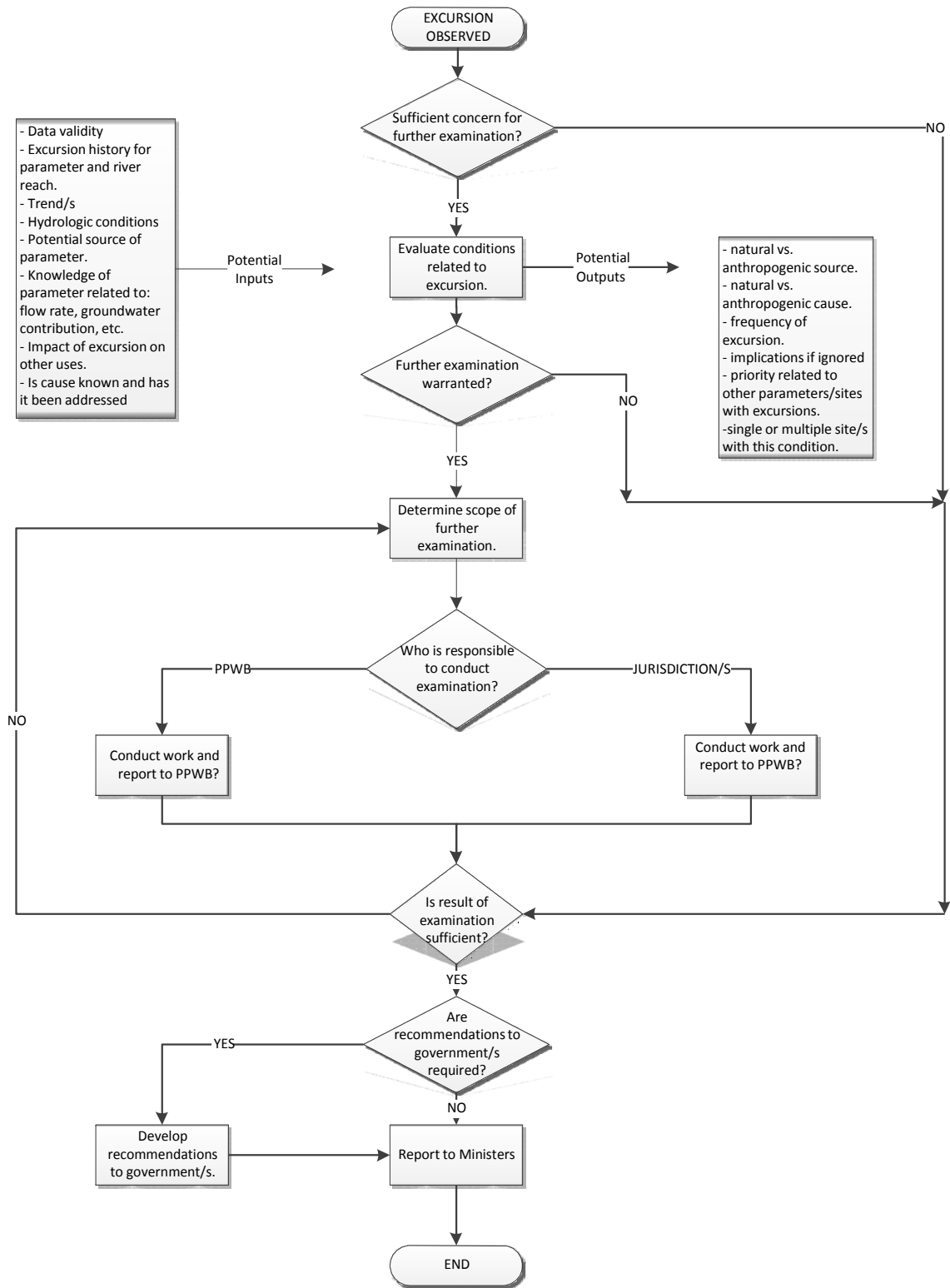


Figure 1: Prairie Provinces Water Board’s Response to Excursion Process (REP)

Table 1: MCPA excursions in Battle River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	MCPA in Battle River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective								3				2		2
Total number of samples								7				6		8
Percent of samples that exceeded objective								43%				33%		25%

Table 2: MCPA excursions in Red Deer River near Bindloss between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	MCPA in Red Deer River near Bindloss													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective								1				1		
Total number of samples								8				8		
Percent of samples that exceeded objective								13%				13%		

Table 3: MCPA excursions in South Saskatchewan River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	MCPA in South Saskatchewan River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective							1				3			0
Total number of samples							8				10			8
Percent of samples that exceeded objective							13%				30%			0%

Table 4: MCPA excursions in Assiniboine River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	MCPA in Assiniboine River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective	2	2	1	4	4	6	2	2	4	3	4	6	3	1
Total number of samples	10	16	11	16	19	15	11	12	12	10	12	12	12	12
Percent of samples that exceeded objective	20%	13%	9%	25%	21%	40%	18%	17%	33%	30%	33%	50%	25%	8%

Table 5: MCPA excursions in Carrot River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	MCPA in Carrot River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective	0	0	0	1	0	2	1	2	1	0	2	1	4	2
Total number of samples	11	12	11	11	12	12	12	12	12	10	11	11	11	9
Percent of samples that exceeded objective	0%	0%	0%	9%	0%	17%	8%	17%	8%	0%	18%	9%	36%	22%

Table 6: MCPA excursions in Qu'Appelle River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	MCPA in Qu'Appelle River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective									1				8	
Total number of samples									9				8	
Percent of samples that exceeded objective									11%				100%	

Table 7: Dicamba excursions in Battle River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in Battle River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective								1				0		0
Total number of samples								7				6		8
Percent of samples that exceeded objective								14%				0%		0%

Table 8: Dicamba excursions in North Saskatchewan River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in North Saskatchewan River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective							0				1			
Total number of samples							5				10			
Percent of samples that exceeded objective							0%				10%			

Table 9: Dicamba excursions in Red Deer River near Bindloss between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in Red Deer River near Bindloss													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective								3				1		
Total number of samples								8				8		
Percent of samples that exceeded objective								38%				13%		

Table 10: Dicamba excursions in South Saskatchewan River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in South Saskatchewan River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective							4				2			2
Total number of samples							8				10			8
Percent of samples that exceeded objective							50%				20%			25%

Table 11: Dicamba excursions in Assiniboine River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in Assiniboine River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective	1	2	0	2	2	7	0	1	1	2	0	0	0	0
Total number of samples	10	16	11	16	19	15	11	12	12	10	12	12	12	12
Percent of samples that exceeded objective	10%	13%	0%	13%	11%	47%	0%	8%	8%	20%	0%	0%	0%	0%

Table 12: Dicamba excursions in Carrot River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in Carrot River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective	1	0	0	0	2	4	2	2	0	0	0	0	1	0
Total number of samples	11	12	11	11	12	12	12	12	12	10	11	11	11	9
Percent of samples that exceeded objective	9%	0%	0%	0%	17%	33%	17%	17%	0%	0%	0%	0%	9%	0%

Table 13: Dicamba excursions in Qu'Appelle River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in Qu'Appelle River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective									0				6	
Total number of samples									9				8	
Percent of samples that exceeded objective									0%				75%	

Table 14: Dicamba excursions in Saskatchewan River between 2000 and 2013. Fields highlighted in yellow indicate sampling years. No samples were collected during years whose fields are not highlighted.

	Dicamba in Saskatchewan River													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of samples that exceeded objective	1	0	0	0	0				0				0	
Total number of samples	3	4	3	2	1				8				8	
Percent of samples that exceeded objective	33%	0%	0%	0%	0%				0%				0%	

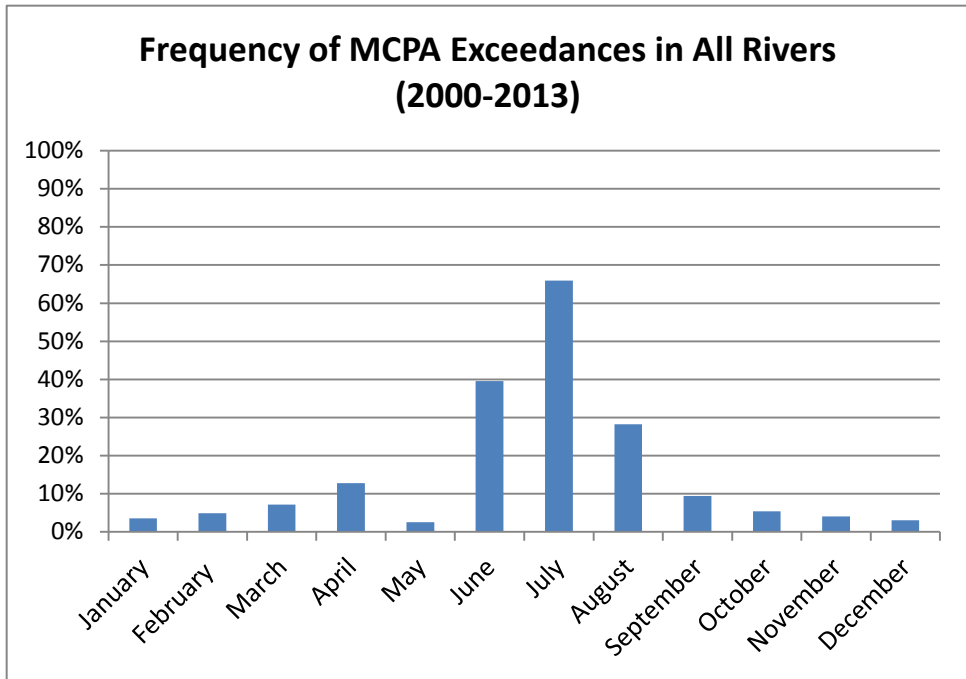


Figure 2: Monthly frequencies of MCPA excursions in all rivers between 2000 and 2013. No samples were collected for the months that do not appear in the graphs:

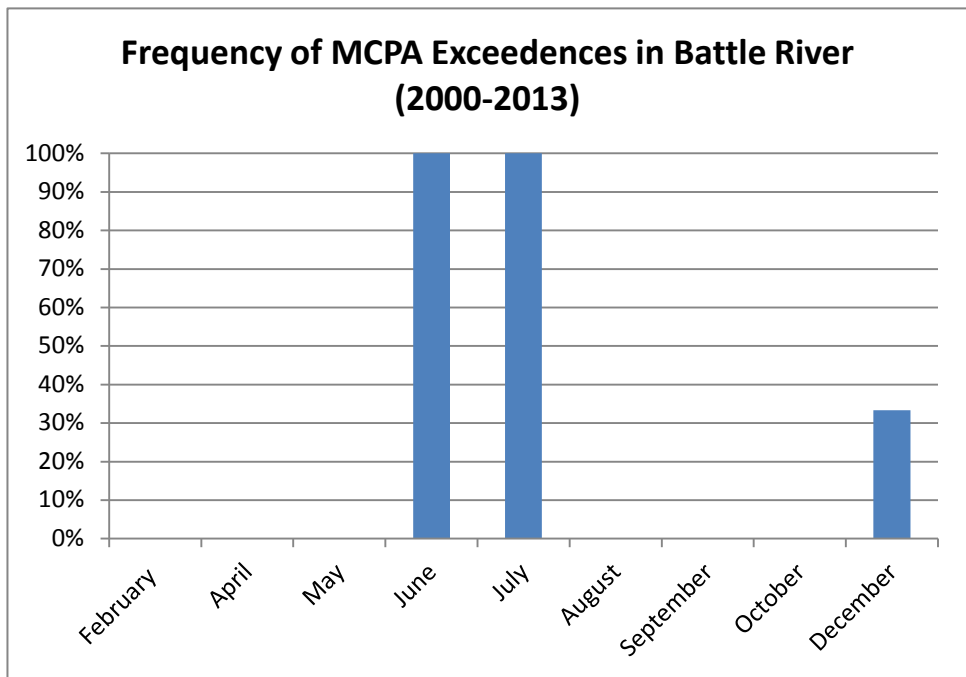


Figure 3: Monthly frequencies of MCPA Excursions in Battle River for 2007, 2011 and 2013. No samples were collected for the months that do not appear in the graphs.

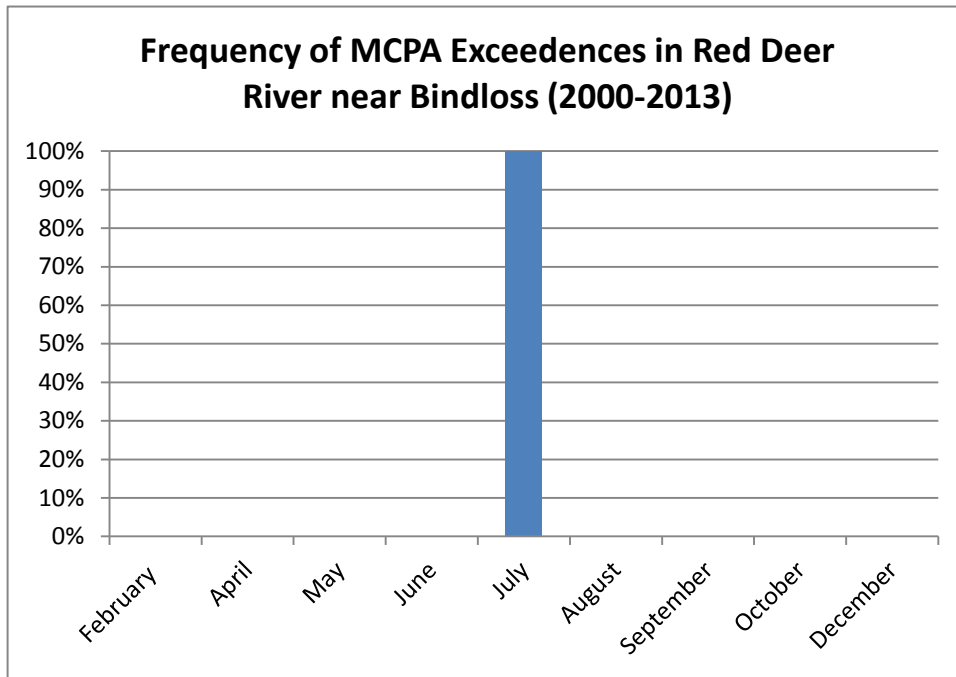


Figure 4: Monthly frequencies of MCPA excursions in Red Deer River near Bindloss for 2007 and 2011. No samples were collected for the months that do not appear in the graphs.

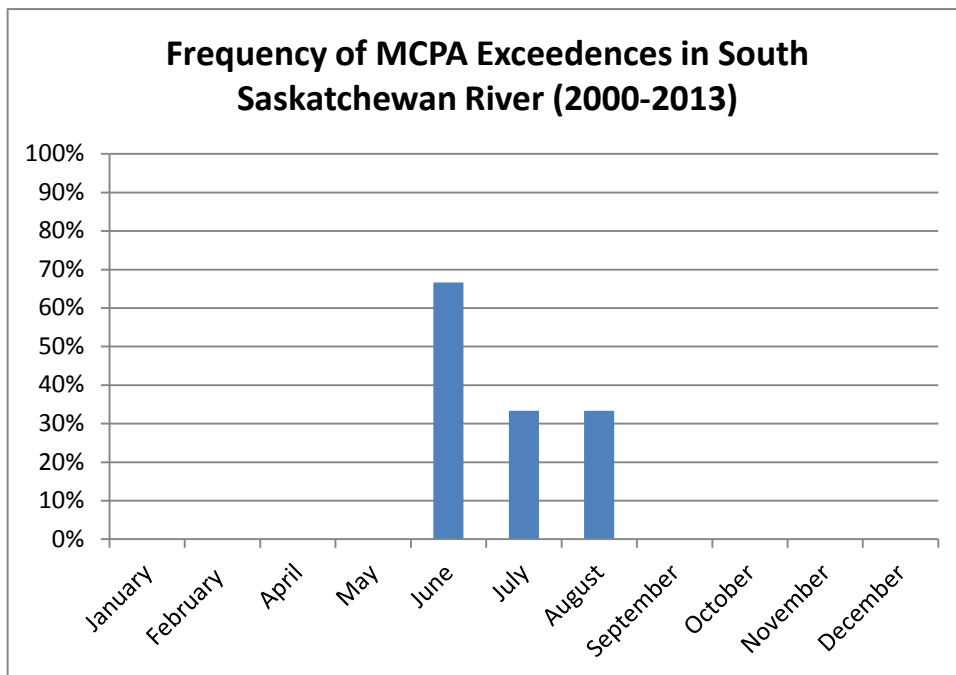


Figure 5: Monthly frequencies of MCPA excursions in South Saskatchewan River for 2006, 2010 and 2013. No samples were collected for the months that do not appear in the graphs.

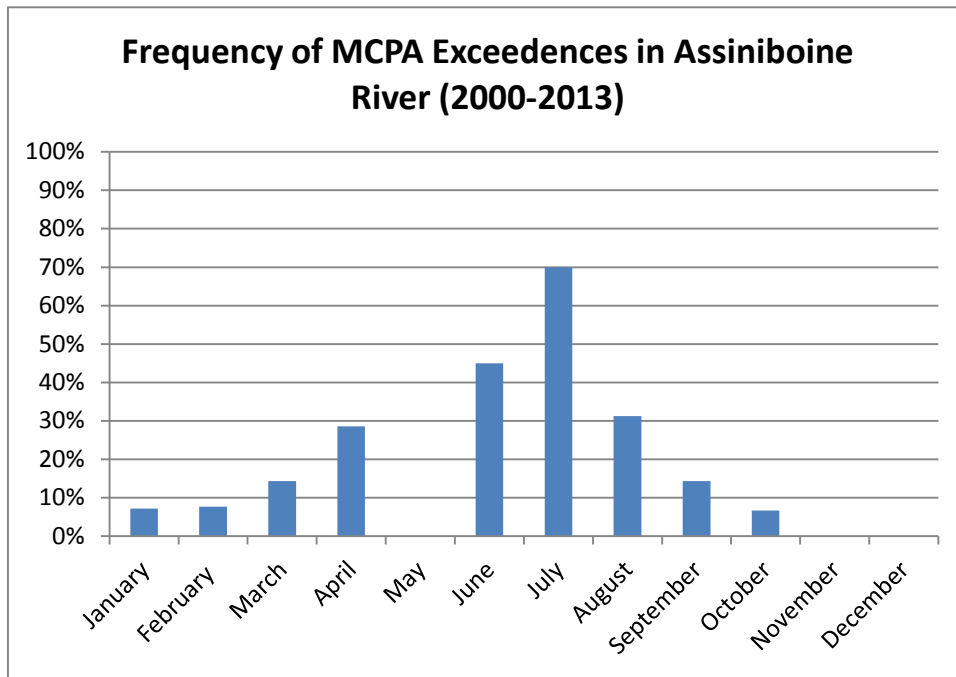


Figure 6: Monthly frequencies of MCPA excursions in Assiniboine River between 2000 and 2013. No samples were collected for the months that do not appear in the graphs.

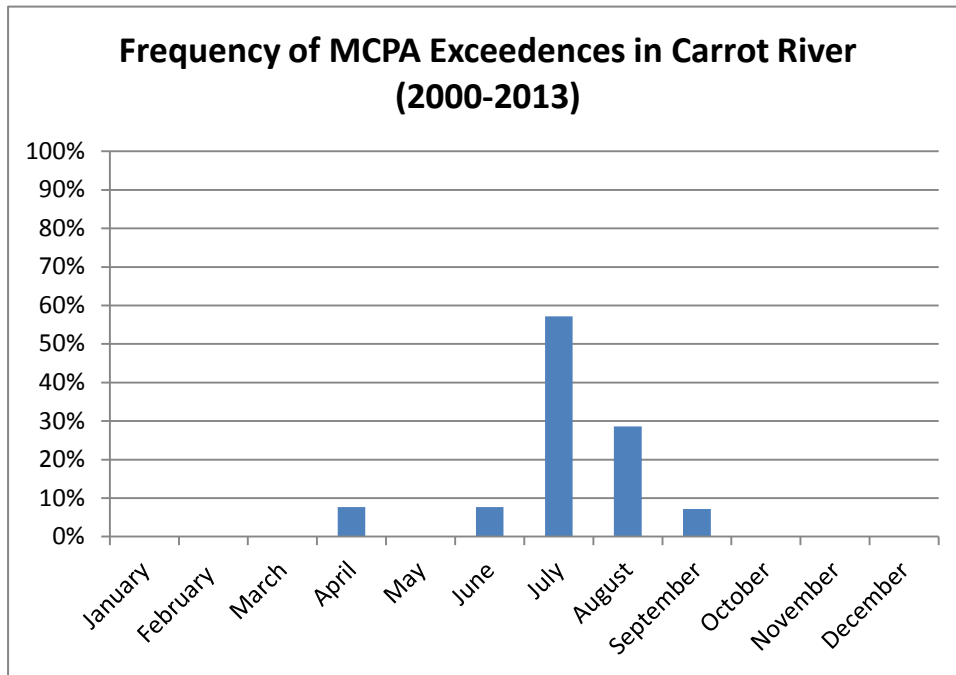


Figure 7: Monthly frequencies of MCPA excursions in Carrot River between 2000 and 2013. No samples were collected for the months that do not appear in the graphs.

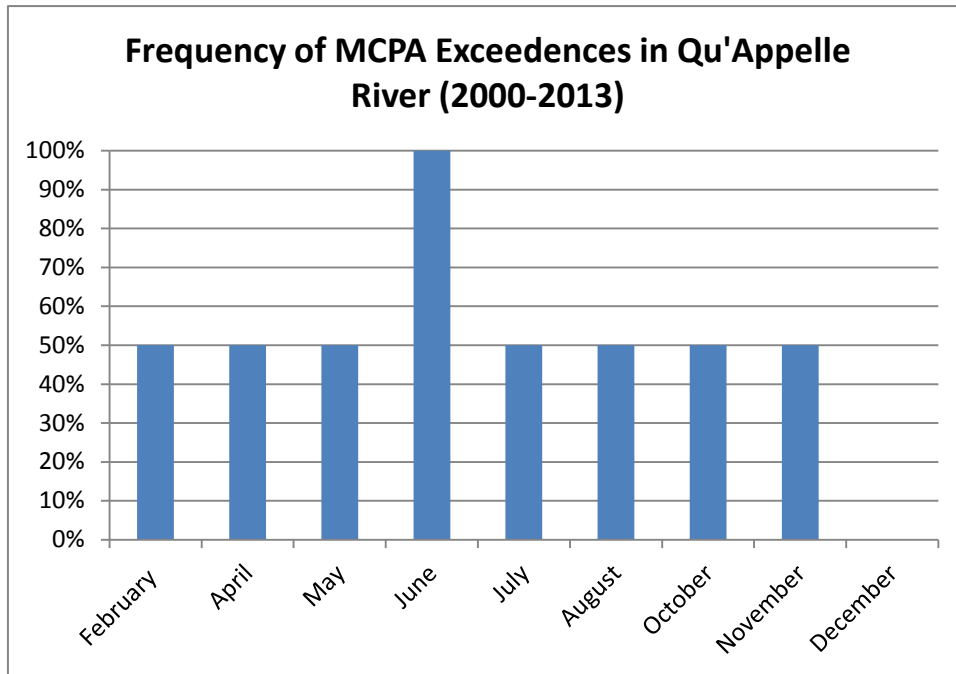


Figure 8: Monthly frequencies of MCPA in Qu'Appelle River for 2008 and 2012. No samples were collected for the months that do not appear in the graphs.

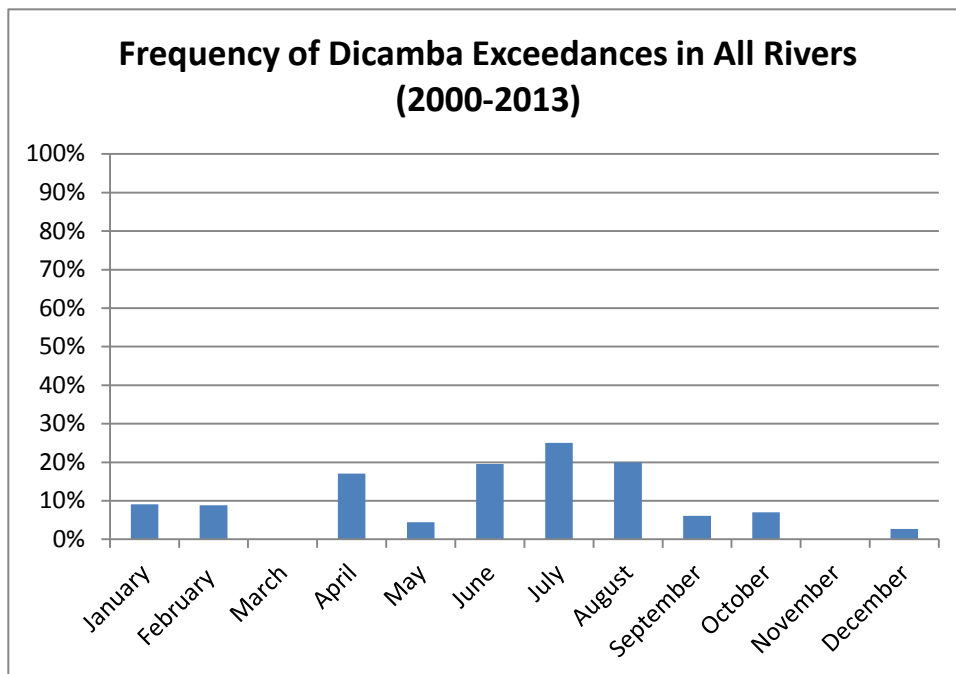


Figure 9: Monthly frequencies of dicamba excursions in all rivers exhibiting excursions between 2000 and 2013. No samples were collected for the months that do not appear in the graphs.

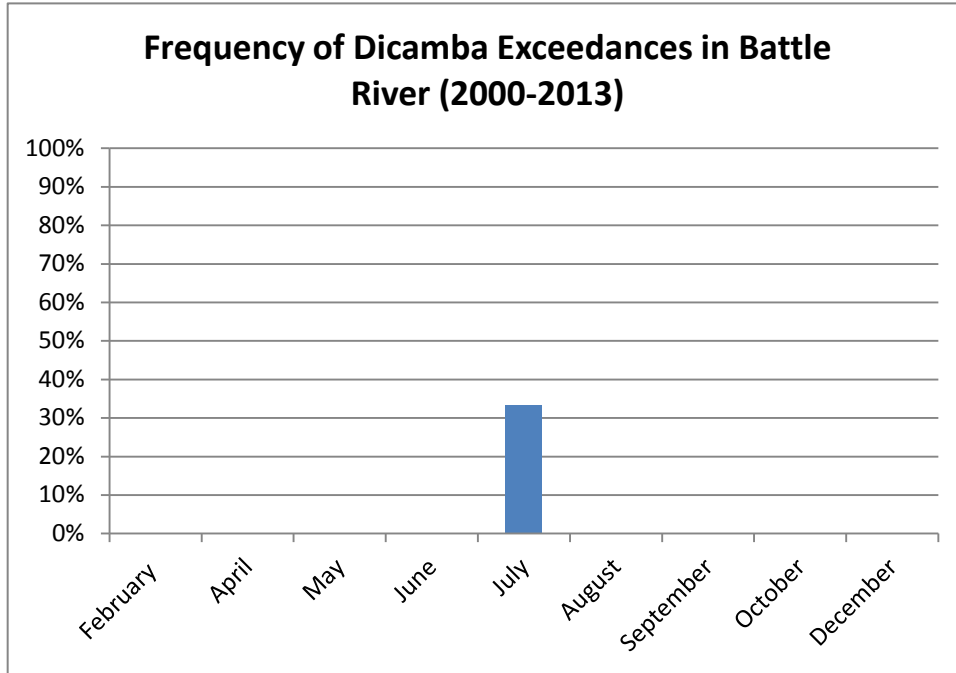


Figure 10: Monthly frequencies of dicamba excursions in Battle River for 2007, 2011 and 2013. No samples were collected for the months that do not appear in the graphs.

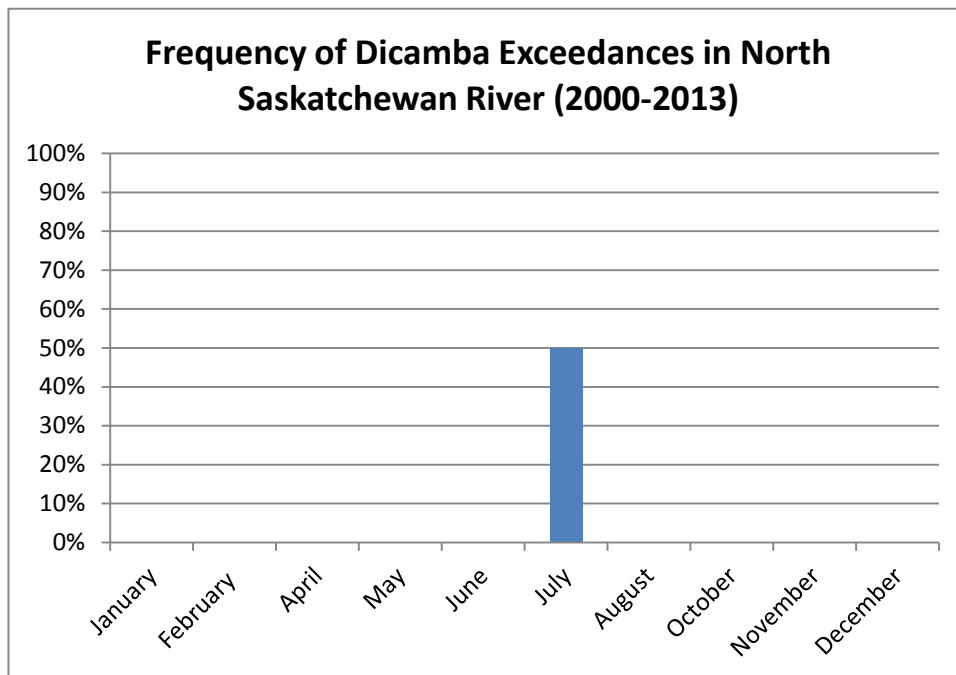


Figure 11: Monthly frequencies of dicamba excursions in North Saskatchewan River for 2006 and 2010. No samples were collected for the months that do not appear in the graphs.

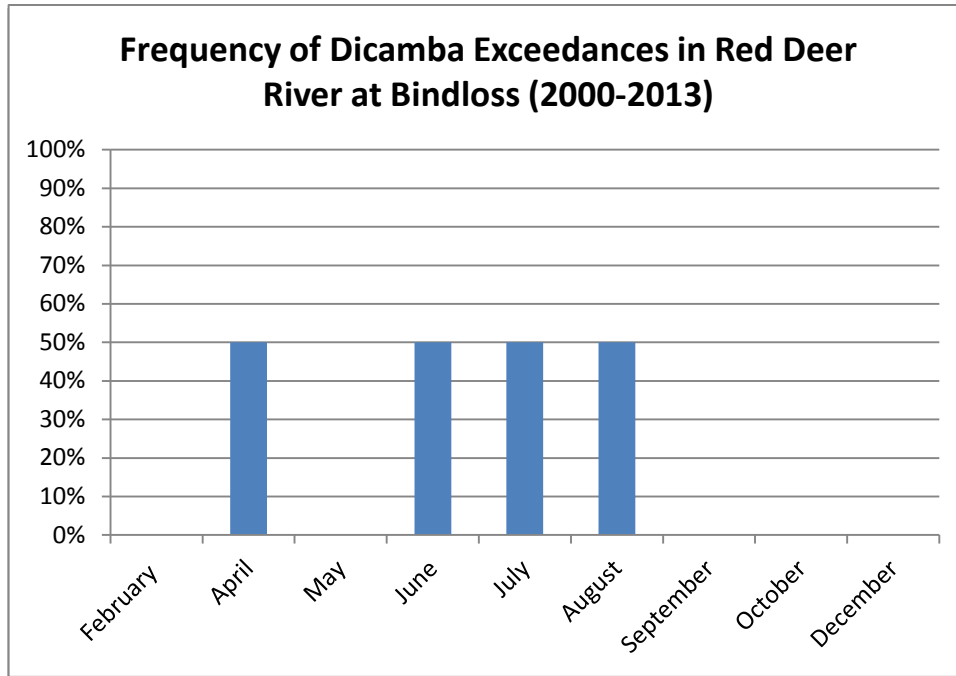


Figure 12: Monthly frequencies of dicamba excursions in Red Deer River near Bindloss for 2007 and 2011. No samples were collected for the months that do not appear in the graphs.

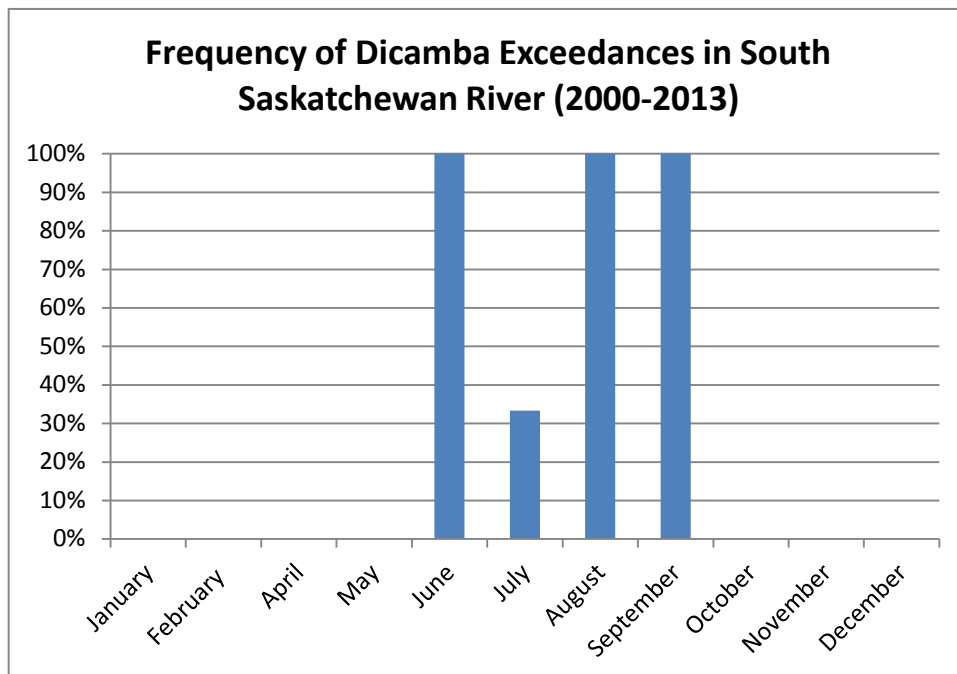


Figure 13: Monthly frequencies of dicamba excursions in South Saskatchewan River for 2006, 2010 and 2013. No samples were collected for the months that do not appear in the graphs.

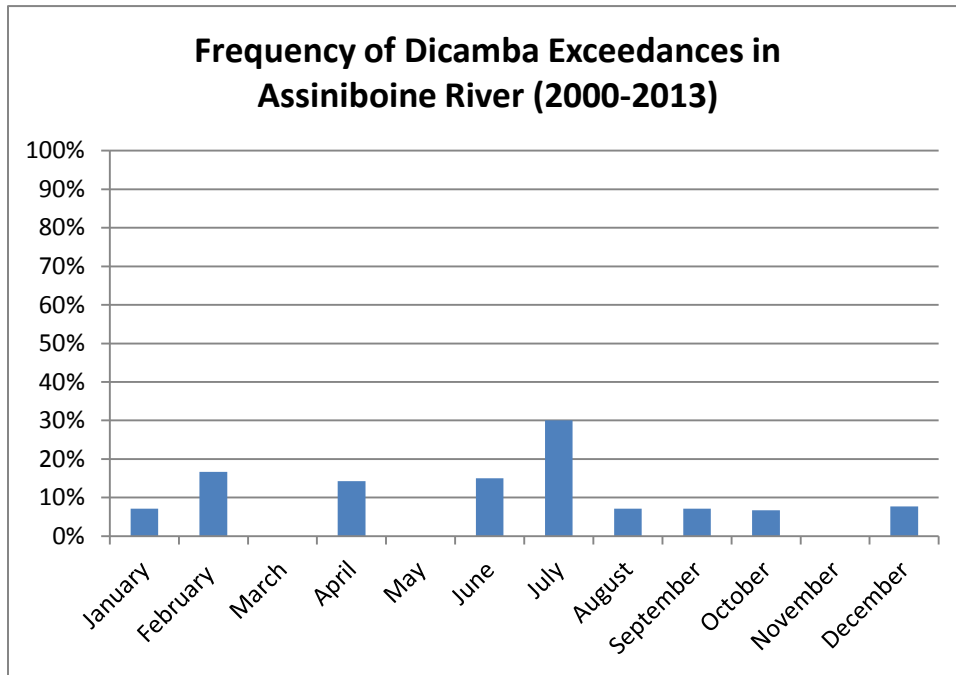


Figure 14: Monthly frequencies of dicamba excursions in Assiniboine River between 2000 and 2013. No samples were collected for the months that do not appear in the graphs.

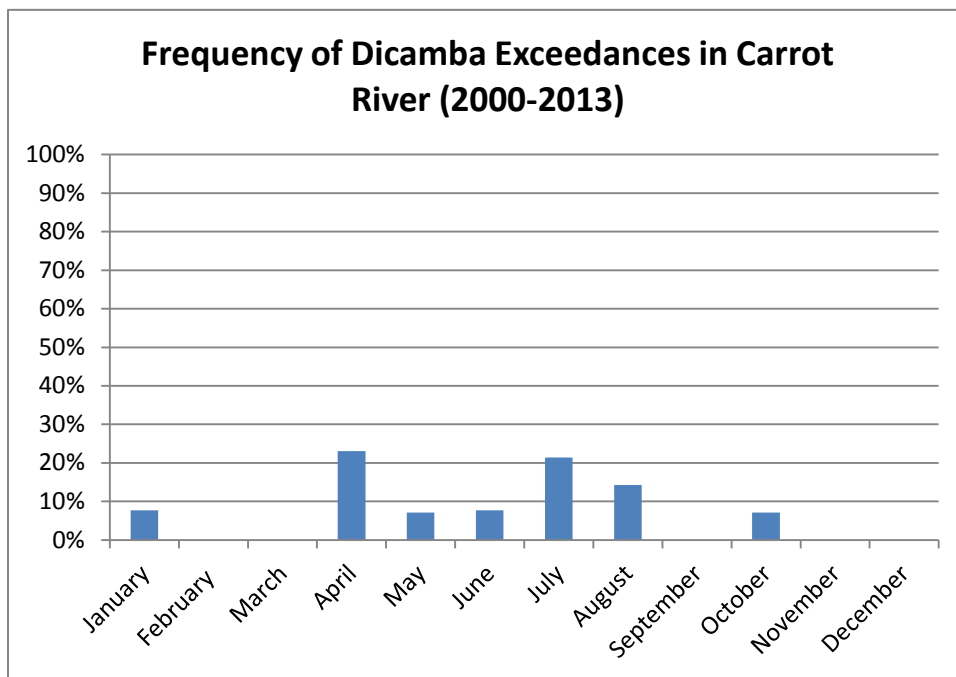


Figure 15: Monthly frequencies of dicamba excursions in Carrot River between 2000 and 2013. No samples were collected for the months that do not appear in the graphs.

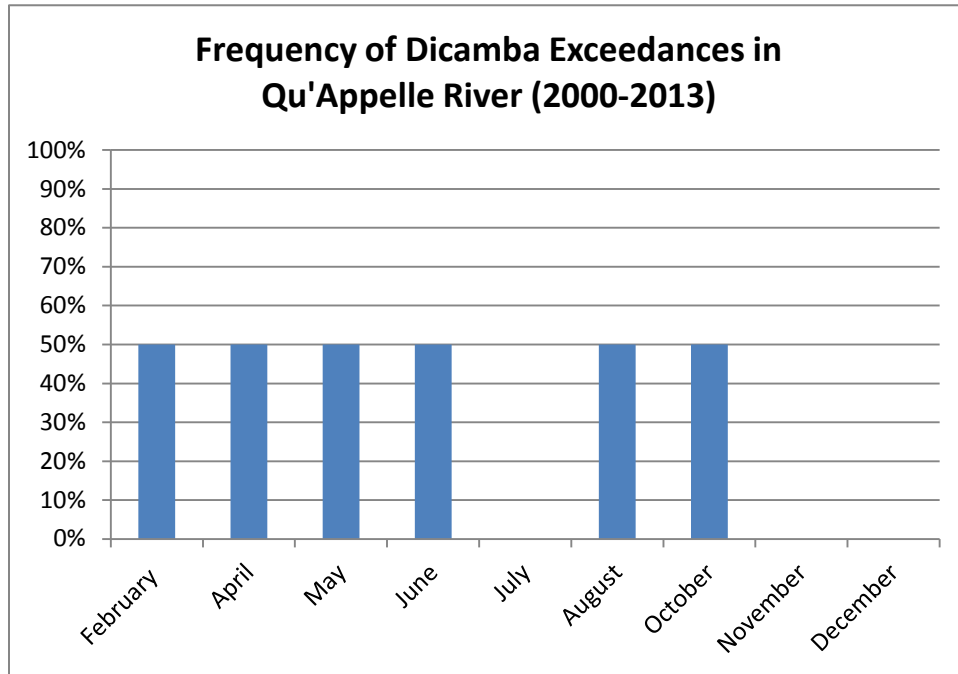


Figure 16: Monthly frequencies of dicamba excursions in Qu'Appelle River for 2008 and 2012. No samples were collected for the months that do not appear in the graphs.

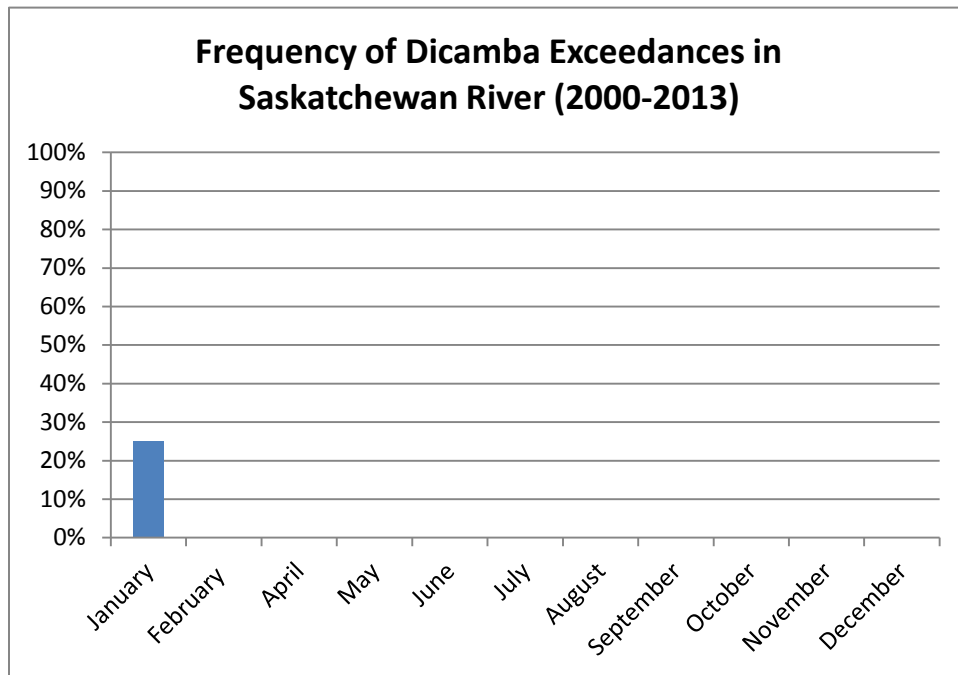


Figure 17: Monthly frequencies of dicamba excursions in Saskatchewan River for 2000, 2001, 2002, 2003, 2004, 2008 and 2012. No samples were collected for the months that do not appear in the graphs.

MCPA in Battle River in 2007

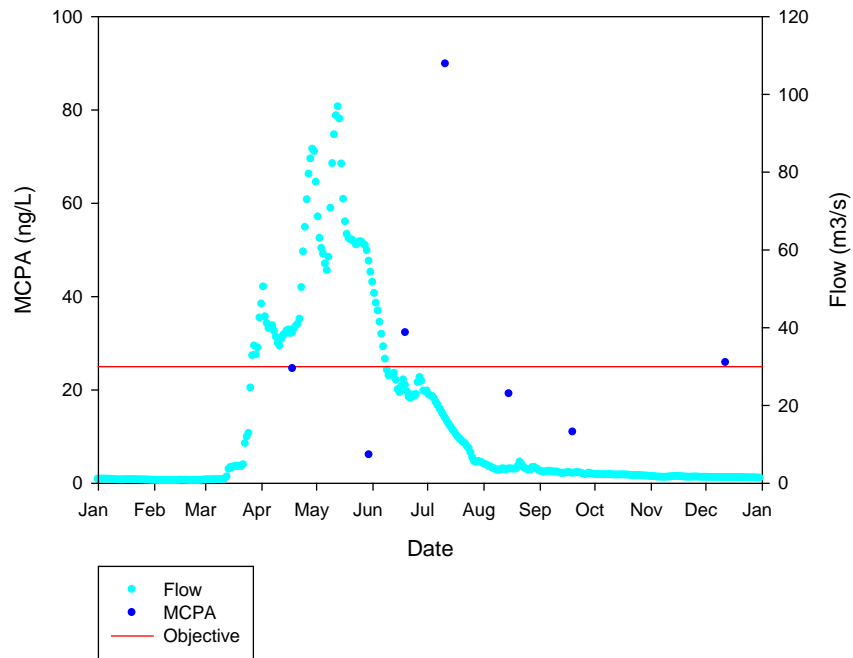


Figure 18: MCPA versus date and flow rate versus date in Battle River in 2007.

MCPA in Battle River in 2011

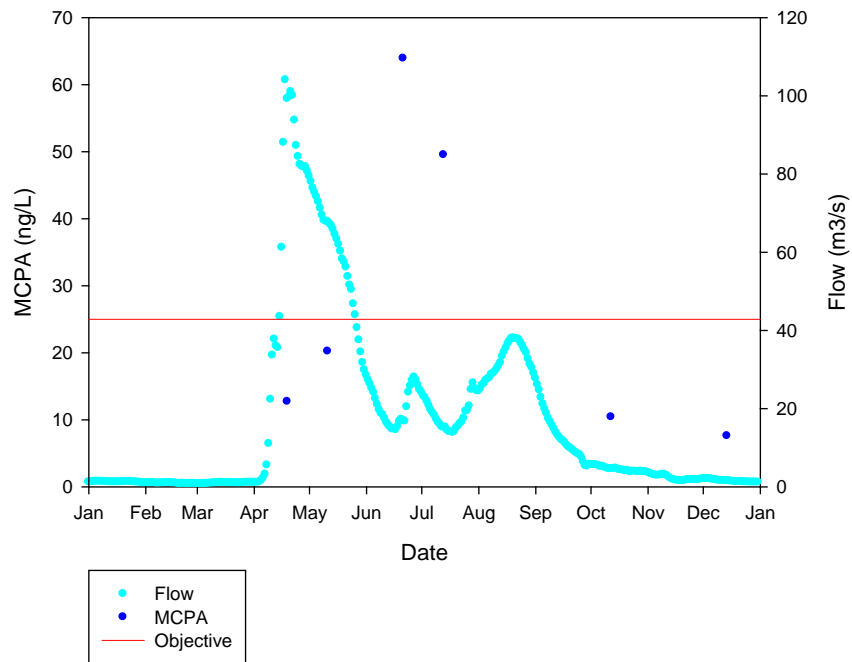


Figure 19: MCPA versus date and flow rate versus date in Battle River in 2011.

MCPA in Red Deer River near Bindloss in 2011

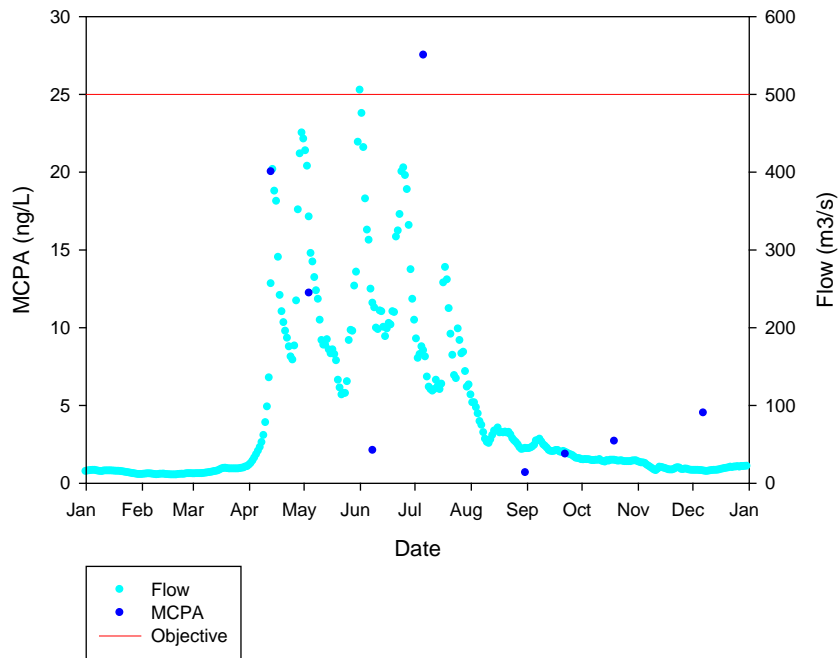


Figure 20: MCPA versus date and flow rate versus date in Red Deer River near Bindloss in 2011.

MCPA in South Saskatchewan River in 2006

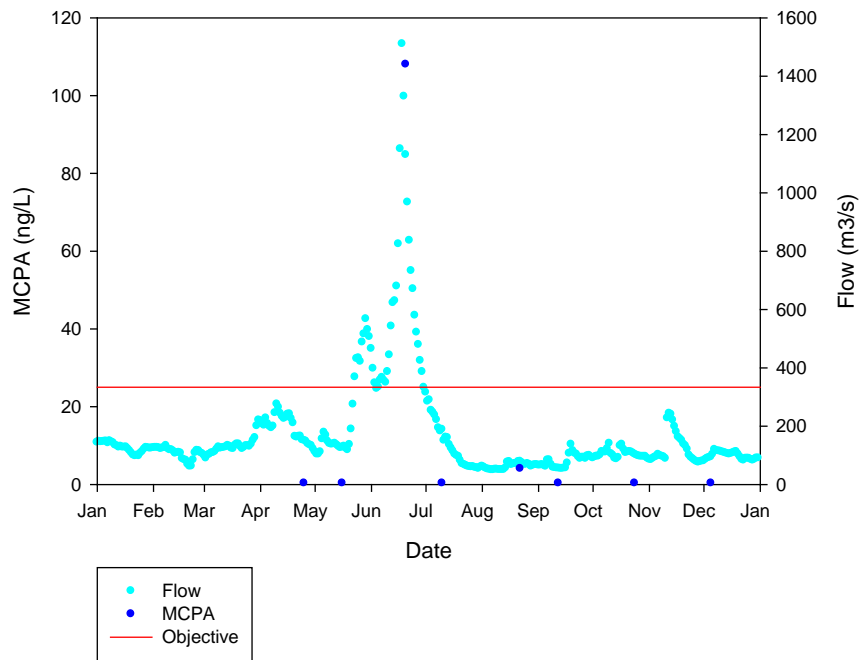


Figure 21: MCPA versus date and flow rate versus date in South Saskatchewan River in 2006.

MCPA in Assiniboine River in 2000

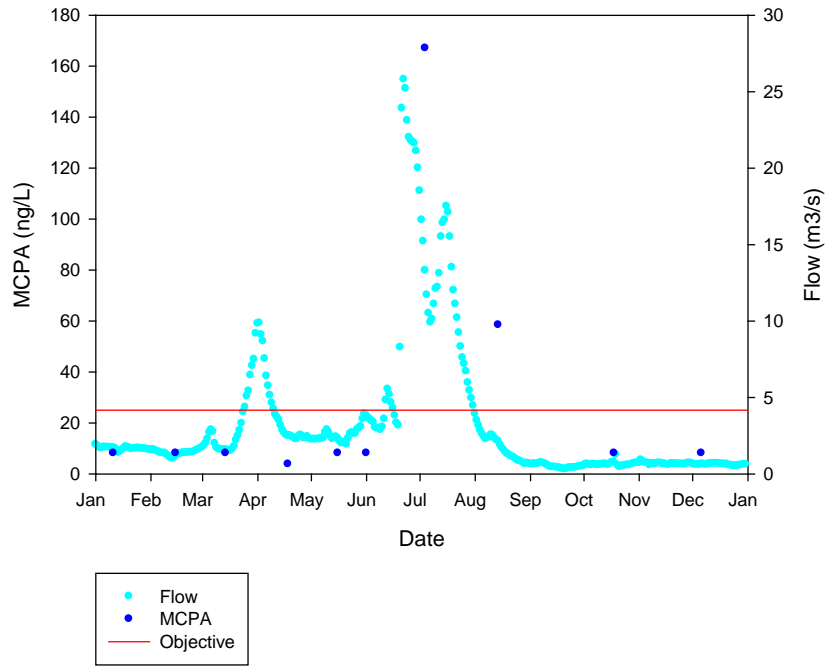


Figure 22: MCPA versus date and flow rate versus date in Assiniboine River in 2000.

MCPA in Assiniboine River in 2001

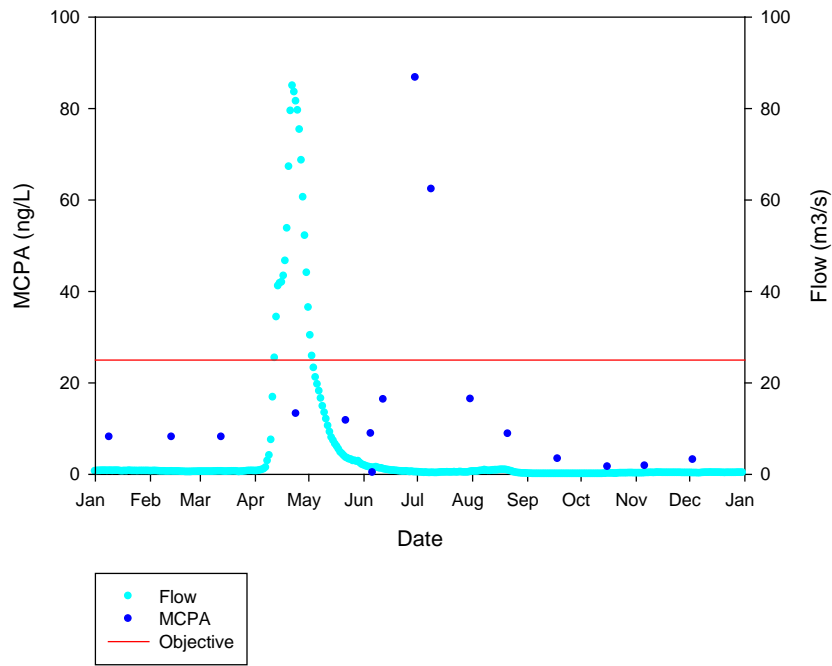


Figure 23: MCPA versus date and flow rate versus date in Assiniboine River in 2001.

MCPA in Assiniboine River in 2003

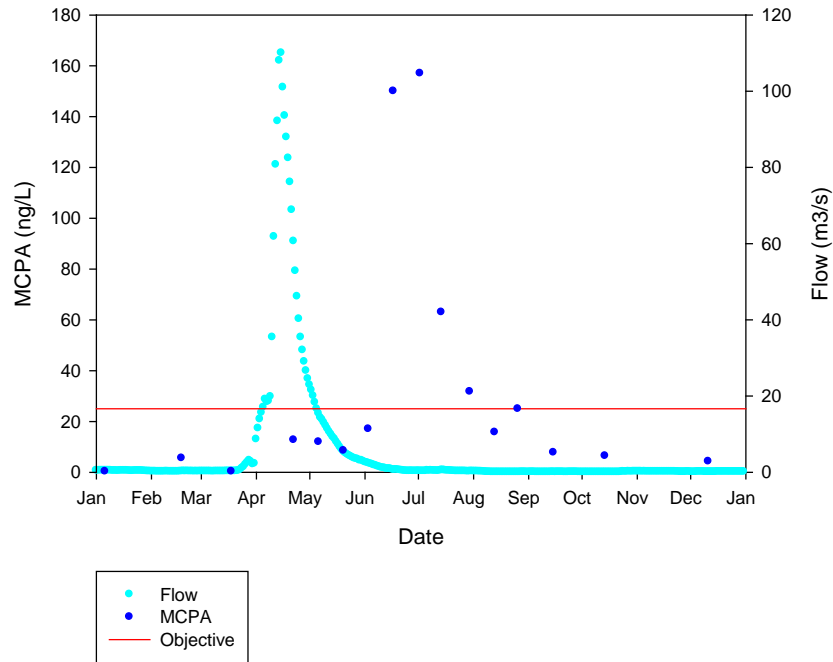


Figure 24: MCPA versus date and flow rate versus date in Assiniboine River in 2003.

MCPA in Assiniboine River in 2006

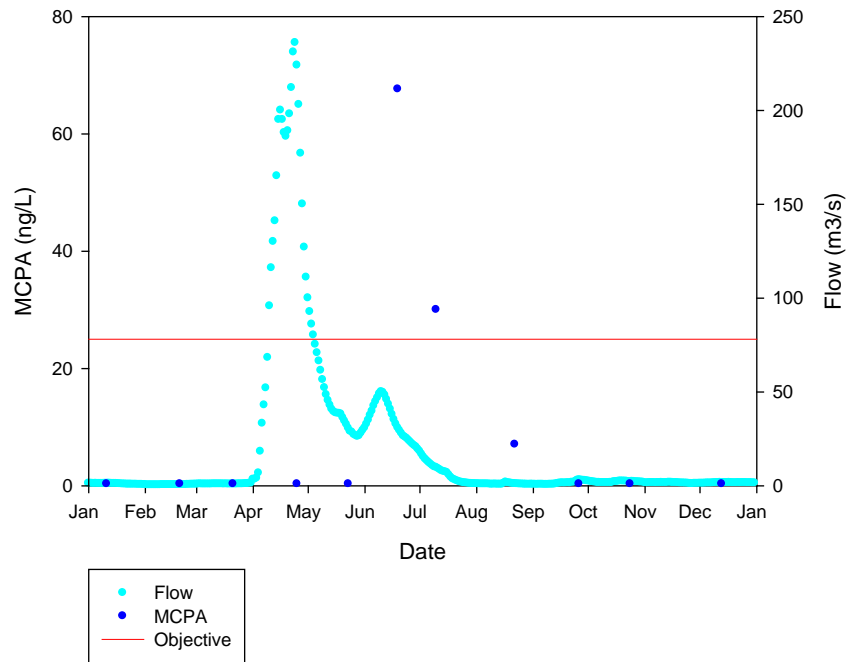


Figure 25: MCPA versus date and flow rate versus date in Assiniboine River in 2006.

MCPA in Assiniboine River in 2007

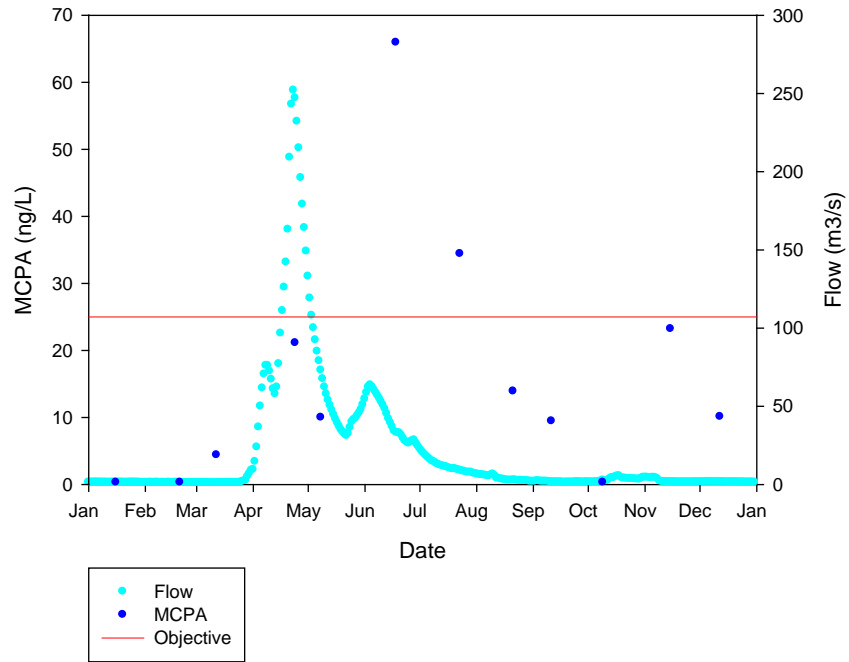


Figure 26: MCPA versus date and flow rate versus date in Assiniboine River in 2007.

MCPA in Assiniboine River in 2008

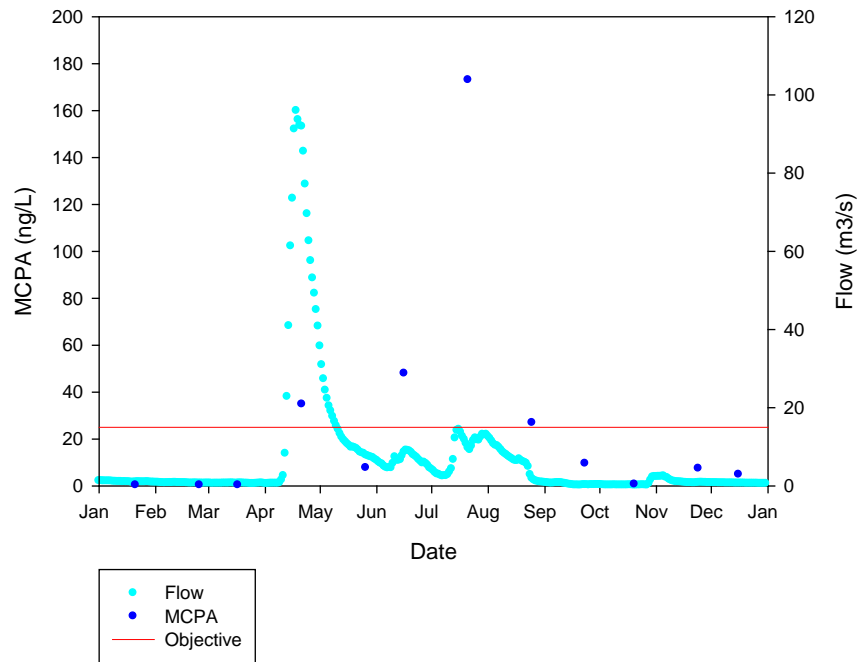


Figure 27: MCPA versus date and flow rate versus date in Assiniboine River in 2008.

MCPA in Assiniboine River in 2009

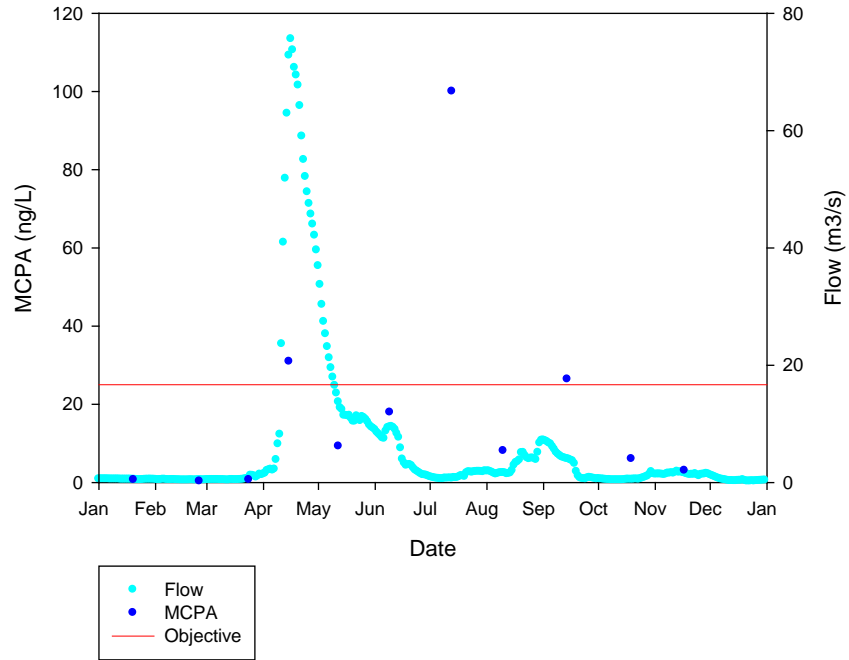


Figure 28: MCPA versus date and flow rate versus date in Assiniboine River in 2009.

MCPA in Assiniboine River in 2011

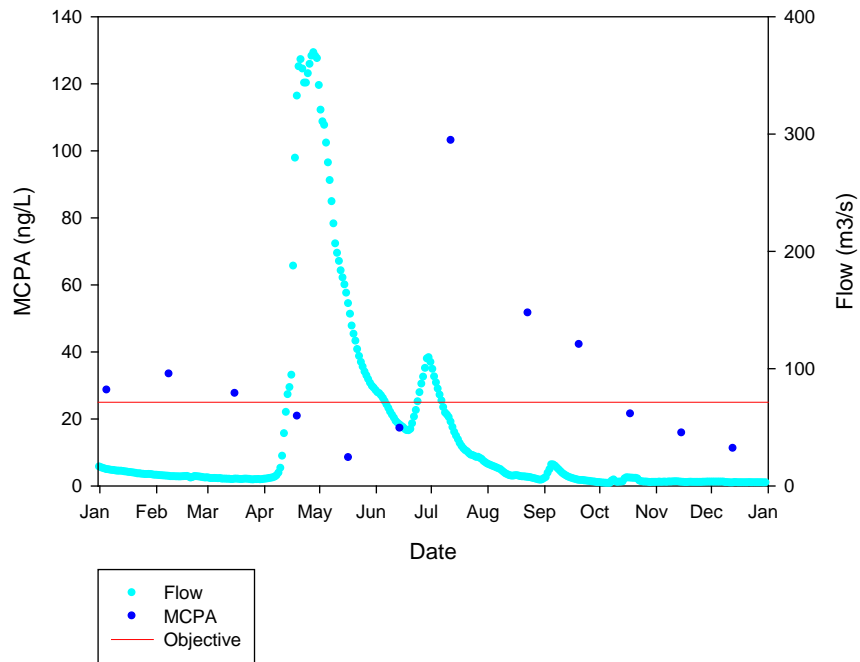


Figure 29: MCPA versus date and flow rate versus date in Assiniboine River in 2011.

MCPA in Assiniboine River in 2013

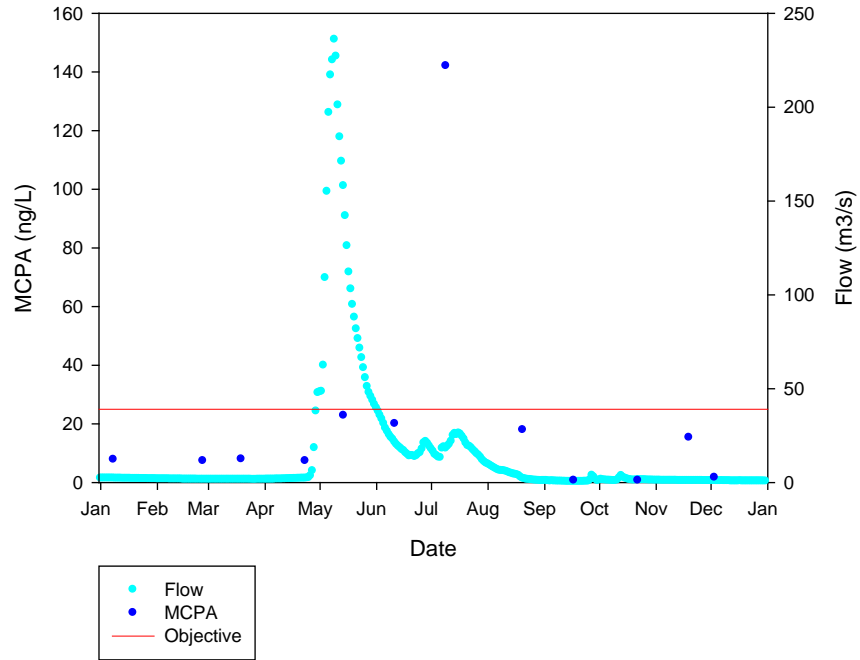


Figure 30: MCPA versus date and flow rate versus date in Assiniboine River in 2013.

MCPA in Carrot River in 2010

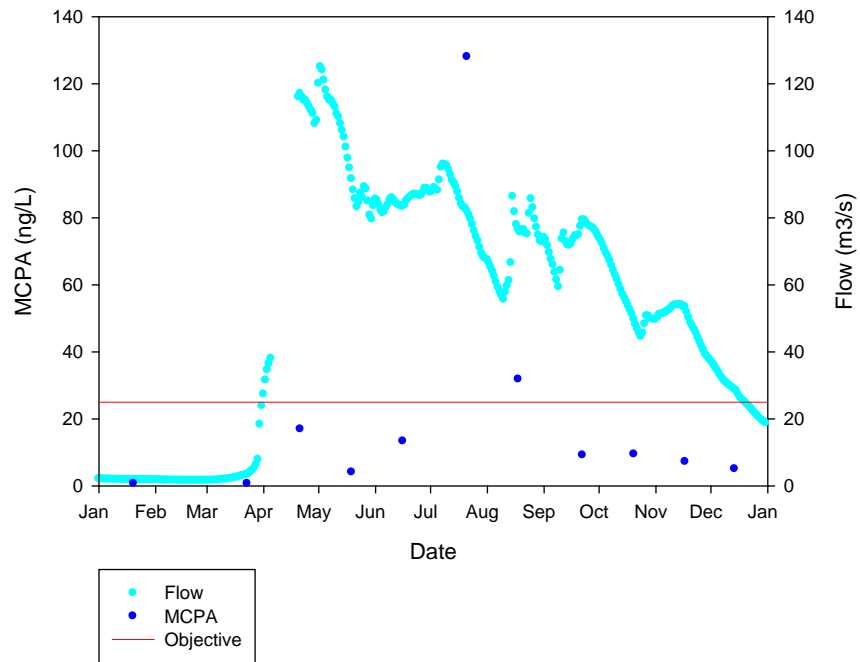


Figure 31: MCPA versus date and flow rate versus date in Carrot River in 2010.

MCPA in Carrot River in 2011

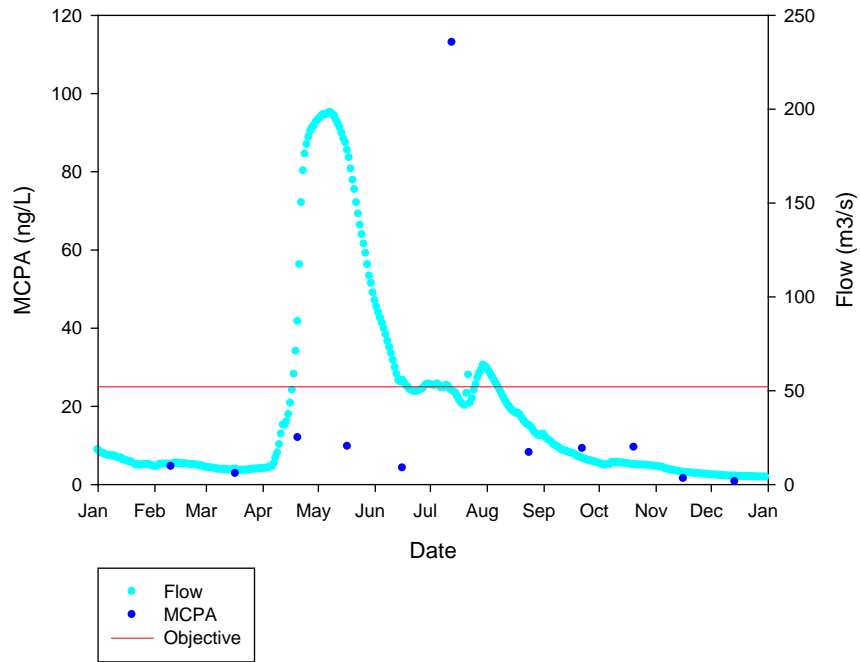


Figure 32: MCPA versus date and flow rate versus date in Carrot River in 2011.

MCPA in Qu'Appelle River in 2012

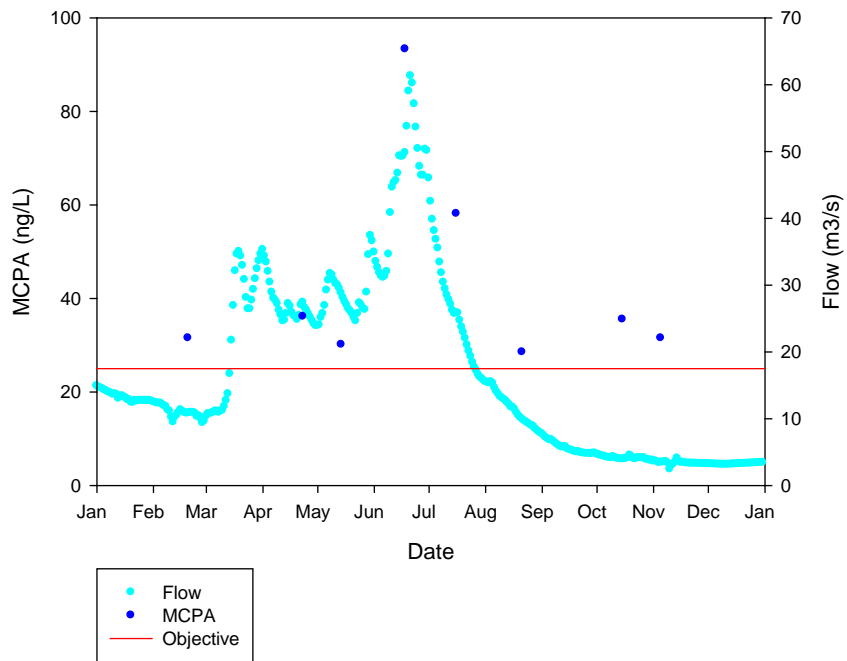


Figure 33: MCPA versus date and flow rate versus date in Qu'Appelle River in 2012.

Dicamba in Red Deer River near Bindloss in 2011

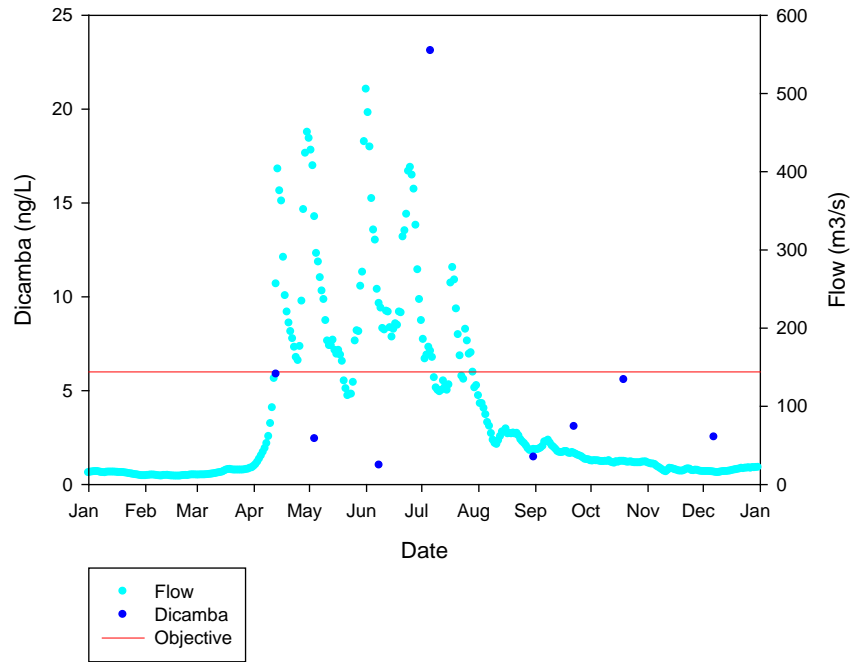


Figure 34: Dicamba versus date and flow rate versus date in Red Deer River near Bindloss in 2011.

Dicamba in South Saskatchewan River in 2010

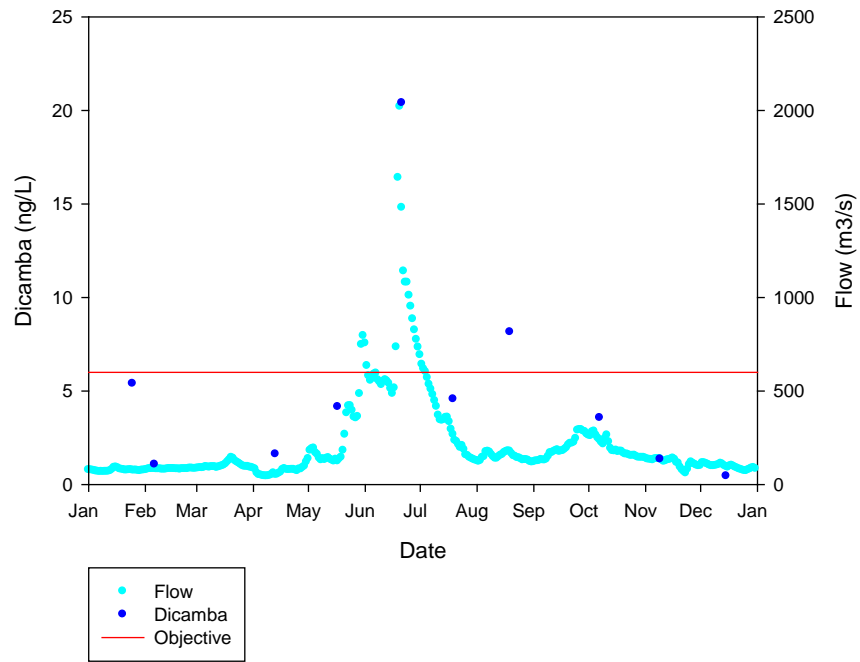


Figure 35: Dicamba versus date and flow rate versus date in South Saskatchewan River in 2010.

Dicamba in Assiniboine River in 2000

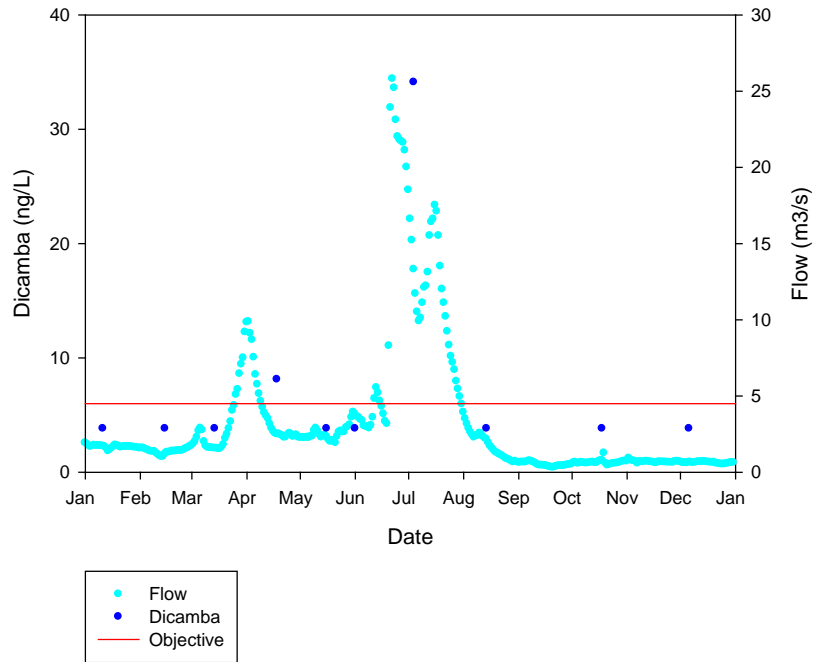


Figure 36: Dicamba versus date and flow rate versus date in Assiniboine River in 2000.

Dicamba in Assiniboine River in 2001

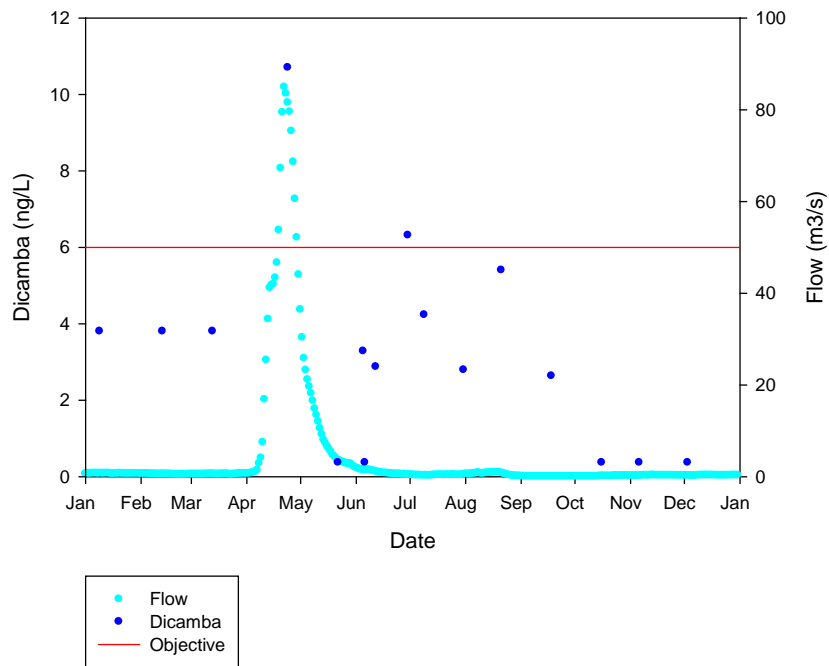


Figure 37: Dicamba versus date and flow rate versus date in Assiniboine River in 2001.

Dicamba in Assiniboine River in 2002

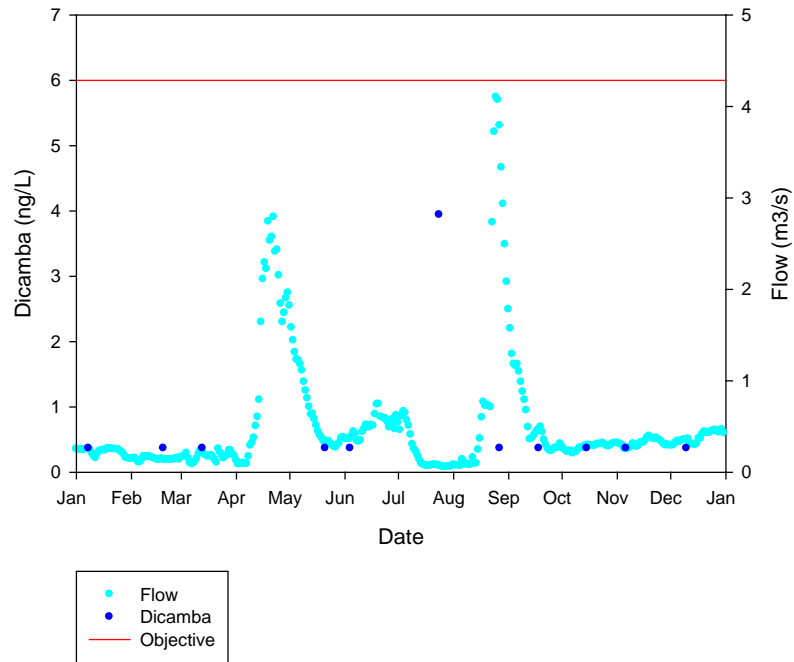


Figure 38: Dicamba versus date and flow rate versus date in Assiniboine River in 2002.

Dicamba in Assiniboine River in 2003

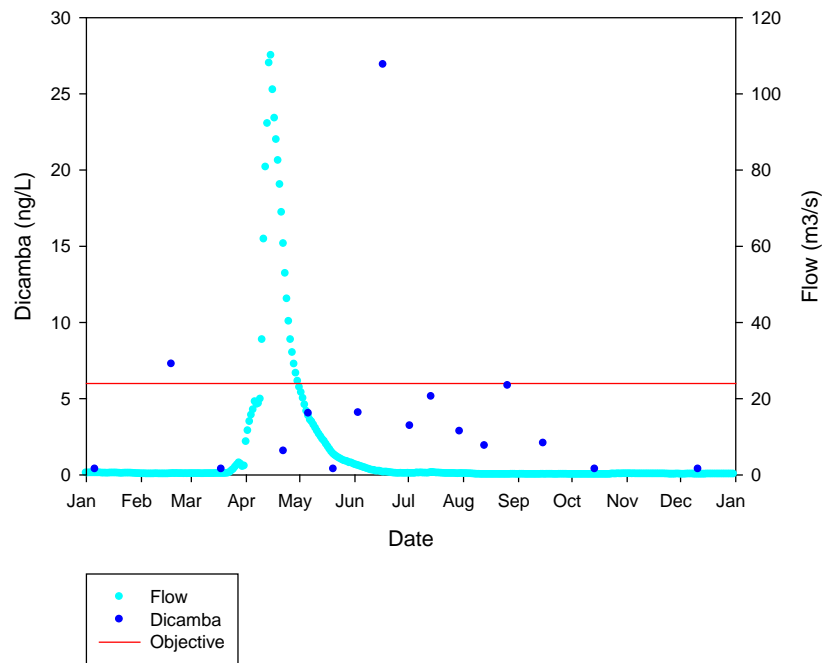


Figure 39: Dicamba versus date and flow rate versus date in Assiniboine River in 2003.

Dicamba in Assiniboine River in 2004

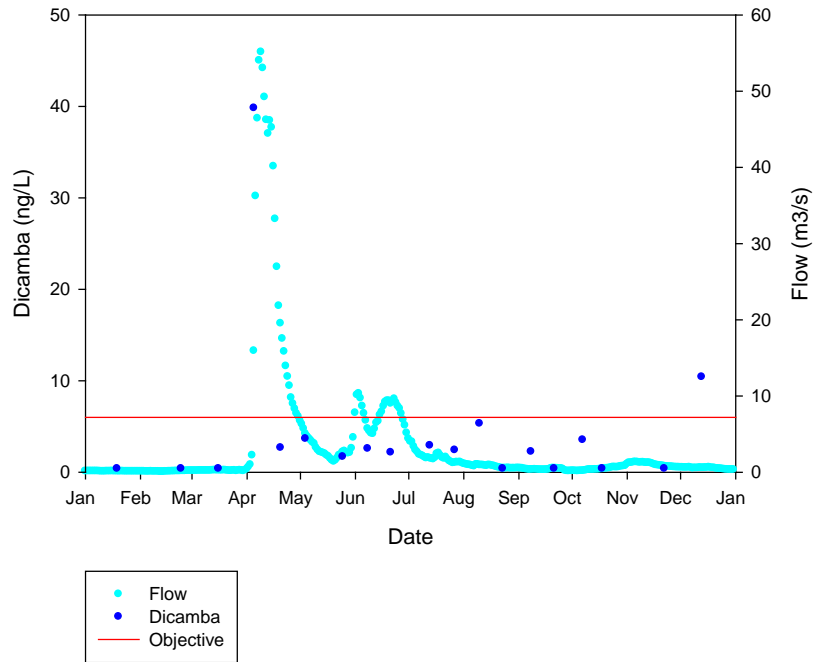


Figure 40: Dicamba versus date and flow rate versus date in Assiniboine River in 2004.

Dicamba in Assiniboine River in 2008

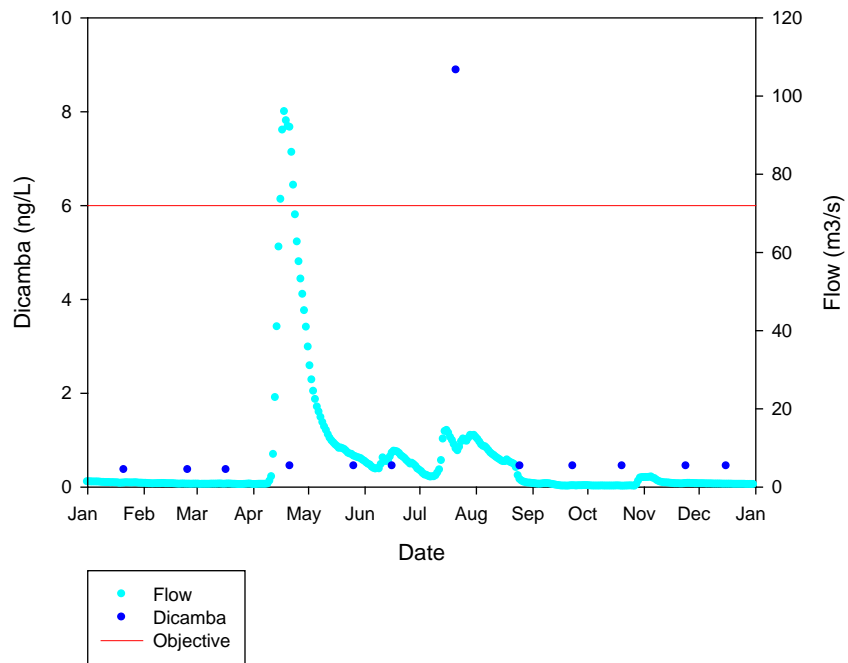


Figure 41: Dicamba versus date and flow rate versus date in Assiniboine River in 2008.

Dicamba in Assiniboine River in 2010

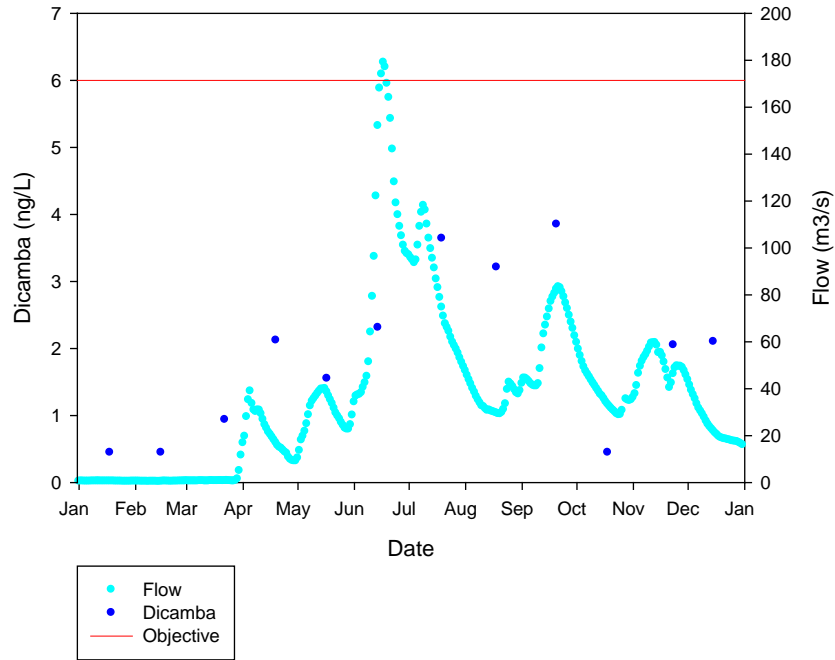


Figure 42: Dicamba versus date and flow rate versus date in Assiniboine River in 2010.

Dicamba in Assiniboine River in 2011

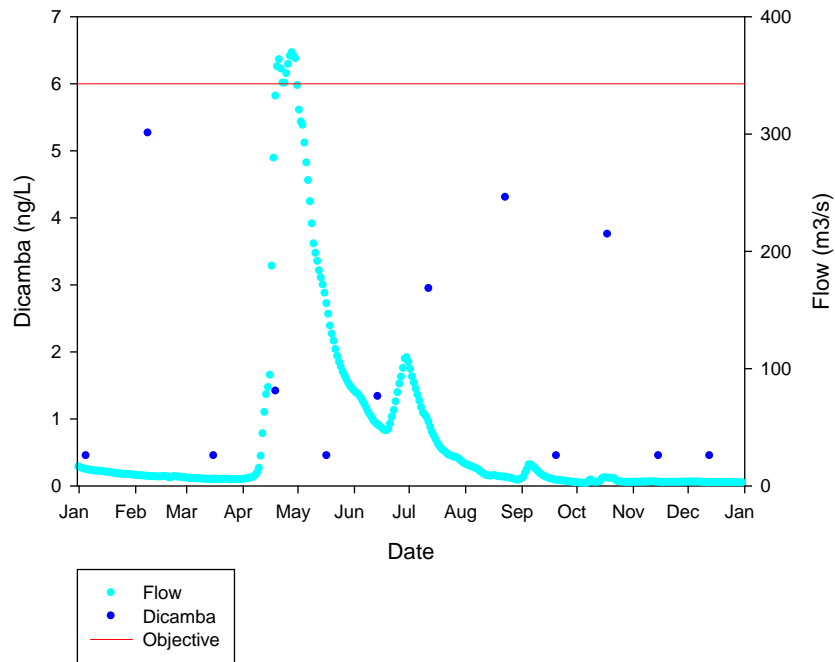


Figure 43: Dicamba versus date and flow rate versus date in Assiniboine River in 2011.

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Appendix A: MCPA with Flow (Entire Data Set, 2000-2013)

MCPA in Battle River (Entire Data Set)

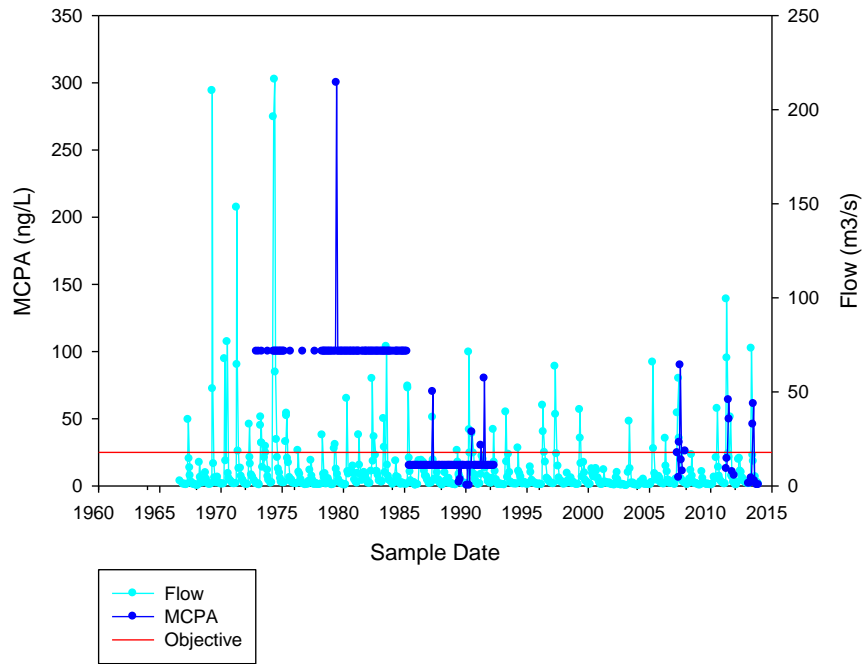


Figure 1: MCPA versus date and flow rate versus date in Battle River (entire data set).

MCPA in Battle River (2000-2013)

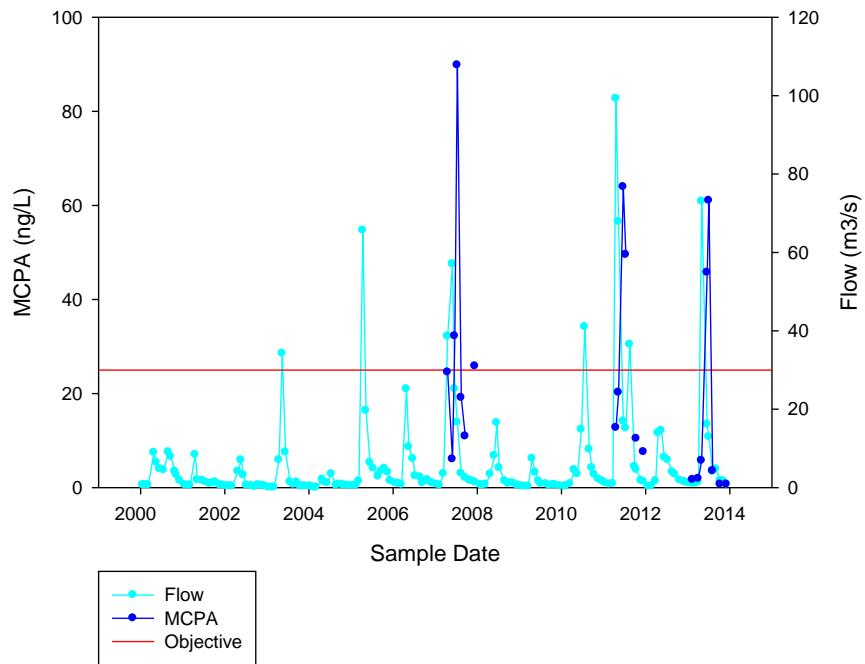


Figure 2: MCPA versus date and flow rate versus date in Battle River from 2000 until 2013.

MCPA in Red Deer River near Bindloss (Entire Data Set)

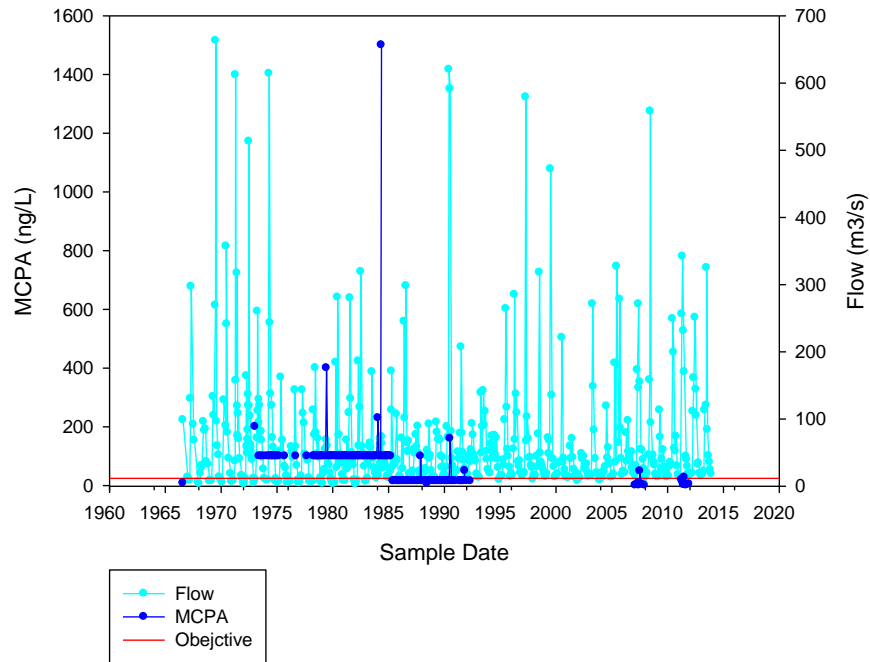


Figure 3: MCPA versus date and flow rate versus date in Red Deer River near Bindloss (entire data set).

MCPA in Red Deer River near Bindloss (2000-2013)

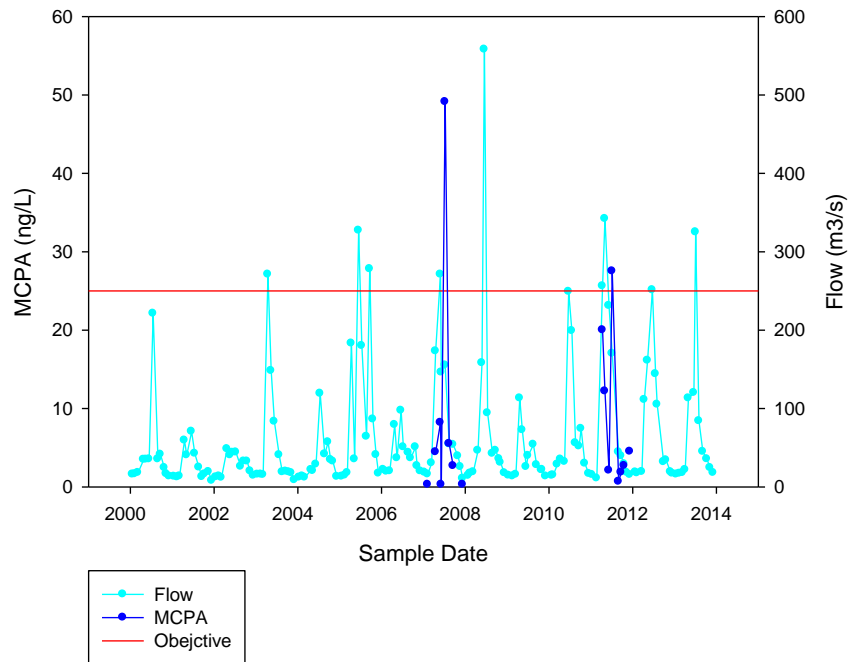


Figure 4: MCPA versus date and flow rate versus date in Red Deer River near Bindloss from 2000 until 2013.

MCPA in South Saskatchewan River (Entire Data Set)

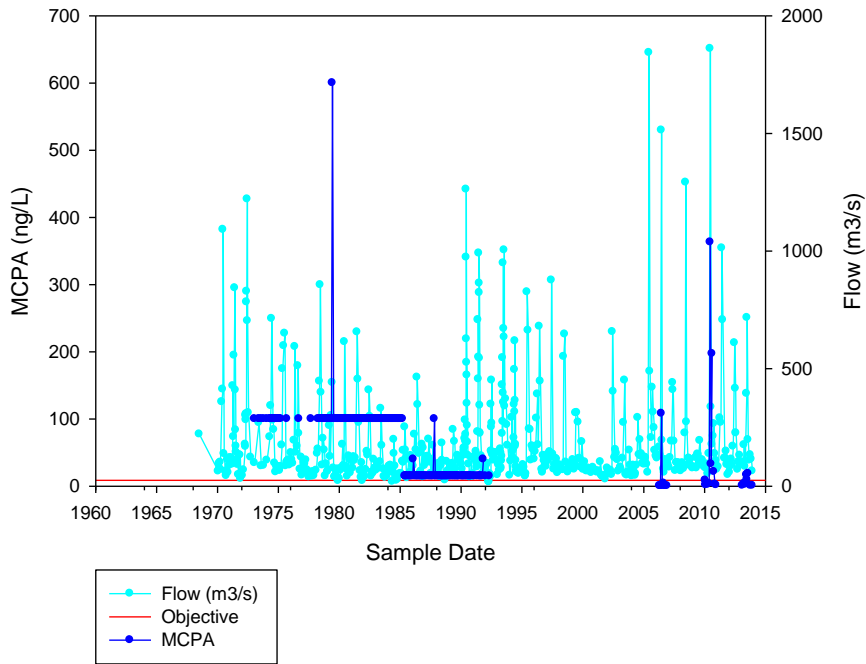


Figure 5: MCPA versus date and flow rate versus date in South Saskatchewan River (entire data set).

MCPA in South Saskatchewan River (2000-2013)

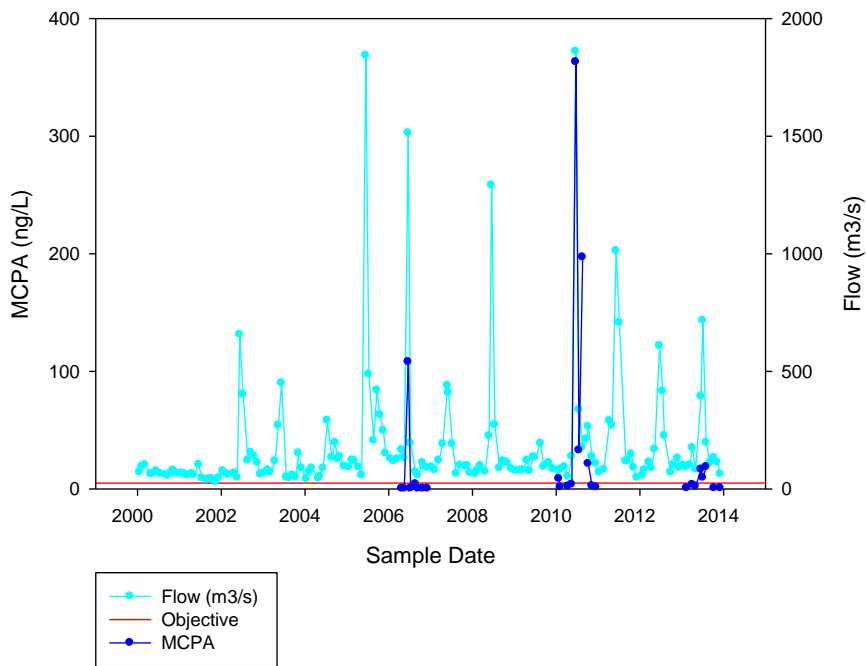


Figure 6: MCPA versus date and flow rate versus date in South Saskatchewan River from 2000 until 2013.

MCPA in Assiniboine River (Entire Data Set)

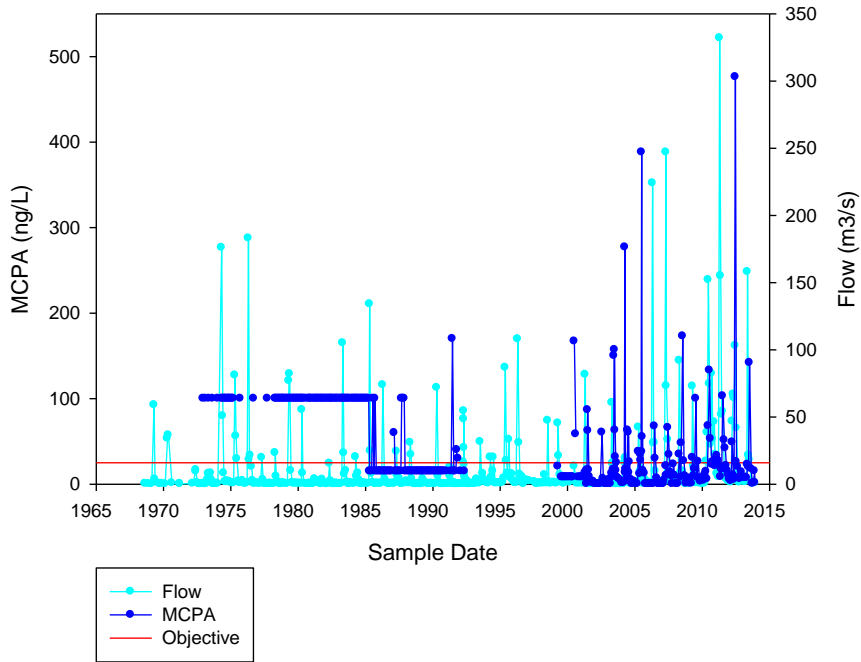


Figure 7: MCPA versus date and flow rate versus date in Assiniboine River (entire data set).

MCPA in Assiniboine River (2000-2013)

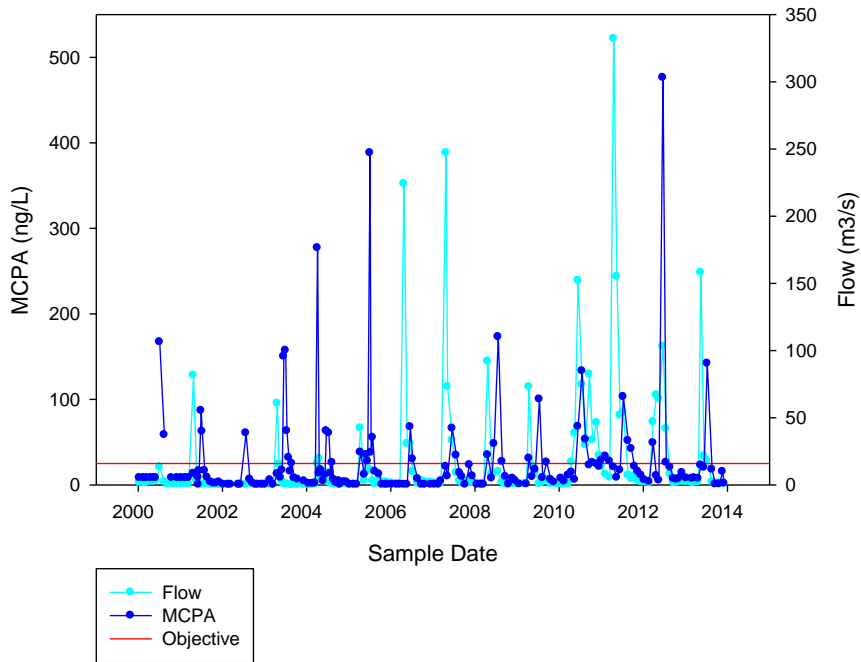


Figure 8: MCPA versus date and flow rate versus date in Assiniboine River from 2000 until 2013.

MCPA in Carrot River (Entire Data Set)

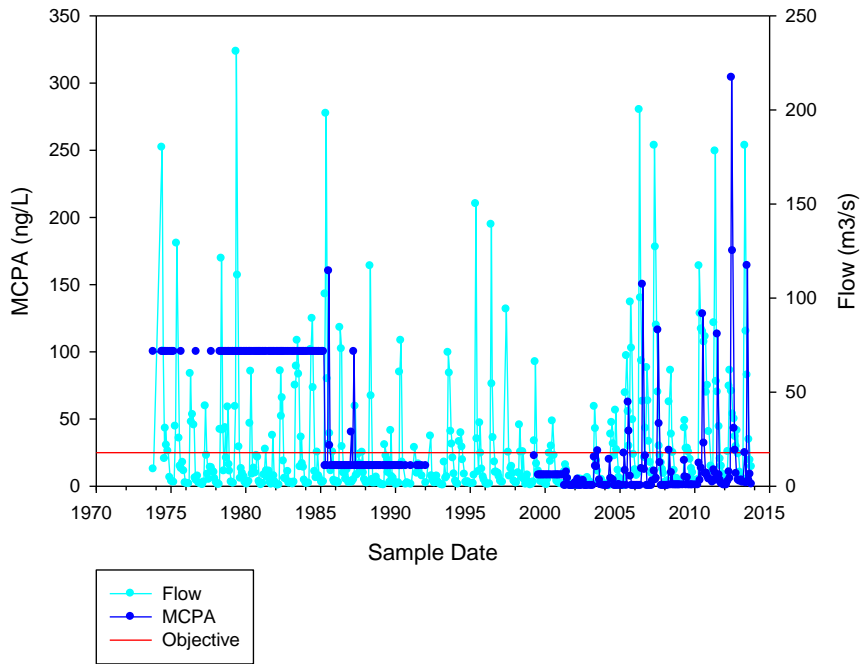


Figure 9: MCPA versus date and flow rate versus date in Carrot River (entire data set).

MCPA in Carrot River (2000-2013)

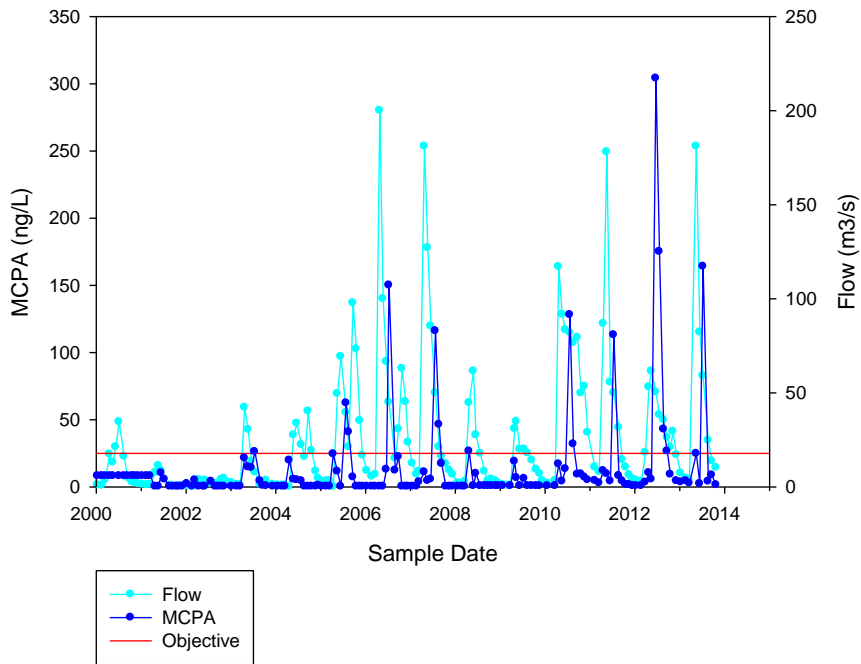


Figure 10: MCPA versus date and flow rate versus date in Carrot River from 2000 until 2013.

MCPA in Qu'Appelle River (Entire Data Set)

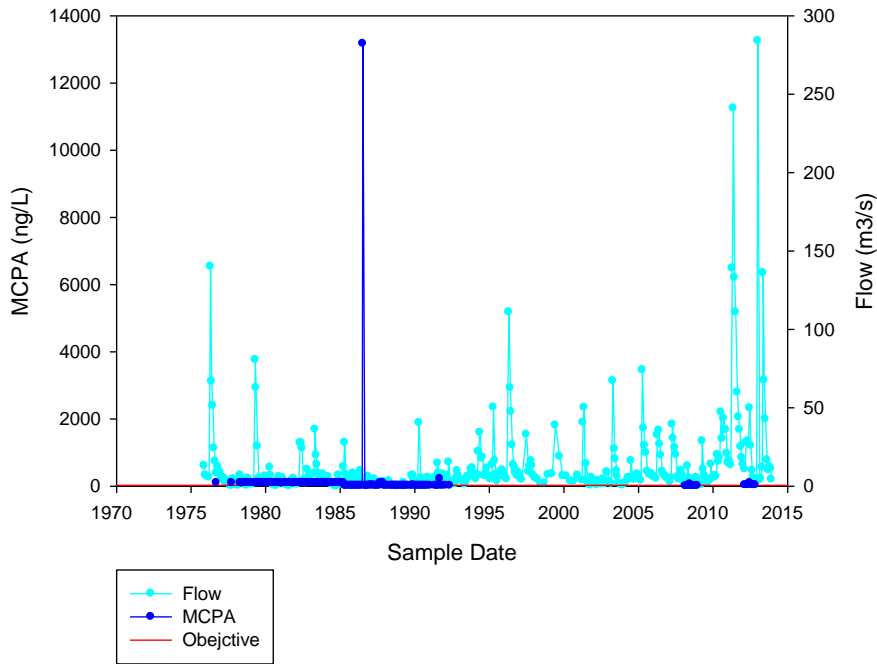


Figure 11: MCPA versus date and flow rate versus date in Qu'Appelle River (entire data set).

MCPA in Qu'Appelle River (2000-2013)

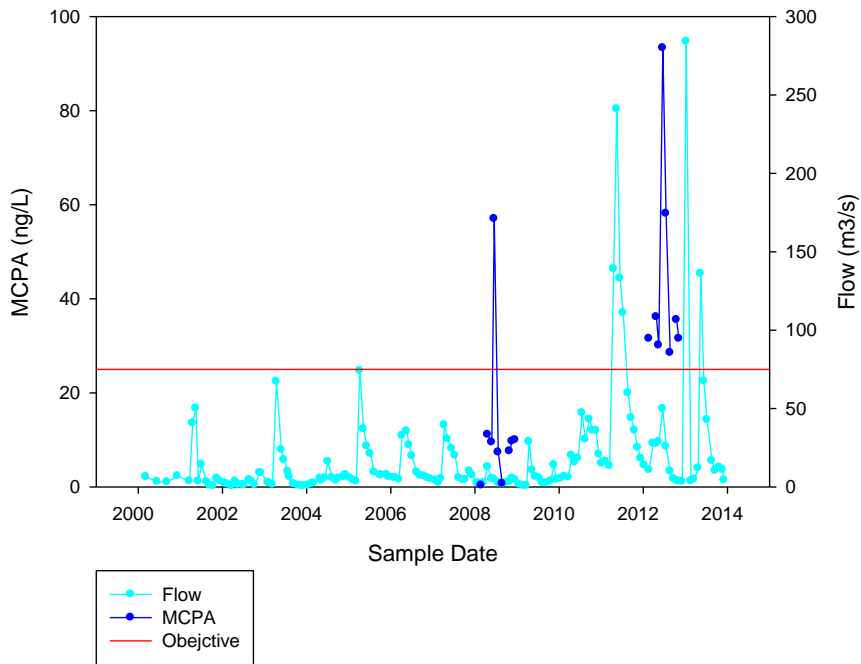


Figure 12: MCPA versus date and flow rate versus date in Qu'Appelle River from 2000 until 2013.

Appendix B: MCPA with Daily Flow (2000-2013)

MCPA in Battle River in 2007

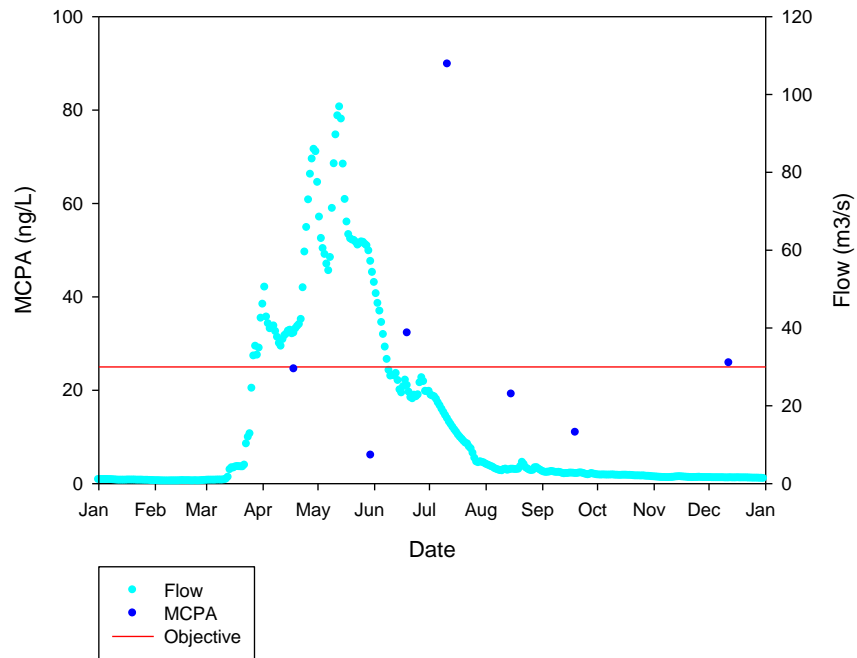


Figure 15: MCPA versus date and flow rate versus date in Battle River in 2007.

MCPA in Battle River in 2011

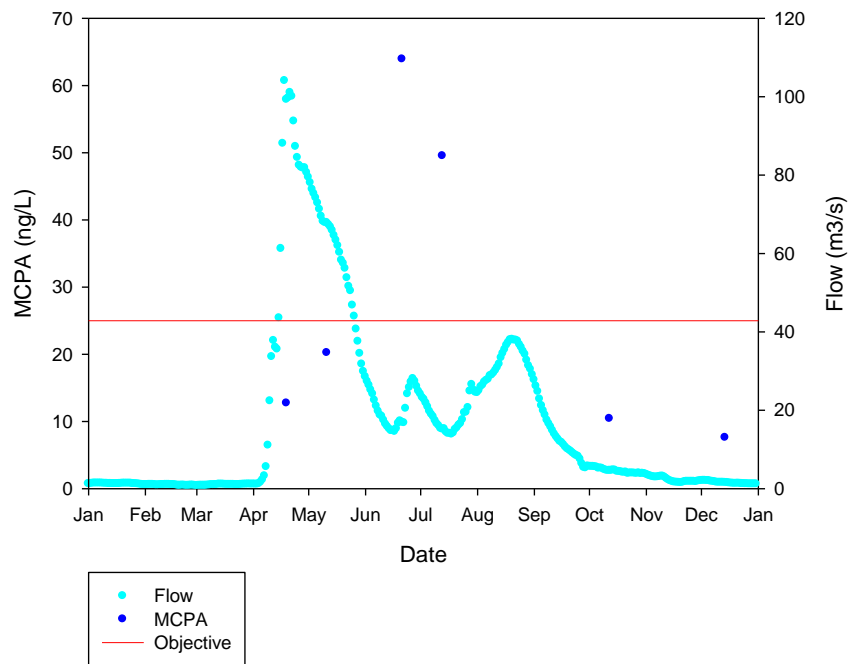


Figure 16: MCPA versus date and flow rate versus date in Battle River in 2011.

MCPA in Battle River in 2013

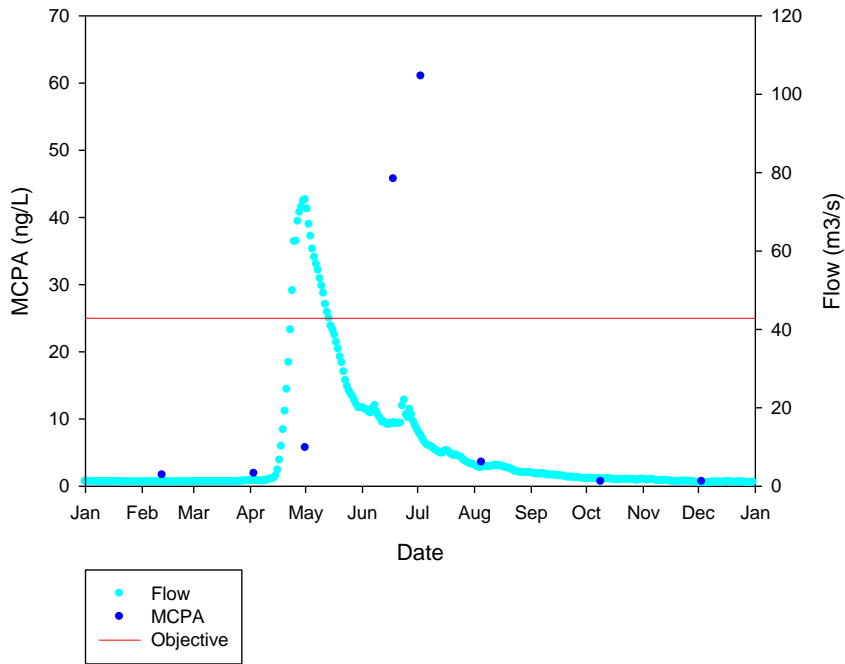


Figure 17: MCPA versus date and flow rate versus date in Battle River in 2013.

MCPA in Red Deer River near Bindloss in 2007

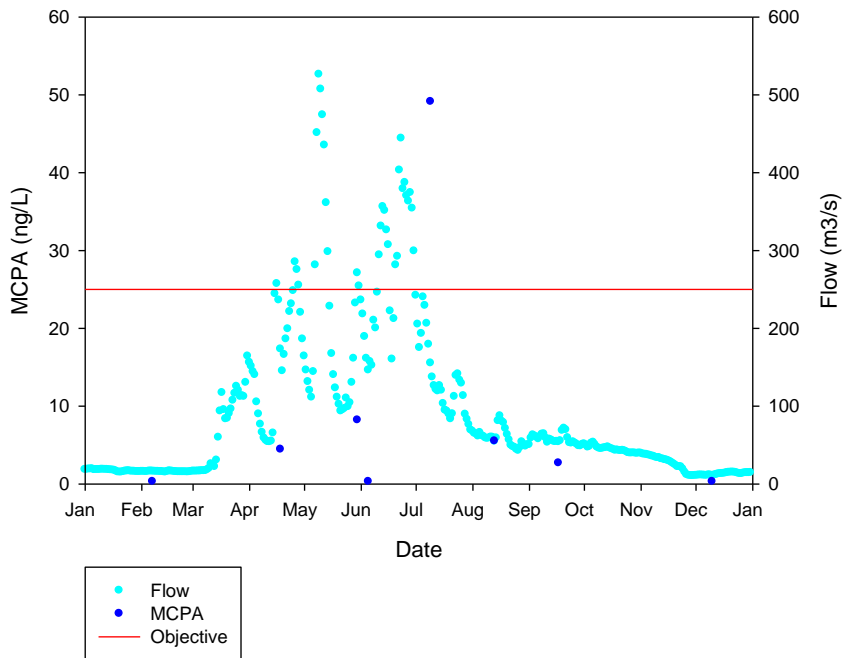


Figure 34: MCPA versus date and flow rate versus date in Red Deer River near Bindloss in 2007.

MCPA in Red Deer River near Bindloss in 2011

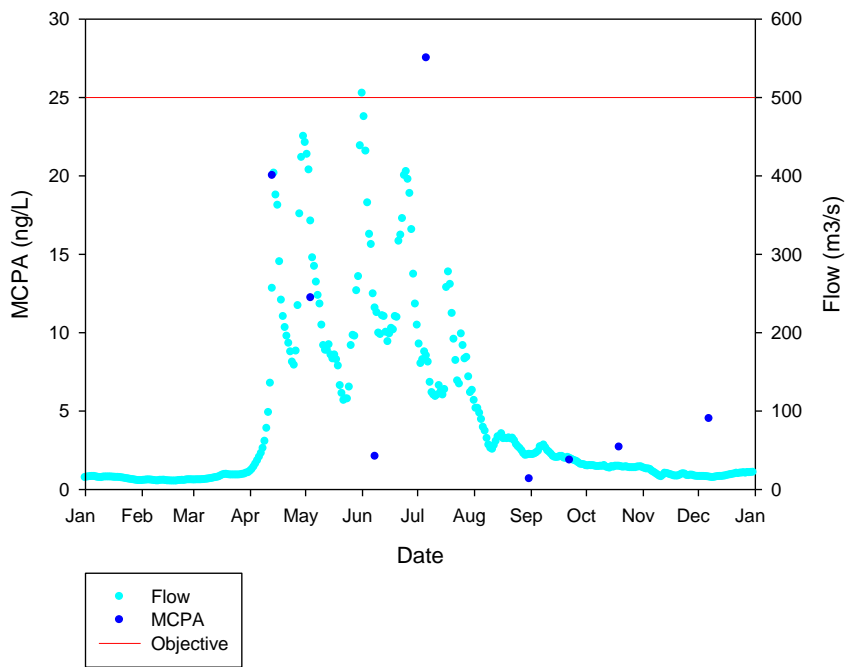


Figure 35: MCPA versus date and flow rate versus date in Red Deer River near Bindloss in 2011.

MCPA in South Saskatchewan River in 2006

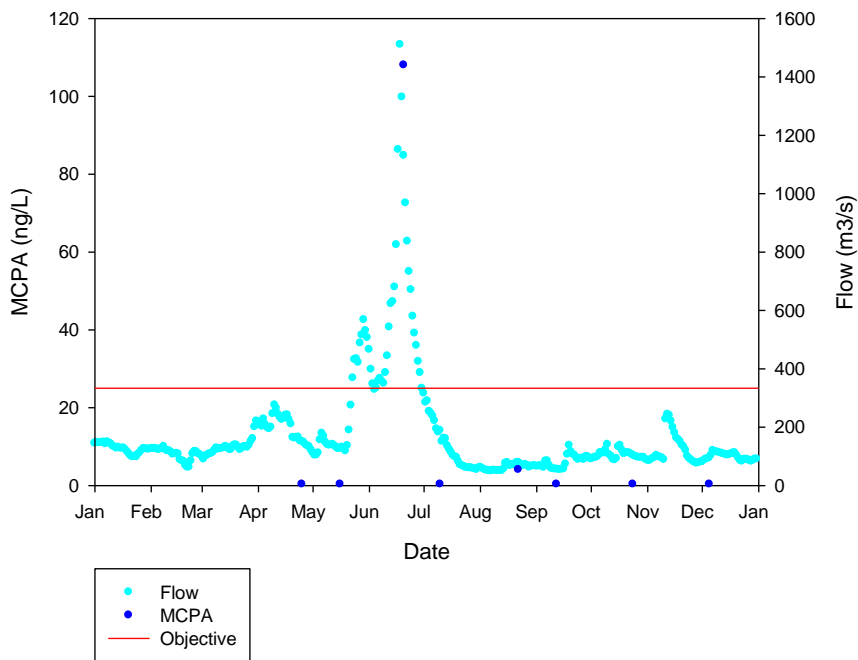


Figure 36: MCPA versus date and flow rate versus date in South Saskatchewan River in 2006.

MCPA in South Saskatchewan River in 2010

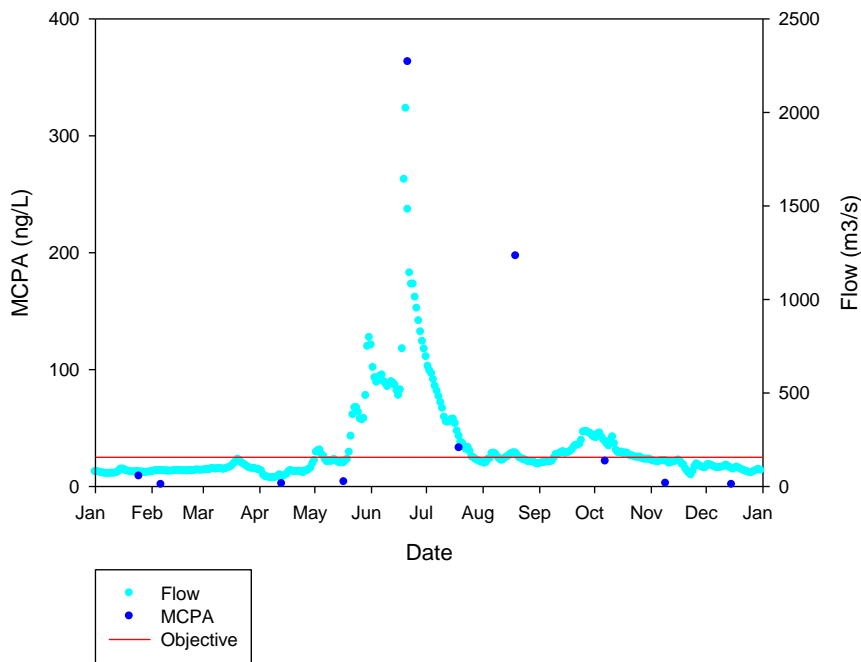


Figure 37: MCPA versus date and flow rate versus date in South Saskatchewan River in 2010.

MCPA in South Saskatchewan River in 2013

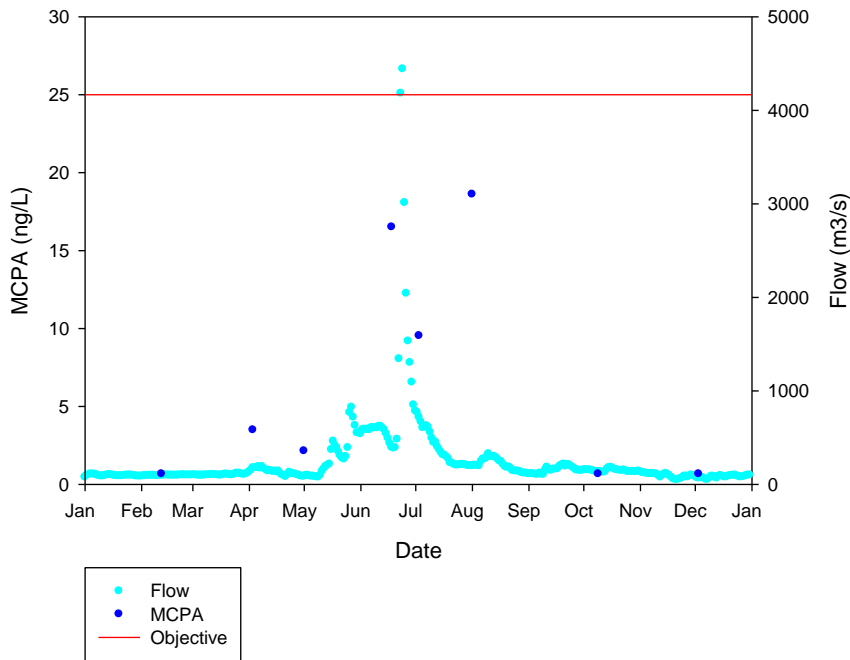


Figure 38: MCPA versus date and flow rate versus date in South Saskatchewan River in 2013.

MCPA in Assiniboine River in 2000

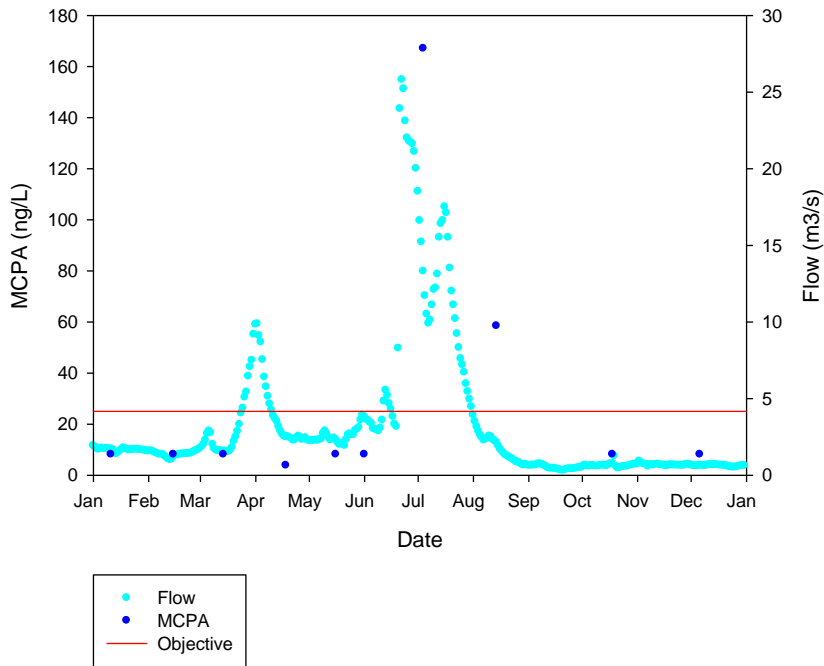


Figure 1: MCPA versus date and flow rate versus date in Assiniboine River in 2000.

MCPA in Assiniboine River in 2001

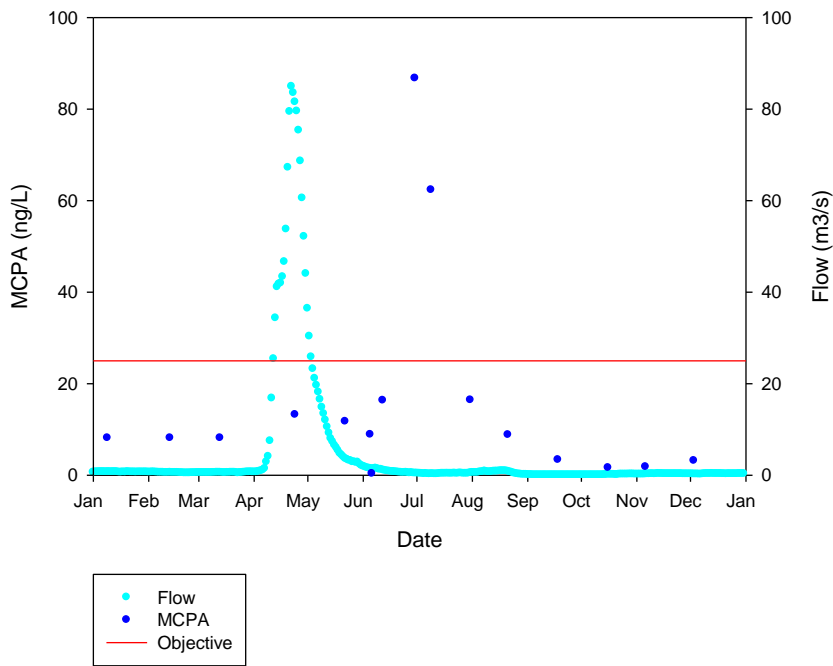


Figure 2: MCPA versus date and flow rate versus date in Assiniboine River in 2001.

MCPA in Assiniboine River in 2002

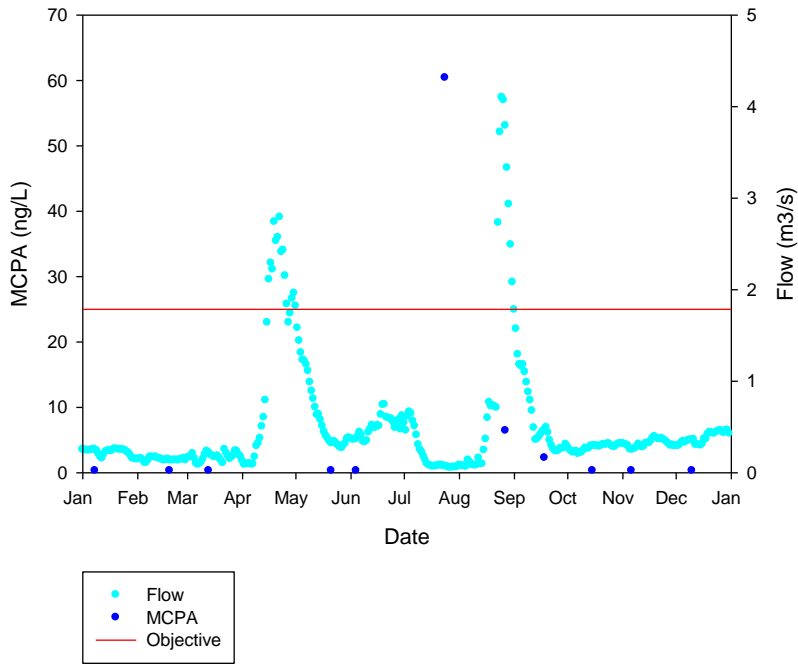


Figure 3: MCPA versus date and flow rate versus date in Assiniboine River in 2002.

MCPA in Assiniboine River in 2003

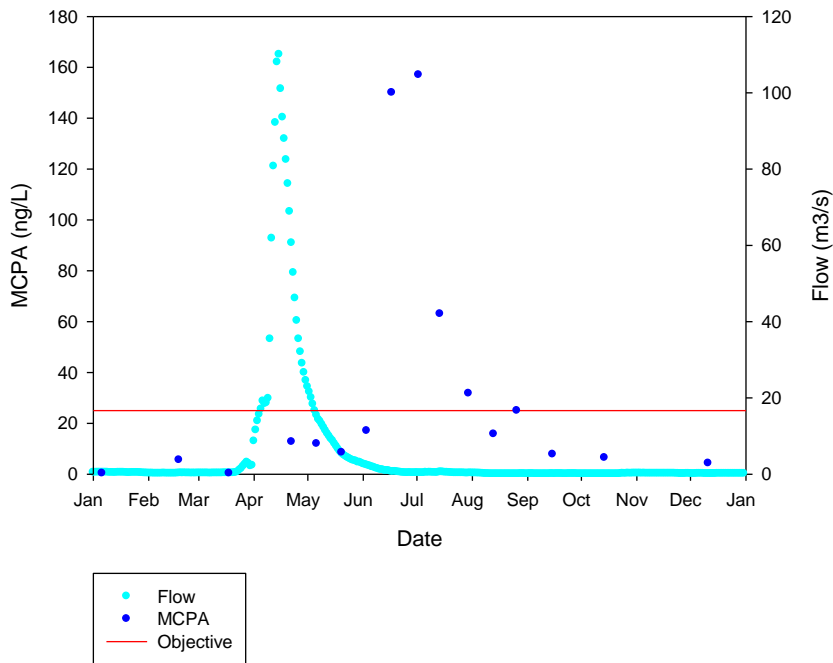


Figure 4: MCPA versus date and flow rate versus date in Assiniboine River in 2003.

MCPA in Assiniboine River in 2004

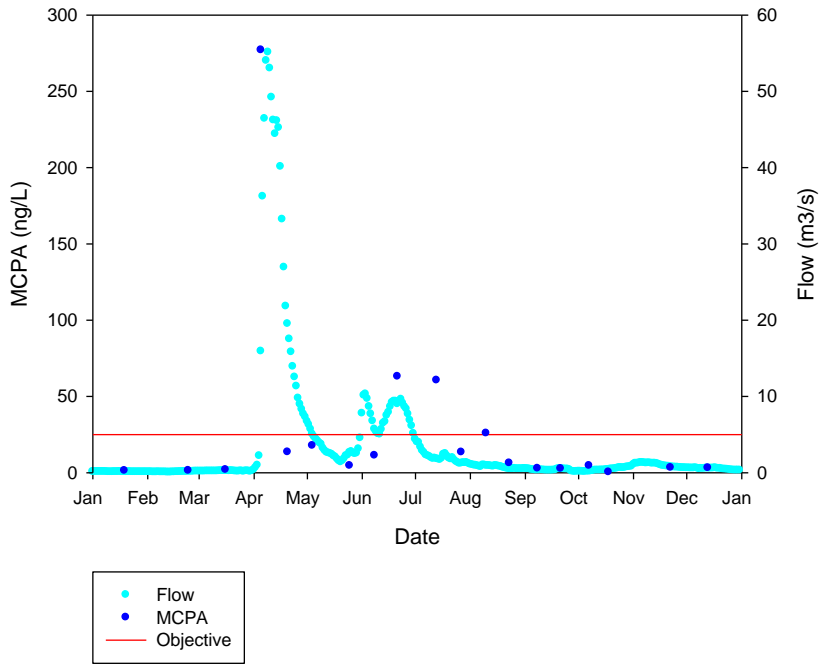


Figure 5: MCPA versus date and flow rate versus date in Assiniboine River in 2004.

MCPA in Assiniboine River in 2005

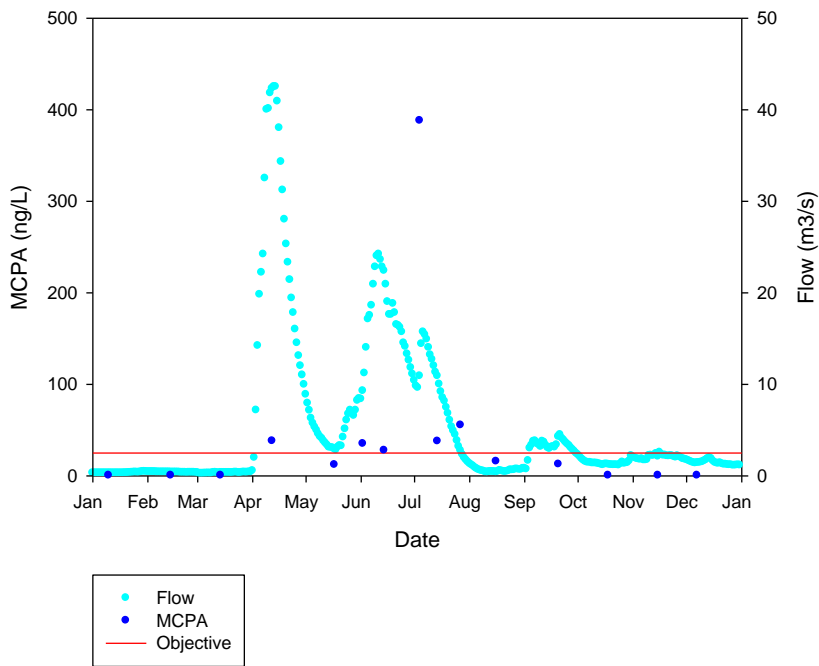


Figure 6: MCPA versus date and flow rate versus date in Assiniboine River in 2005.

MCPA in Assiniboine River in 2006

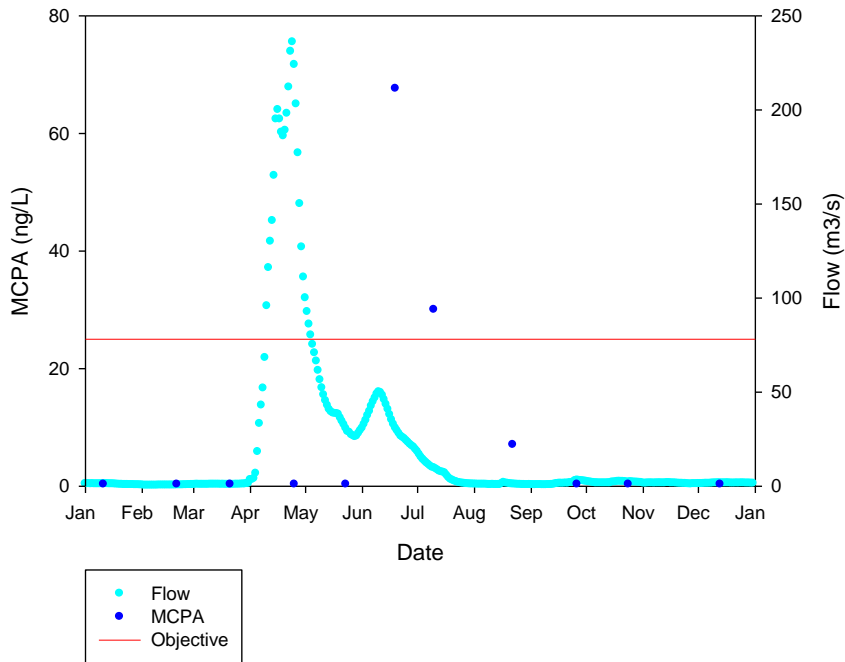


Figure 7: MCPA versus date and flow rate versus date in Assiniboine River in 2006.

MCPA in Assiniboine River in 2007

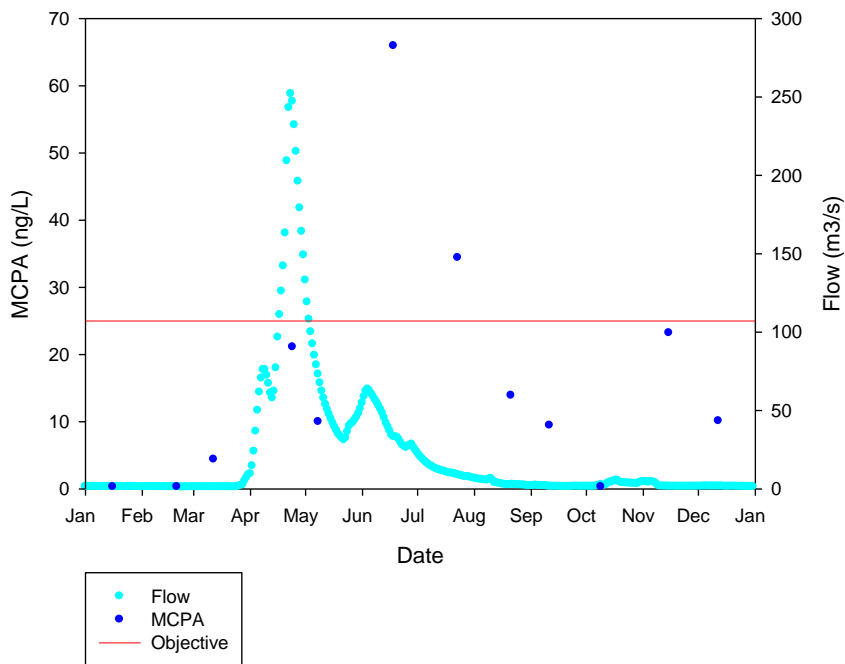


Figure 8: MCPA versus date and flow rate versus date in Assiniboine River in 2007.

MCPA in Assiniboine River in 2008

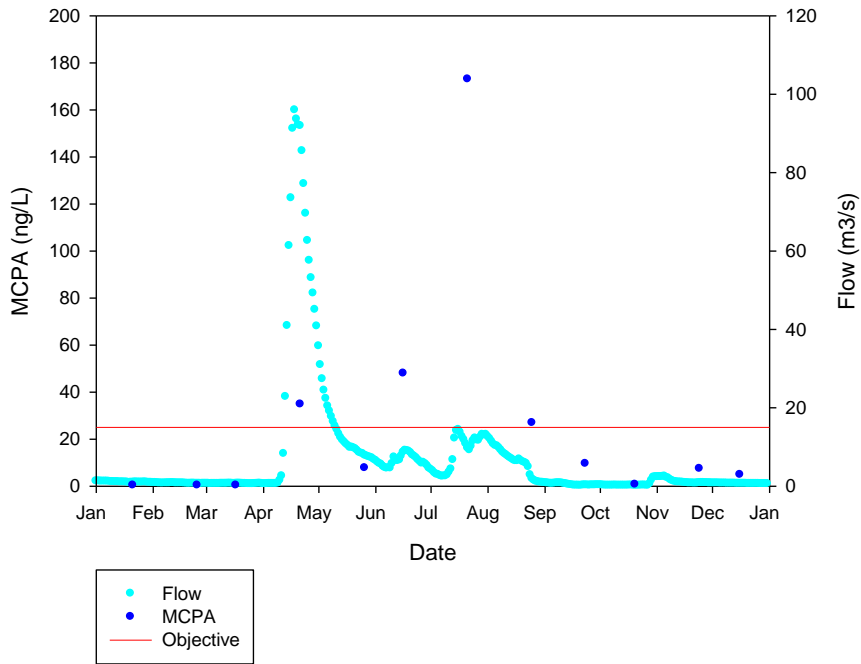


Figure 9: MCPA versus date and flow rate versus date in Assiniboine River in 2008.

MCPA in Assiniboine River in 2009

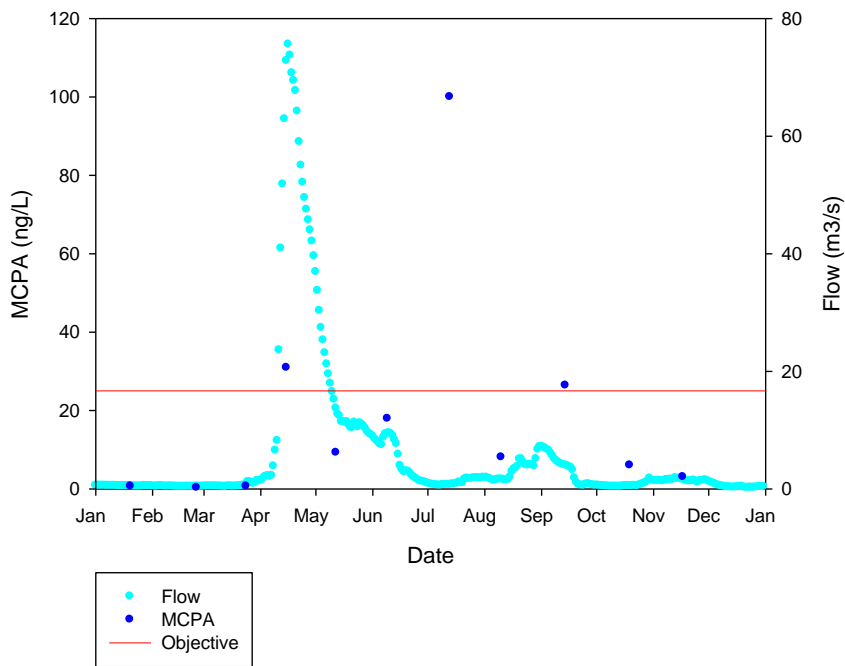


Figure 10: MCPA versus date and flow rate versus date in Assiniboine River in 2009.

MCPA in Assiniboine River in 2010

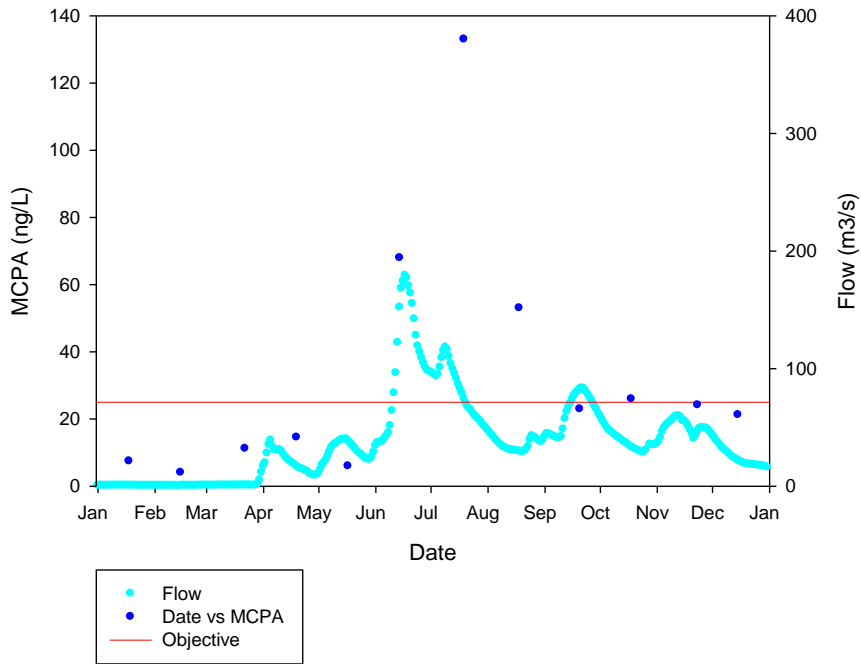


Figure 11: MCPA versus date and flow rate versus date in Assiniboine River in 2010.

MCPA in Assiniboine River in 2011

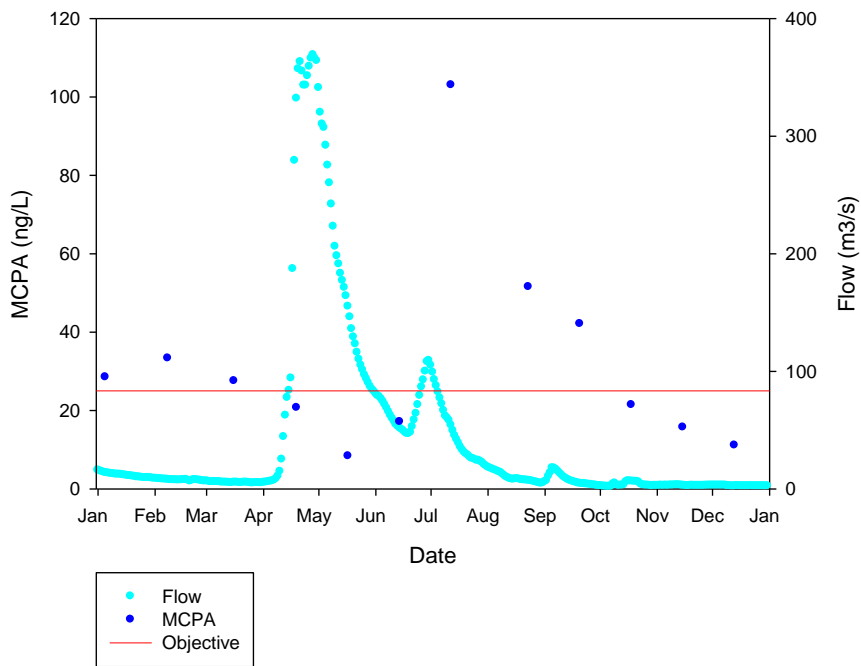


Figure 12: MCPA versus date and flow rate versus date in Assiniboine River in 2011.

MCPA in Assiniboine River in 2012

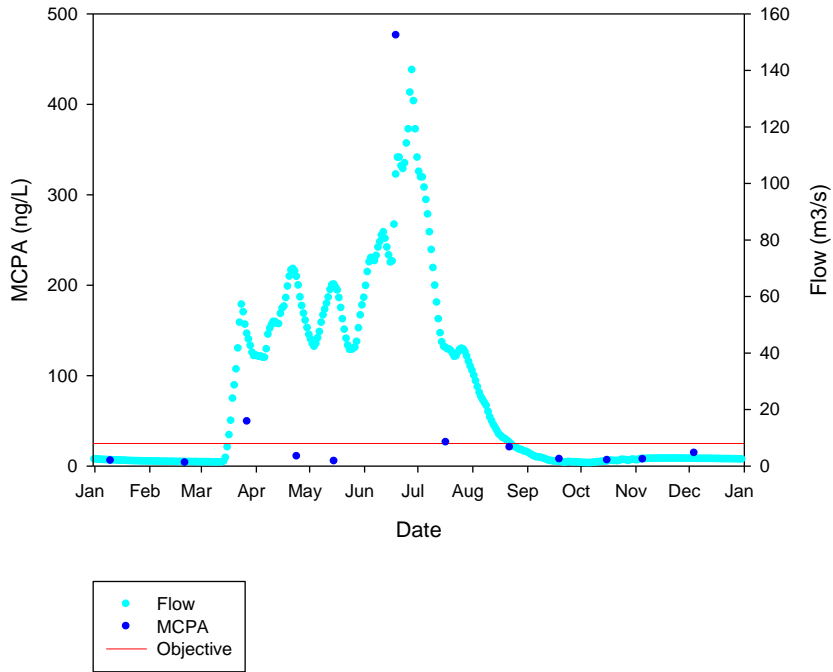


Figure 13: MCPA versus date and flow rate versus date in Assiniboine River in 2012.

MCPA in Assiniboine River in 2013

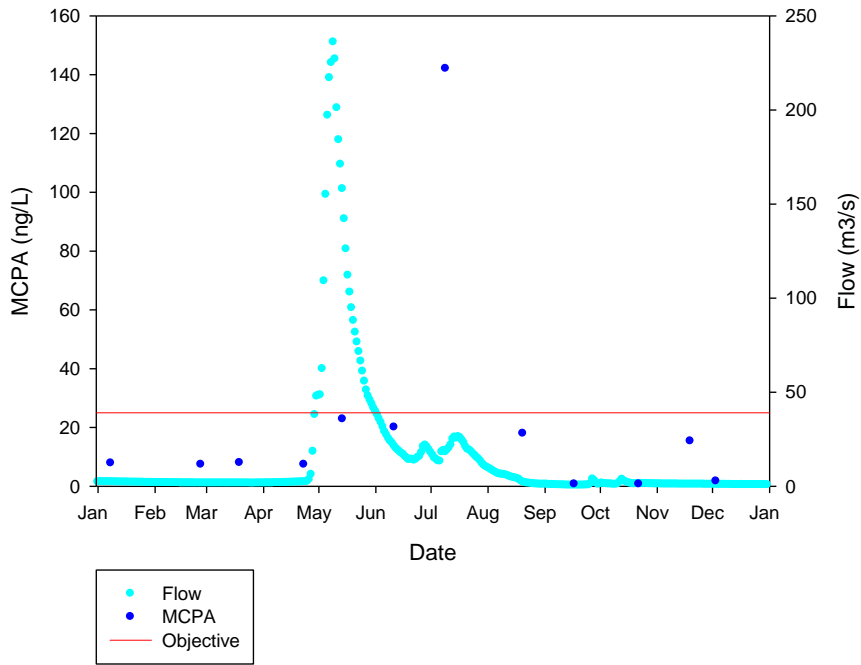


Figure 14: MCPA versus date and flow rate versus date in Assiniboine River in 2013.

MCPA in Carrot River in 2000

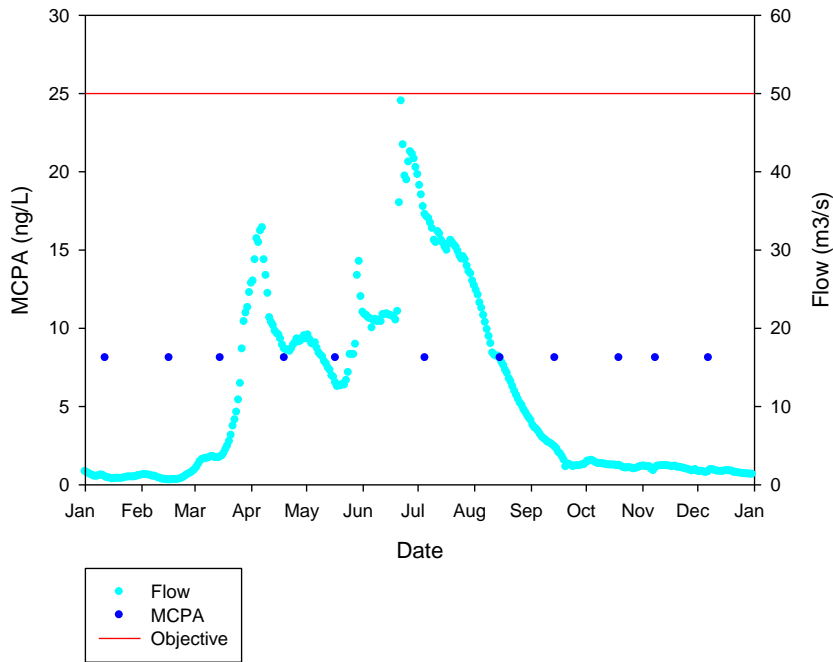


Figure 18: MCPA versus date and flow rate versus date in Carrot River in 2000.

MCPA in Carrot River in 2001

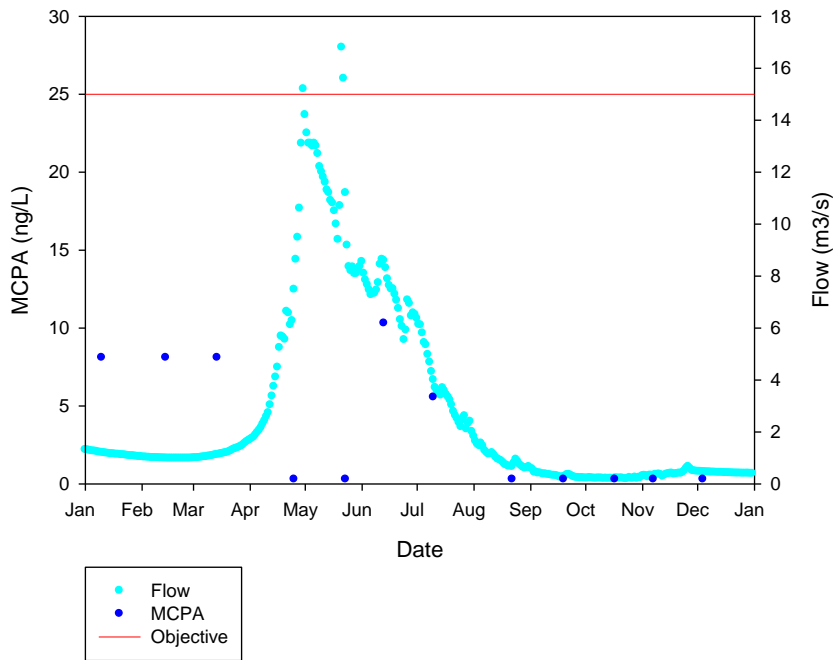


Figure 19: MCPA versus date and flow rate versus date in Carrot River in 2001.

MCPA in Carrot River in 2002

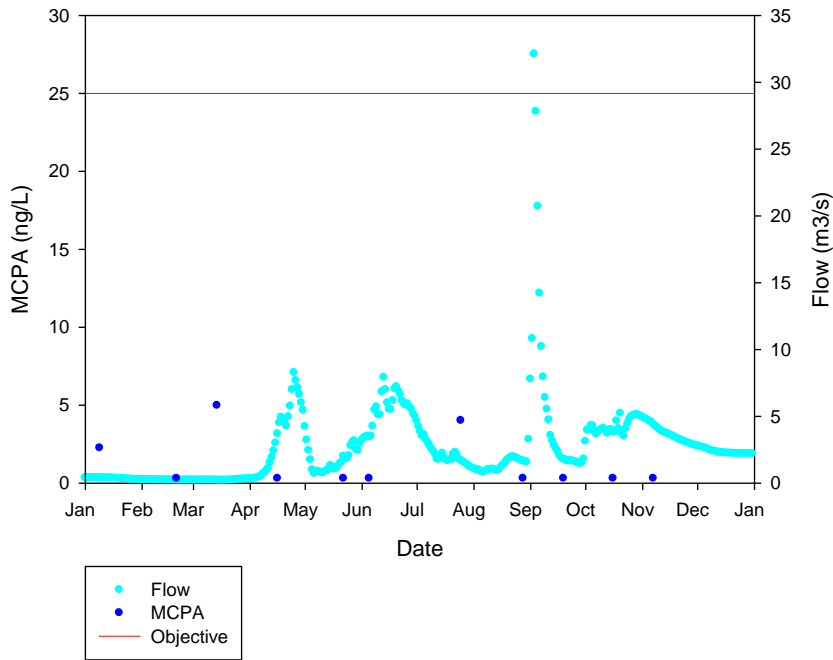


Figure 20: MCPA versus date and flow rate versus date in Carrot River in 2002.

MCPA in Carrot River in 2003

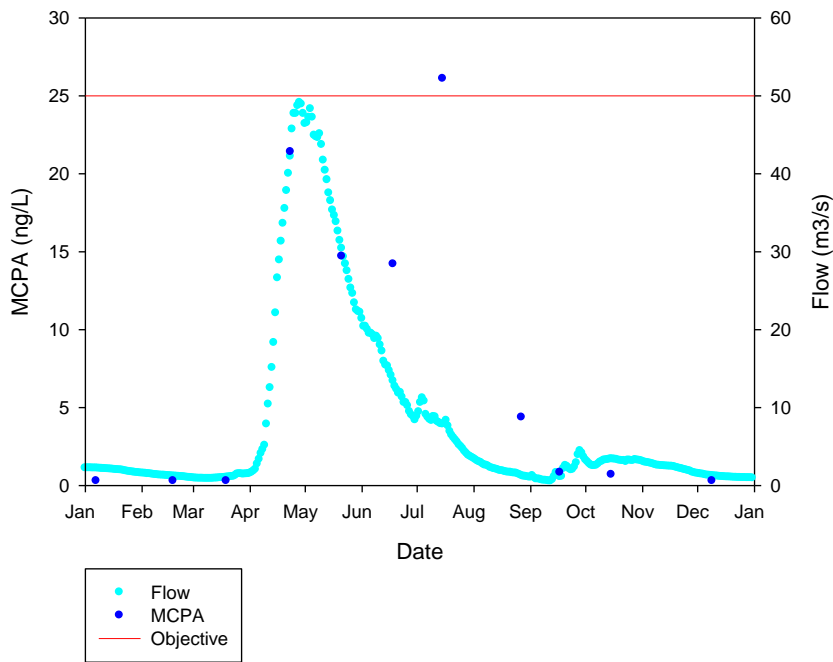


Figure 21: MCPA versus date and flow rate versus date in Carrot River in 2003.

MCPA in Carrot River in 2004

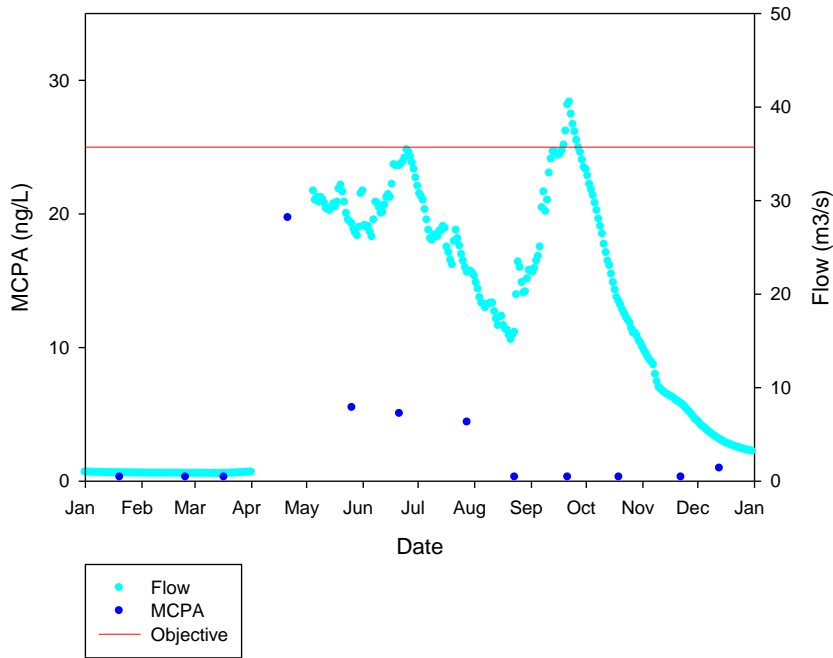


Figure 22: MCPA versus date and flow rate versus date in Carrot River in 2004.

MCPA in Carrot River in 2005

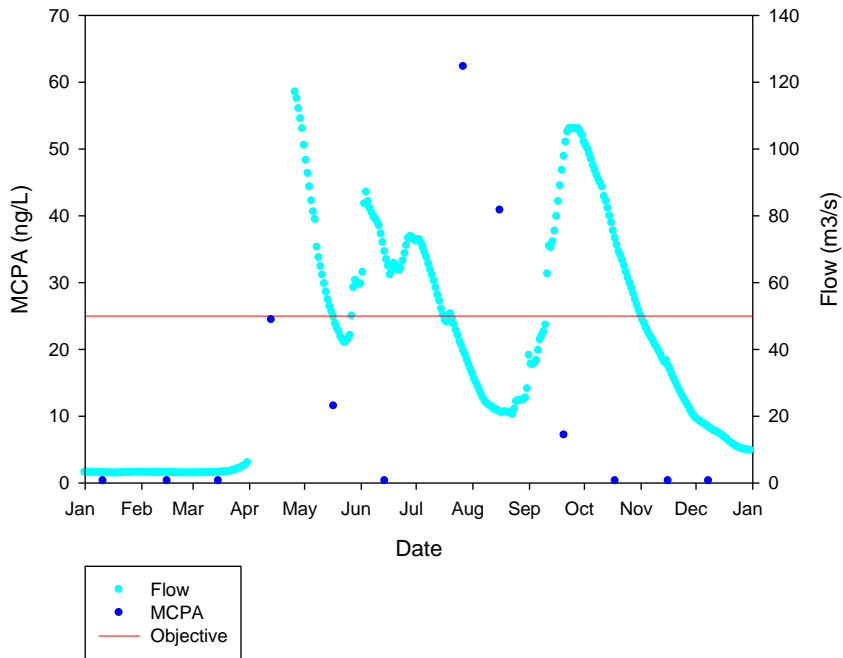


Figure 23: MCPA versus date and flow rate versus date in Carrot River in 2005.

MCPA in Carrot River in 2006

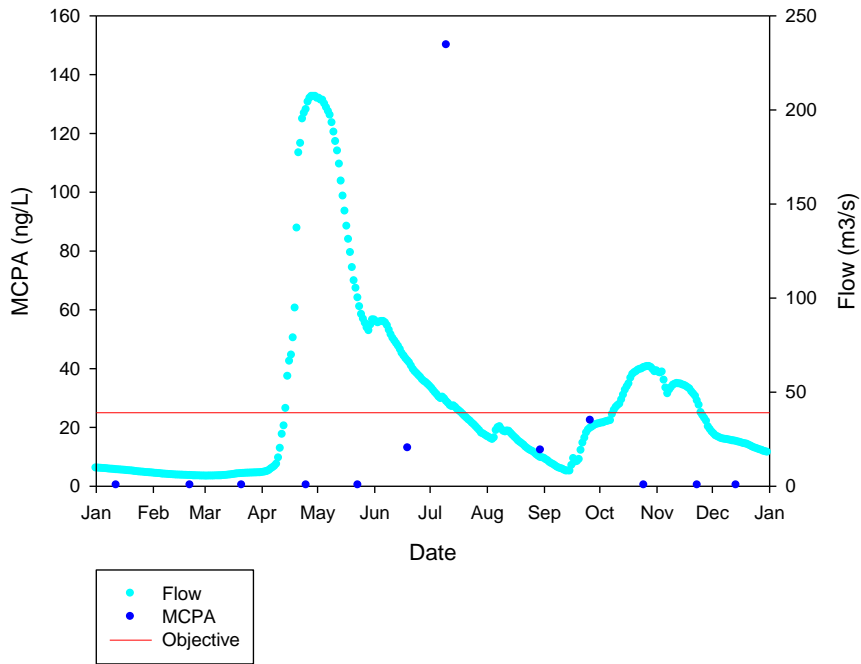


Figure 24: MCPA versus date and flow rate versus date in Carrot River in 2006.

MCPA in Carrot River in 2007

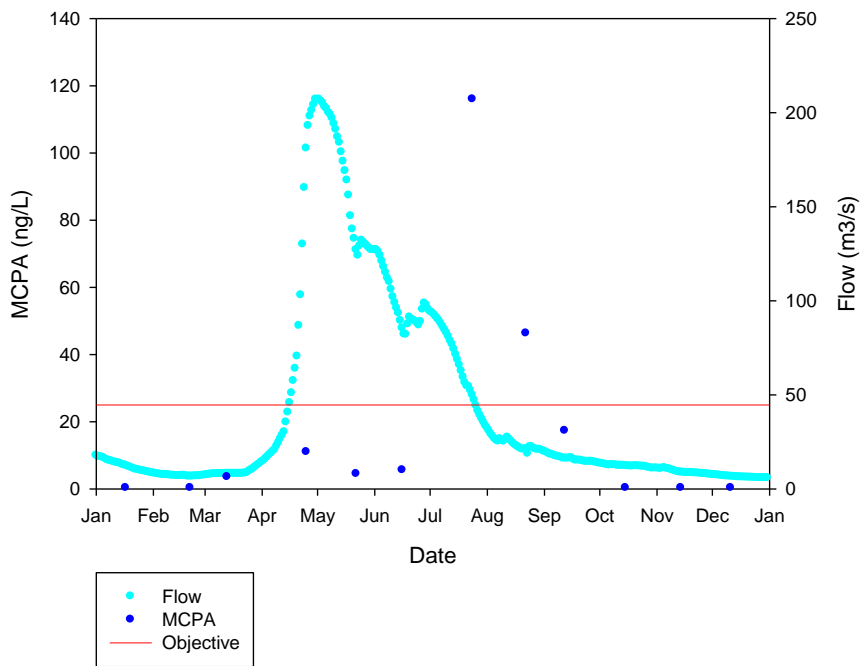


Figure 25: MCPA versus date and flow rate versus date in Carrot River in 2007.

MCPA in Carrot River in 2008

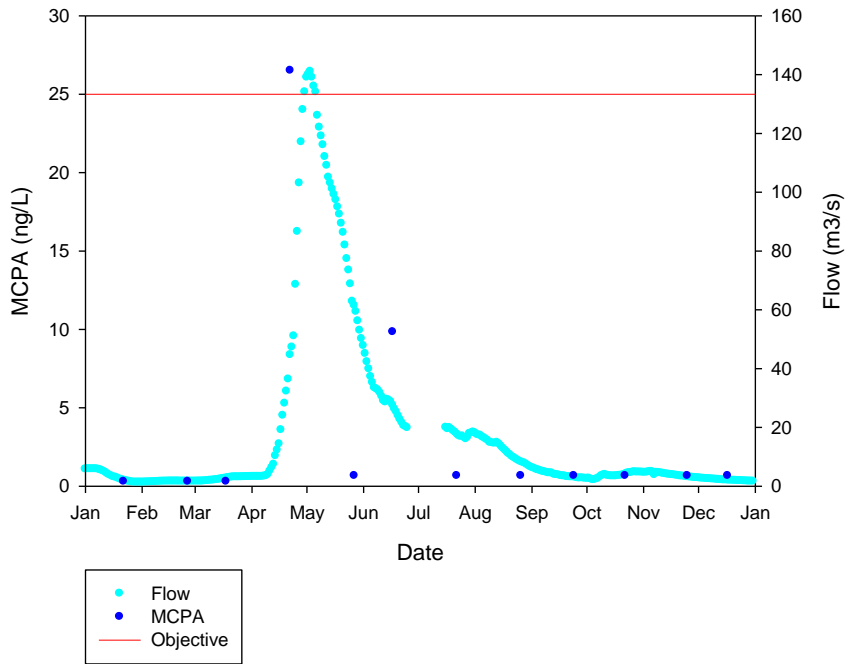


Figure 26: MCPA versus date and flow rate versus date in Carrot River in 2008.

MCPA in Carrot River in 2009

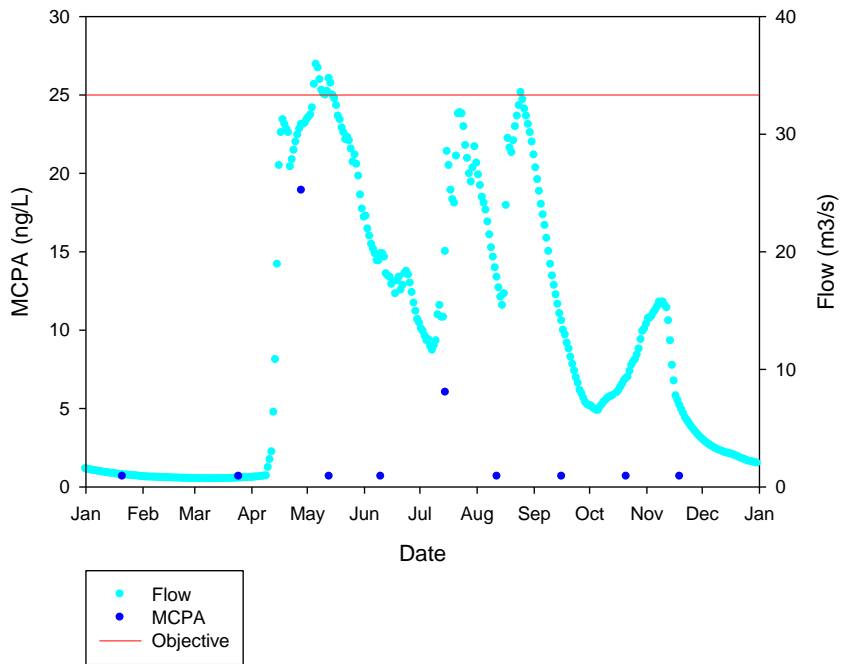


Figure 27: MCPA versus date and flow rate versus date in Carrot River in 2009.

MCPA in Carrot River in 2010

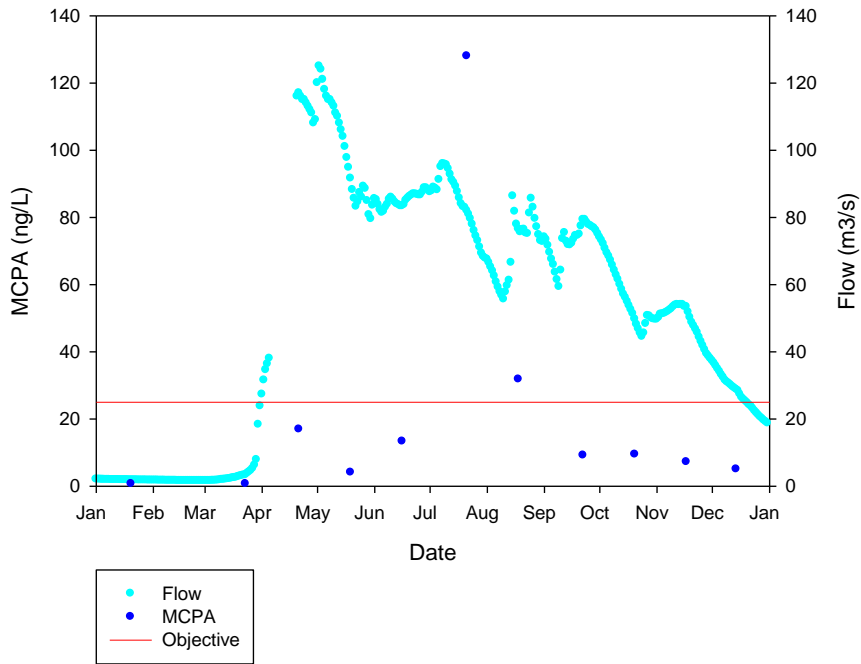


Figure 28: MCPA versus date and flow rate versus date in Carrot River in 2010.

MCPA in Carrot River in 2011

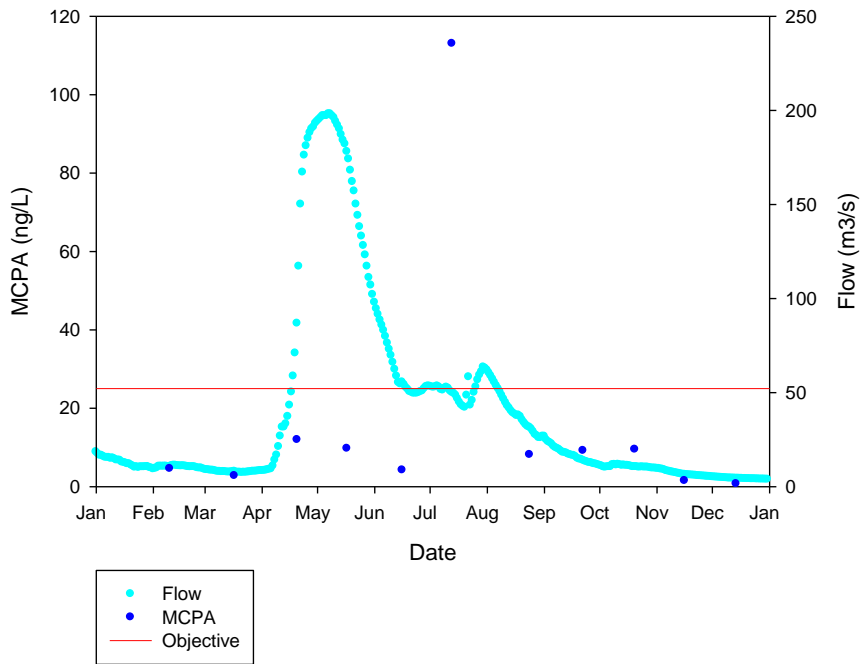


Figure 29: MCPA versus date and flow rate versus date in Carrot River in 2011.

MCPA in Carrot River in 2012

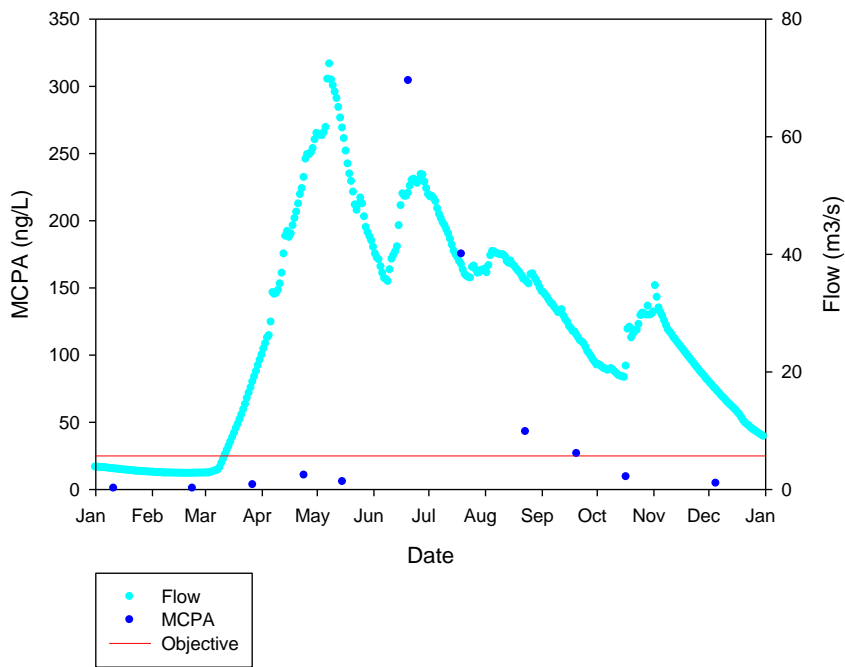


Figure 30: MCPA versus date and flow rate versus date in Carrot River in 2012.

MCPA in Carrot River in 2013

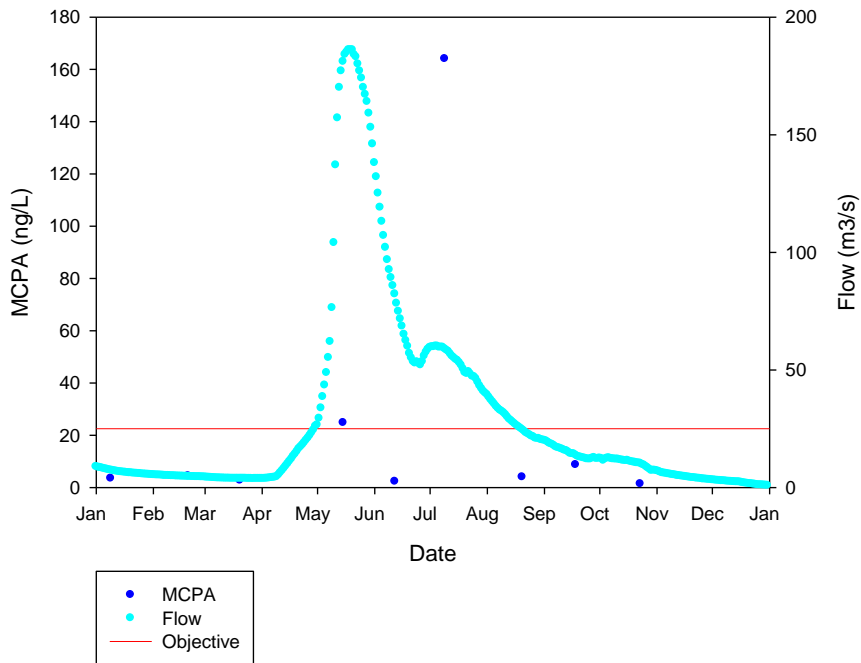


Figure 31: MCPA versus date and flow rate versus date in Carrot River in 2013.

MCPA in Qu'Appelle River in 2008

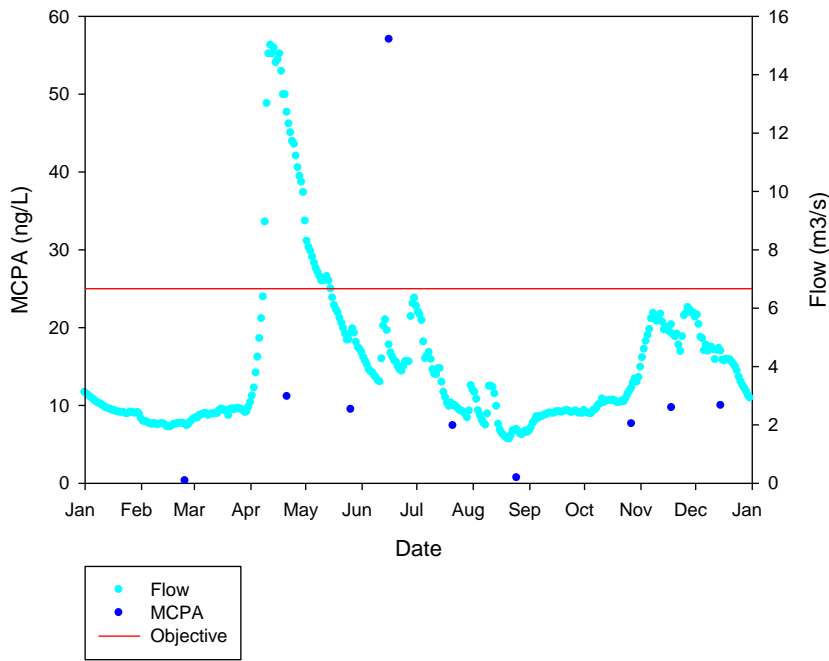


Figure 32: MCPA versus date and flow rate versus date in Qu'Appelle River in 2008.

MCPA in Qu'Appelle River in 2012

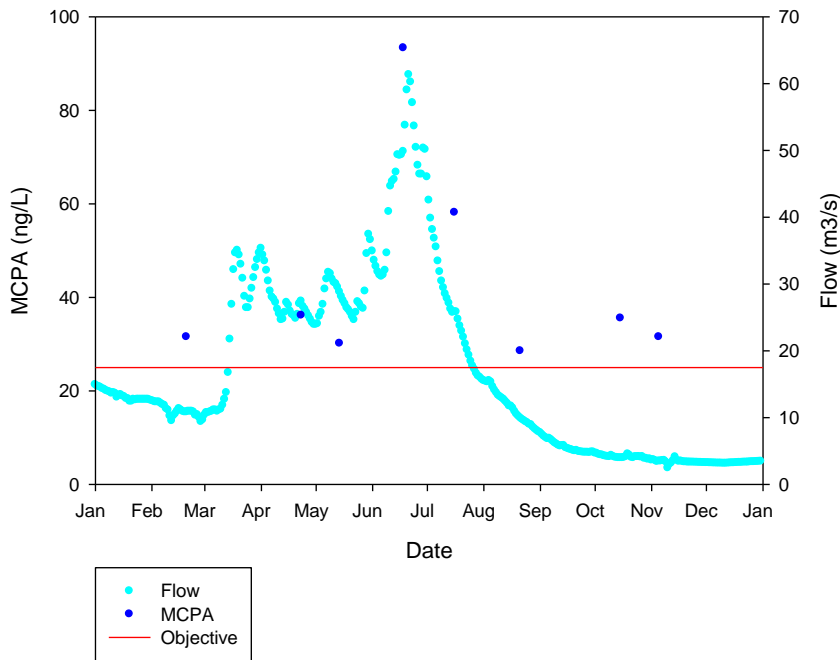


Figure 33: MCPA versus date and flow rate versus date in Qu'Appelle River in 2012.

Appendix C: Dicamba with Flow (Entire Data Set, 2000-2013)

Dicamba in Battle River (Entire Data Set)

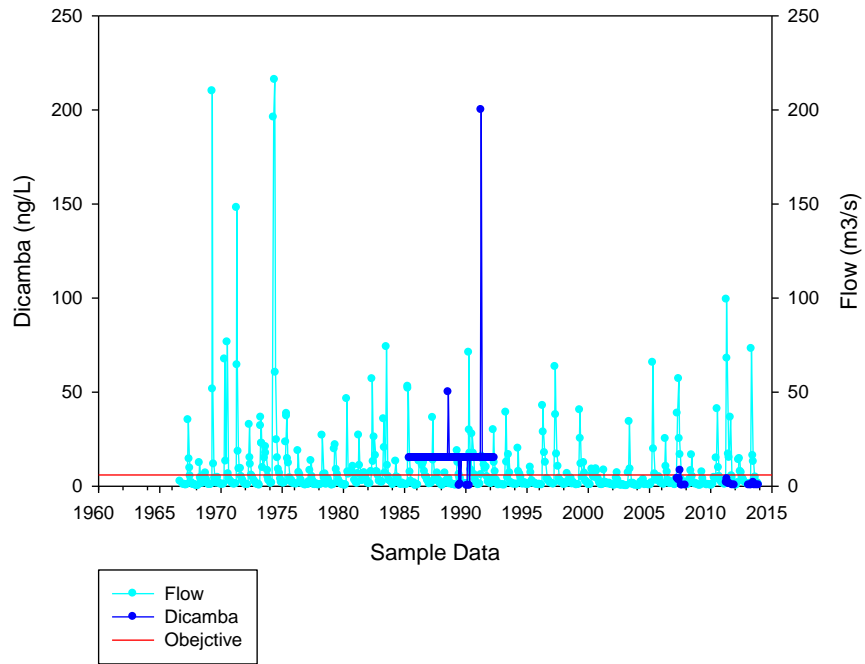


Figure 3: Dicamba versus date and flow rate versus date in Battle River (entire data set).

Dicamba in Battle River (2000-2013)

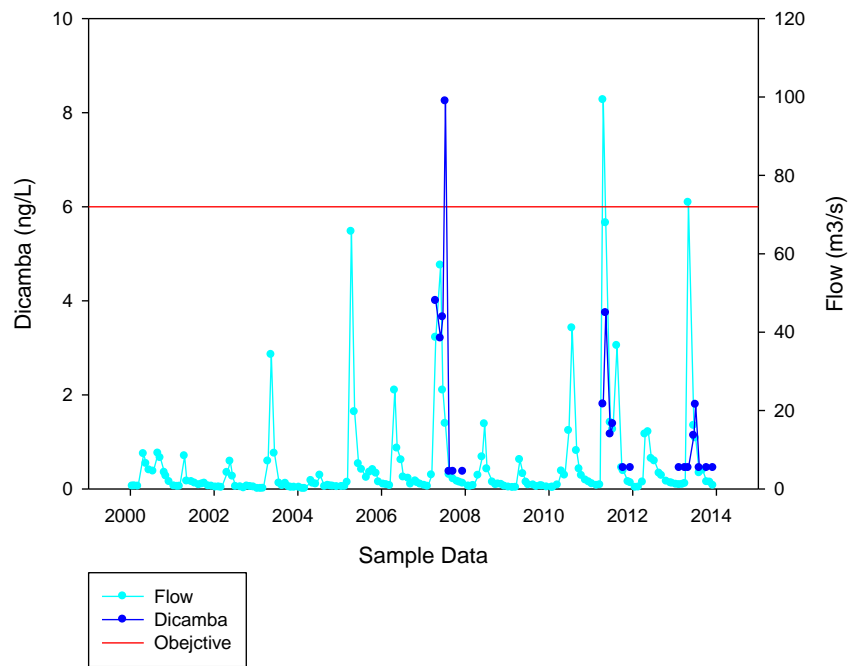


Figure 4: Dicamba versus date and flow rate versus date in Battle River from 2000 until 2013.

Dicamba in North Saskatchewan River (Entire Data Set)

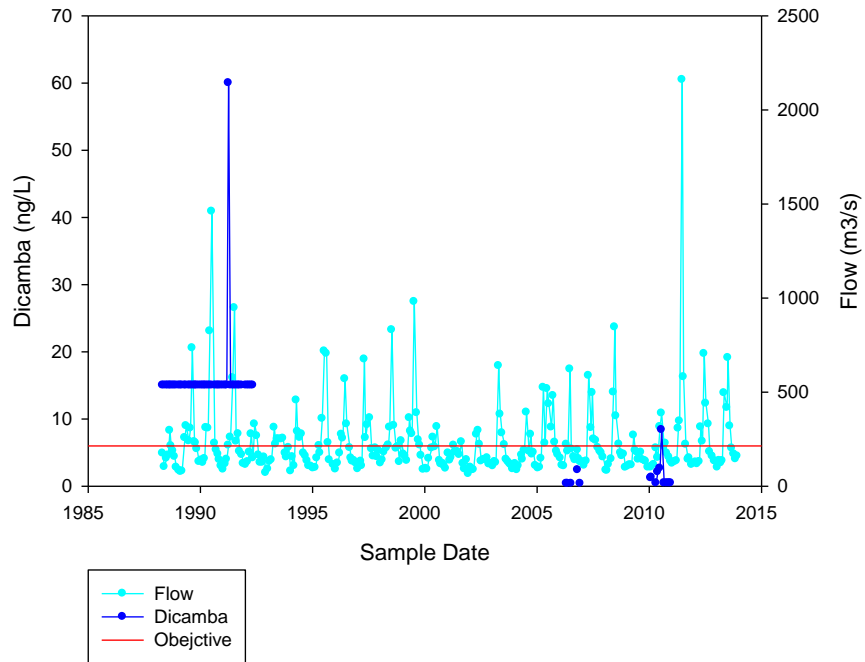


Figure 7: Dicamba versus date and flow rate versus date in North Saskatchewan River (entire data set).

Dicamba in North Saskatchewan River (2000-2013)

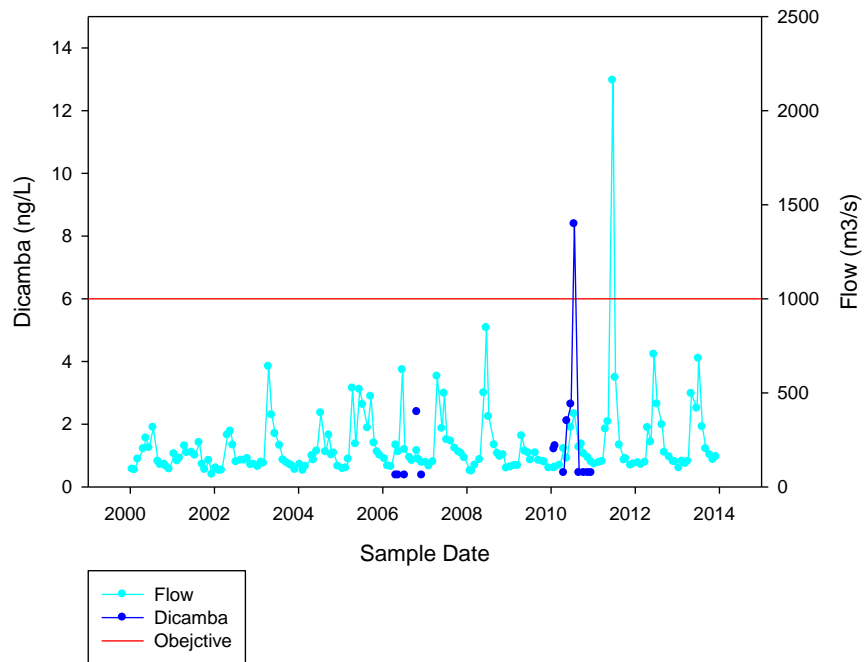


Figure 8: Dicamba versus date and flow rate versus date in North Saskatchewan River from 2000 until 2013.

Dicamba in Red Deer River near Bindloss (Entire Data Set)

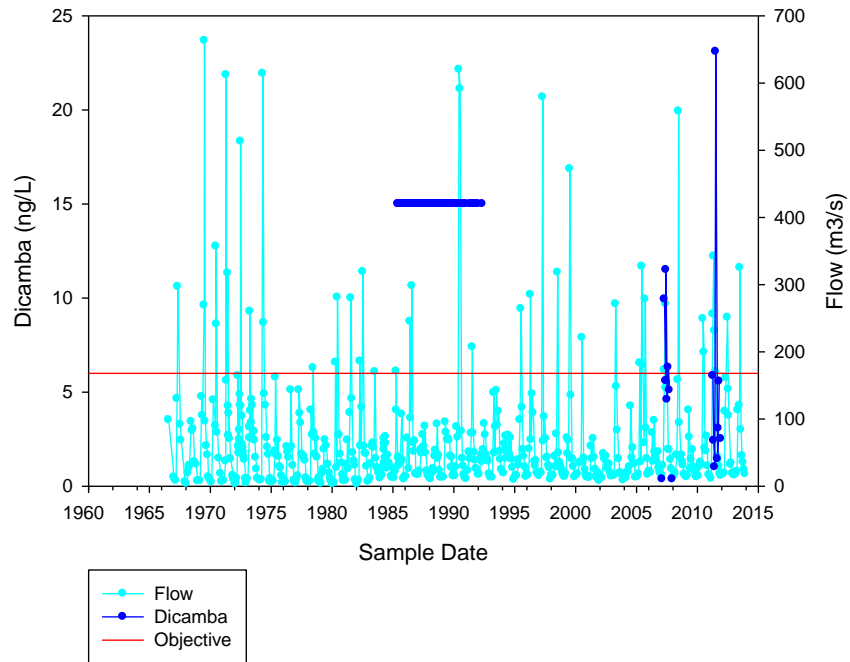


Figure 11: Dicamba versus date and flow rate versus date in Red Deer River near Bindloss (entire data set).

Dicamba in Red Deer River near Bindloss (2000-2013)

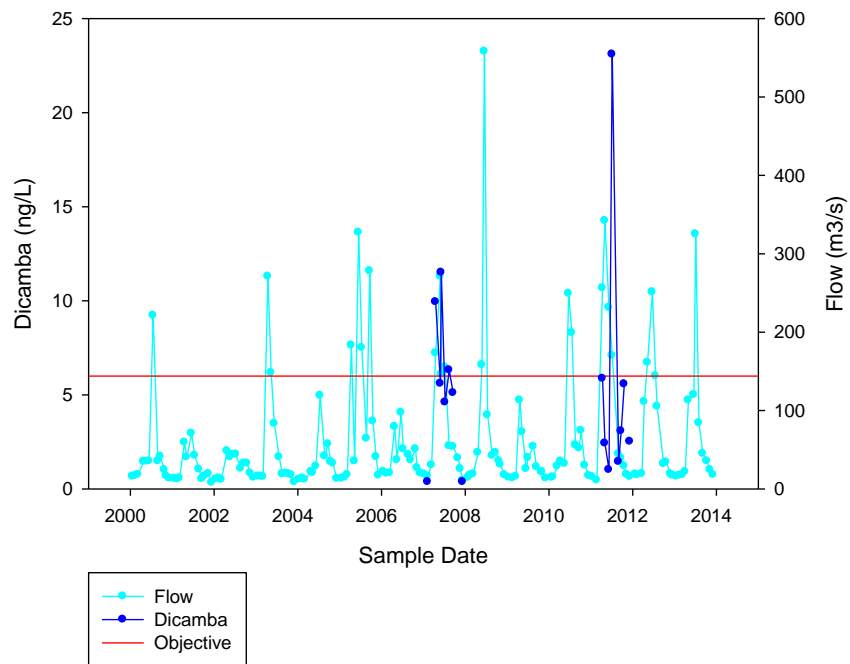


Figure 12: Dicamba versus date and flow rate versus date in Red Deer River near Bindloss from 2000 until 2013.

Dicamba in South Saskatchewan River (Entire Data Set)

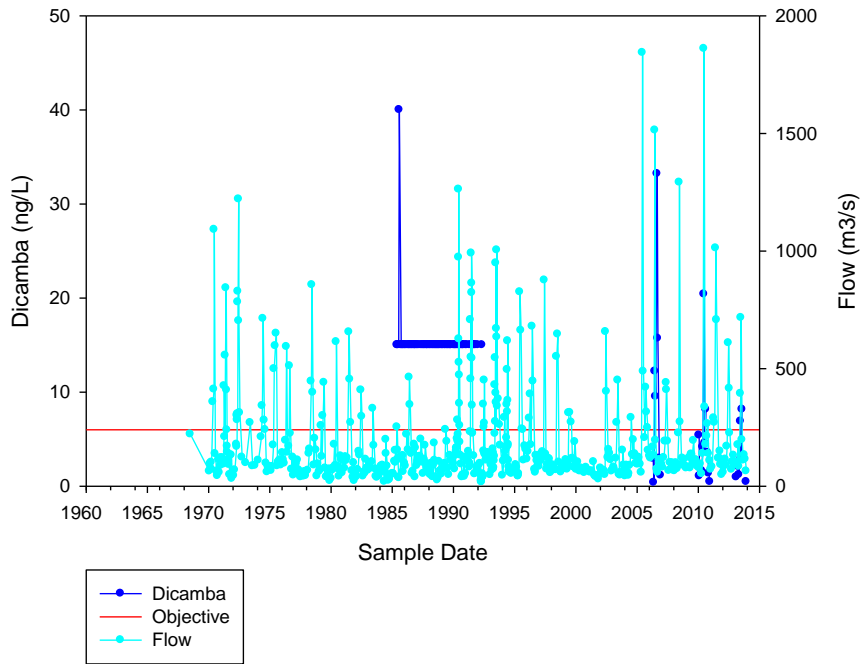


Figure 13: Dicamba versus date and flow rate versus date in South Saskatchewan River (entire data set).

Dicamba in South Saskatchewan River (2000-2013)

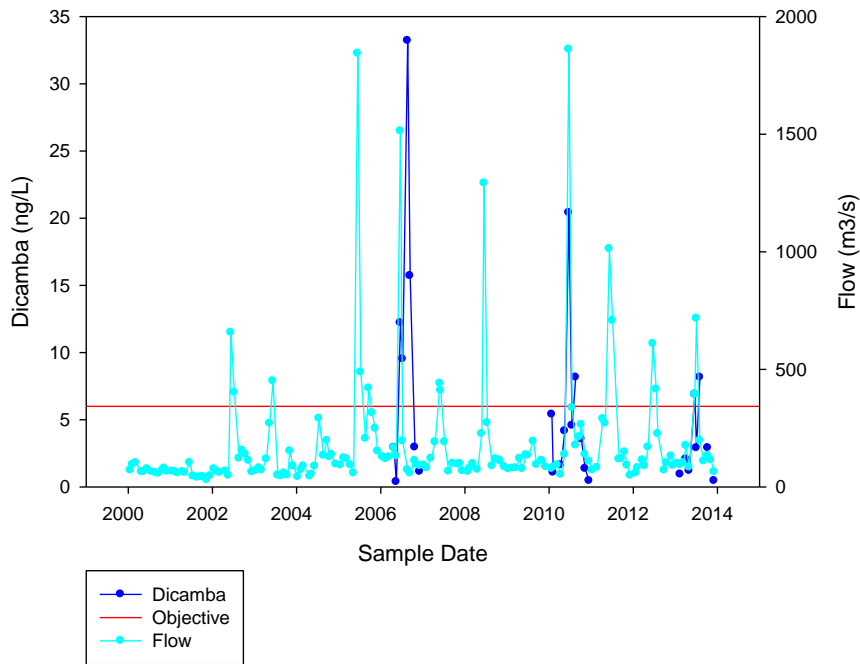


Figure 14: Dicamba versus date and flow rate versus date in South Saskatchewan River from 2000 until 2013.

Dicamba in Assiniboine River (Entire Data Set)

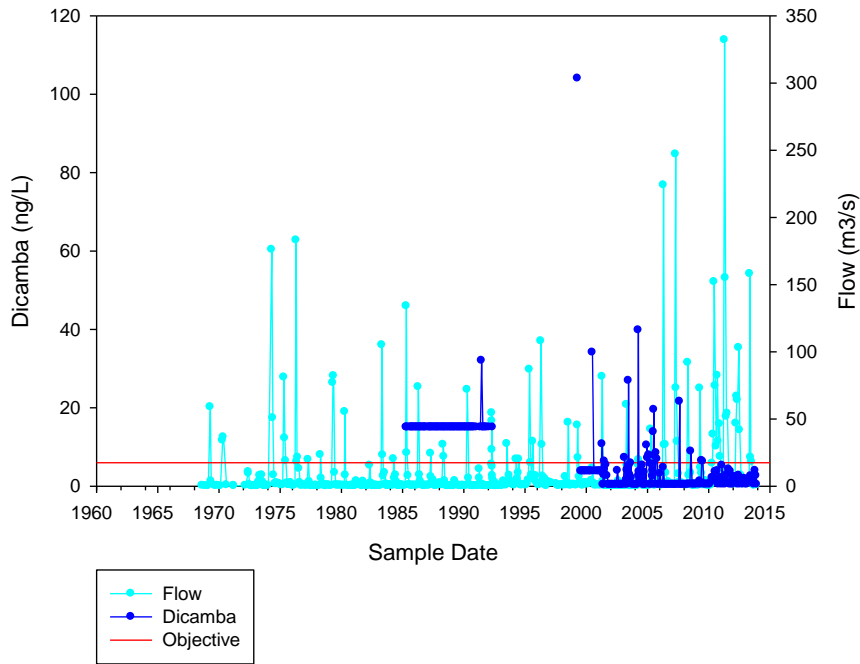


Figure 1: Dicamba versus date and flow rate versus date in Assiniboine River (entire data set).

Dicamba in Assiniboine River (2000-2013)

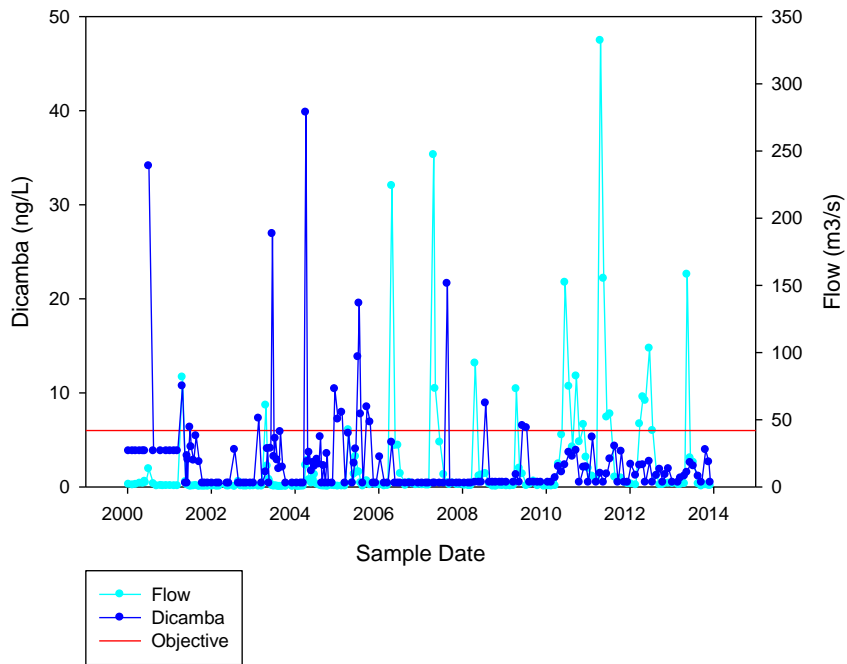


Figure 2: Dicamba versus date and flow rate versus date in Assiniboine River from 2000 until 2013.

Dicamba in Carrot River (Entire Data Set)

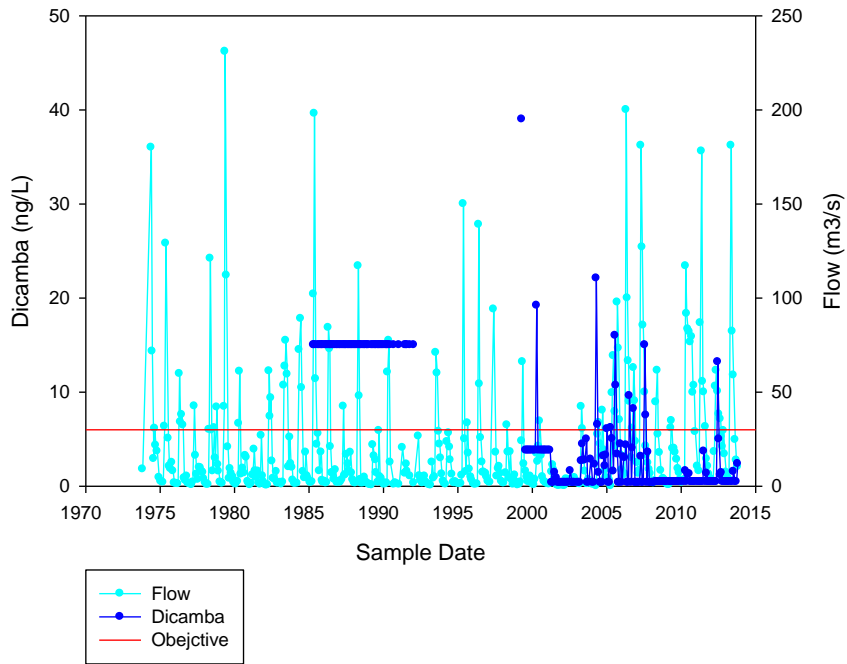


Figure 5: Dicamba versus date and flow rate versus date in Carrot River (entire data set).

Dicamba in Carrot River (2000-2013)

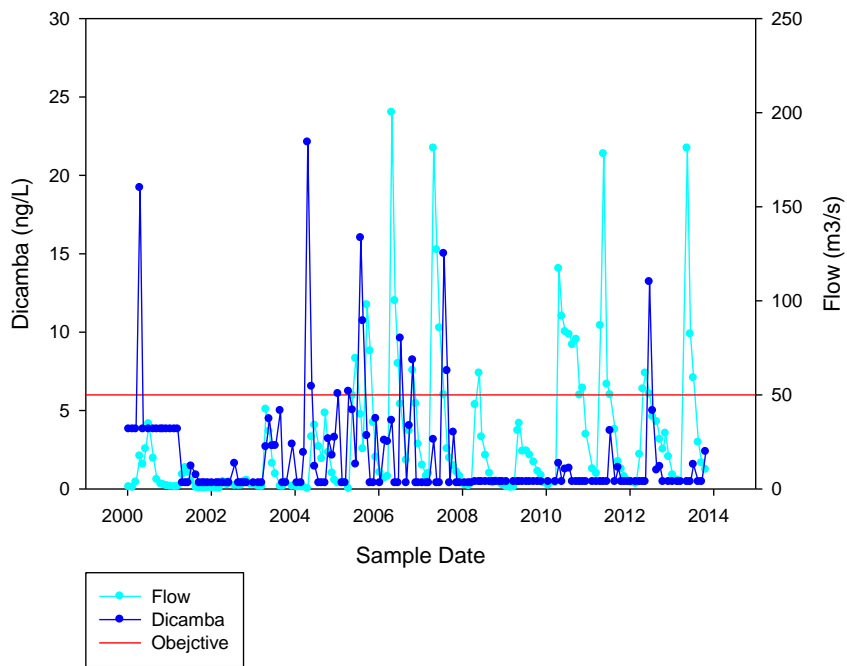


Figure 6: Dicamba versus date and flow rate versus date in Carrot River from 2000 until 2013.

Dicamba in Qu'Appelle River (Entire Data Set)

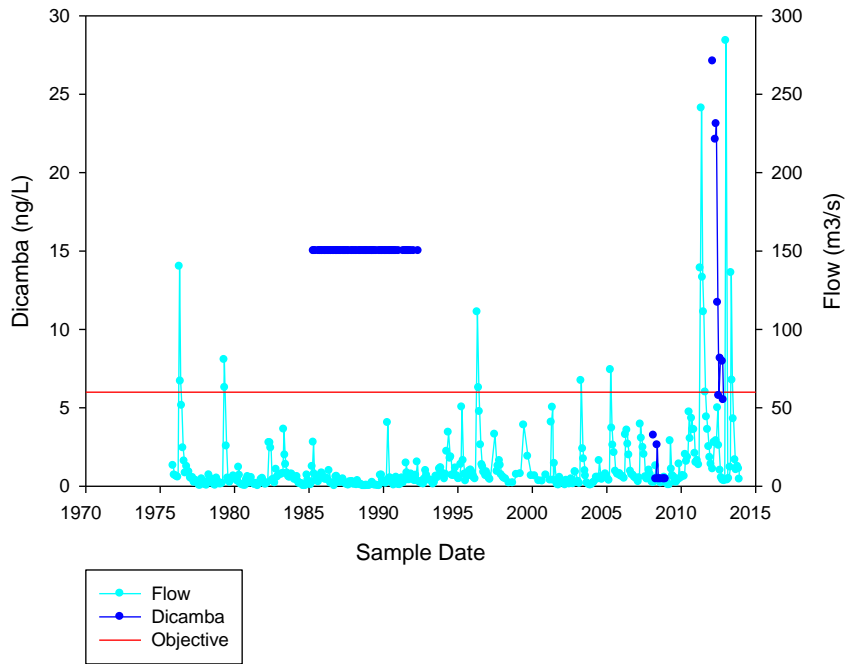


Figure 9: Dicamba versus date and flow rate versus date in Qu'Appelle River (entire data set).

Dicamba in Qu'Appelle River (2000-2013)

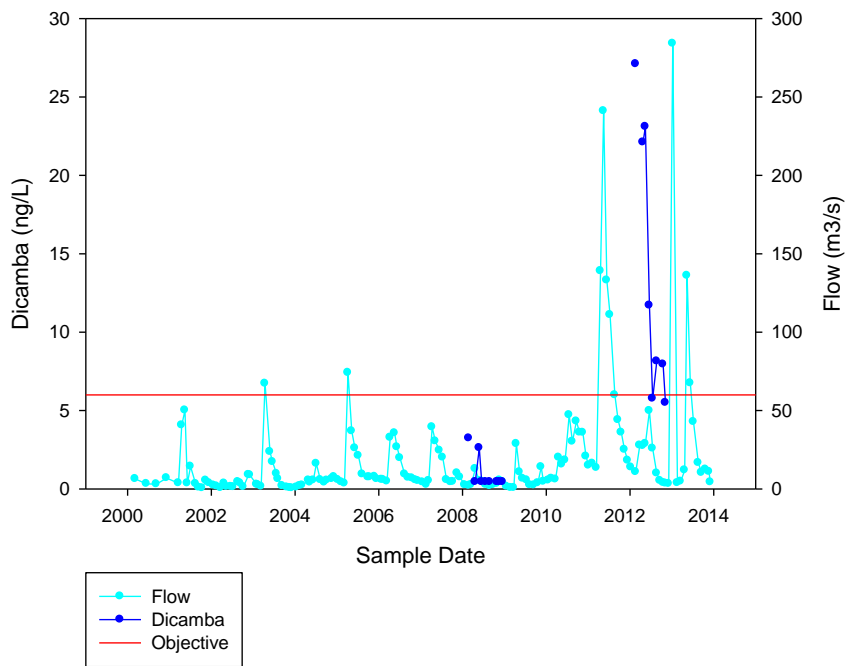


Figure 10: Dicamba versus date and flow rate versus date in Qu'Appelle River from 2000 until 2013.

Dicamba in Saskatchewan River (Entire Data Set)

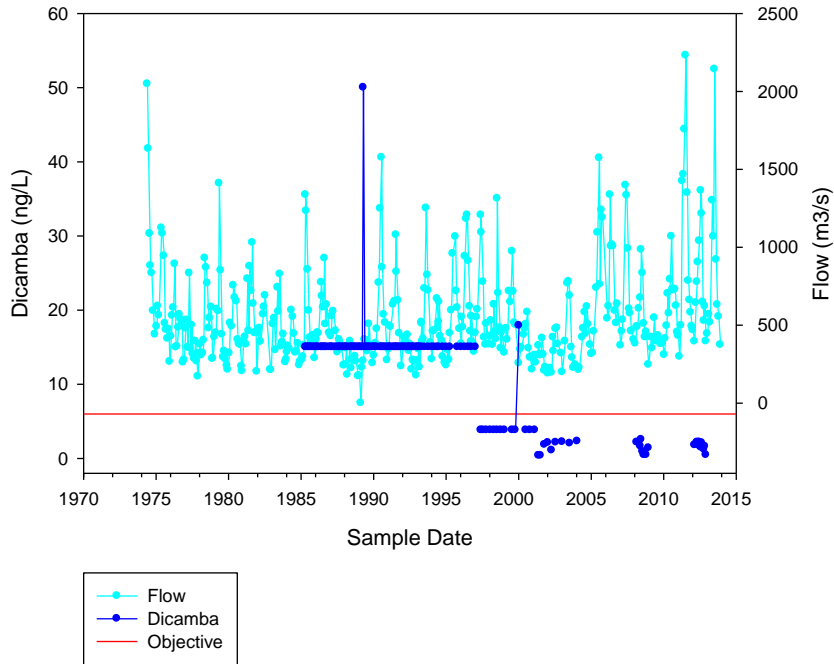


Figure 15: Dicamba versus date and flow rate versus date in Saskatchewan River (entire data set).

Dicamba in Saskatchewan River (2000-2013)

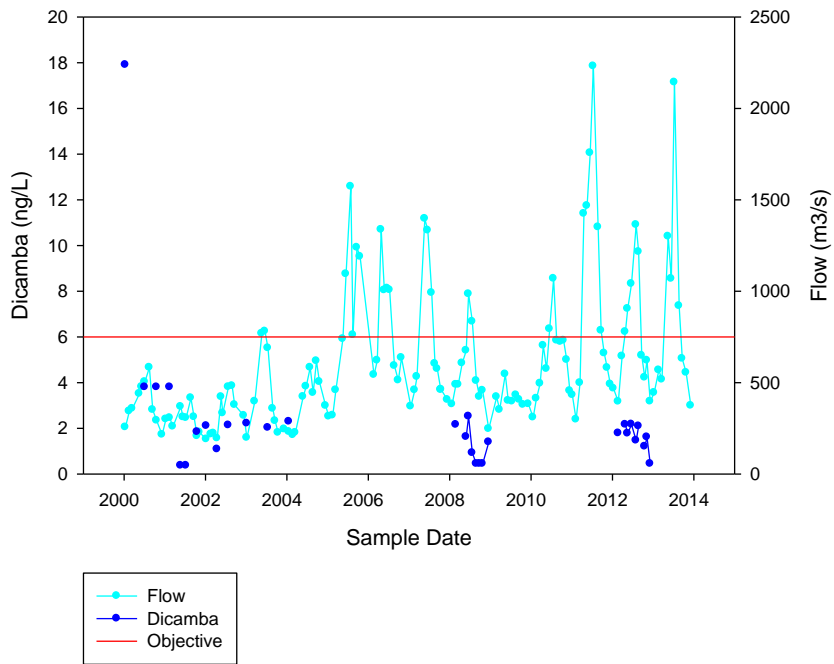


Figure 16: Dicamba versus date and flow rate versus date in Saskatchewan River from 2000 until 2013.

Appendix D: Dicamba with Daily Flow (2000-2013)

Dicamba in Battle River in 2007

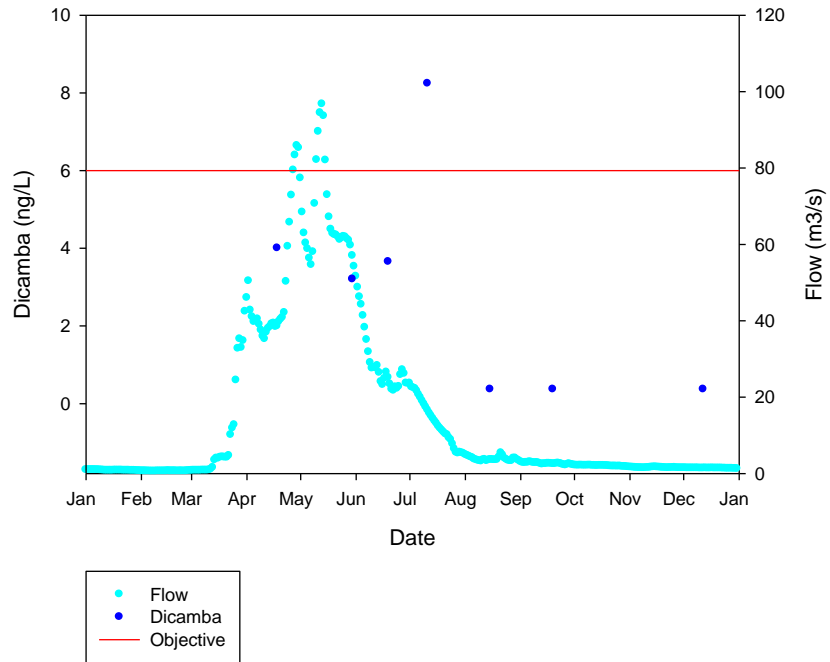


Figure 15: Dicamba versus date and flow rate versus date in Battle River in 2007.

Dicamba in Battle River in 2011

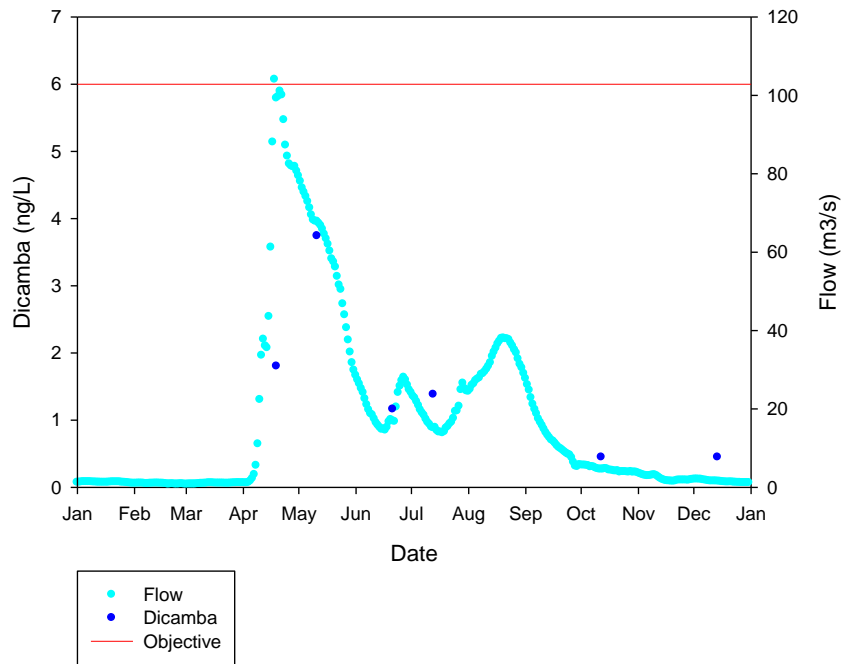


Figure 16: Dicamba versus date and flow rate versus date in Battle River in 2011.

Dicamba in Battle River in 2013

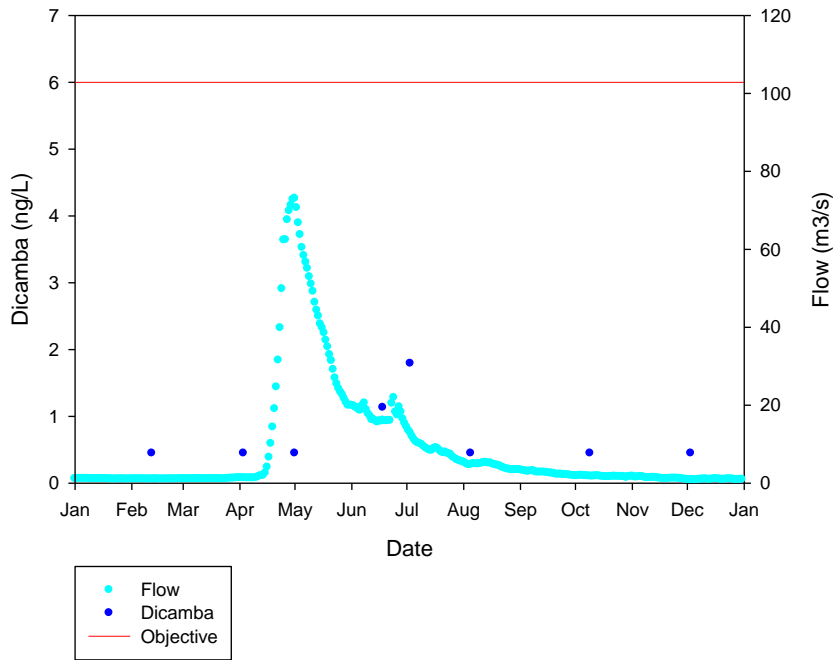


Figure 17: Dicamba versus date and flow rate versus date in Battle River in 2013.

Dicamba in North Saskatchewan River in 2006

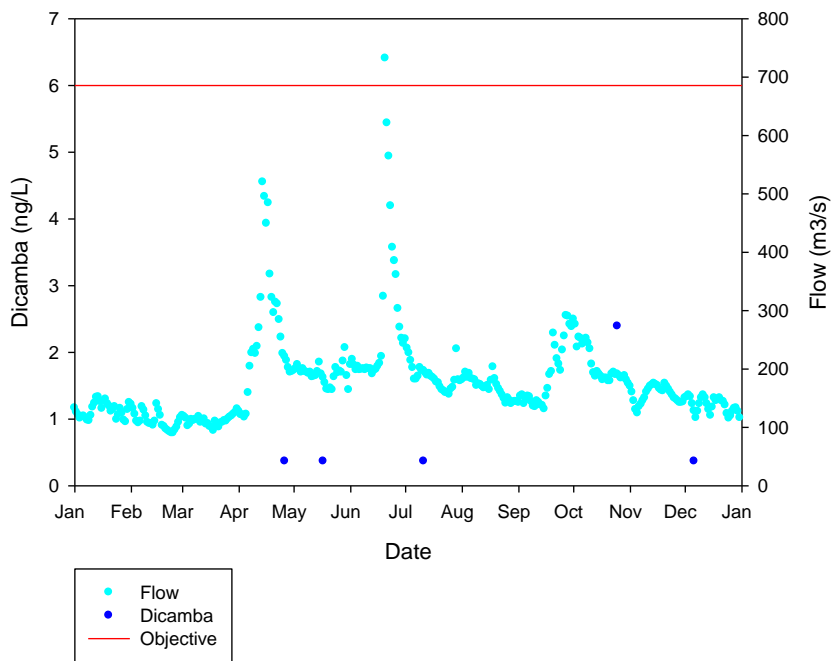


Figure 32: Dicamba versus date and flow rate versus date in North Saskatchewan River in 2006.

Dicamba in North Saskatchewan River in 2010

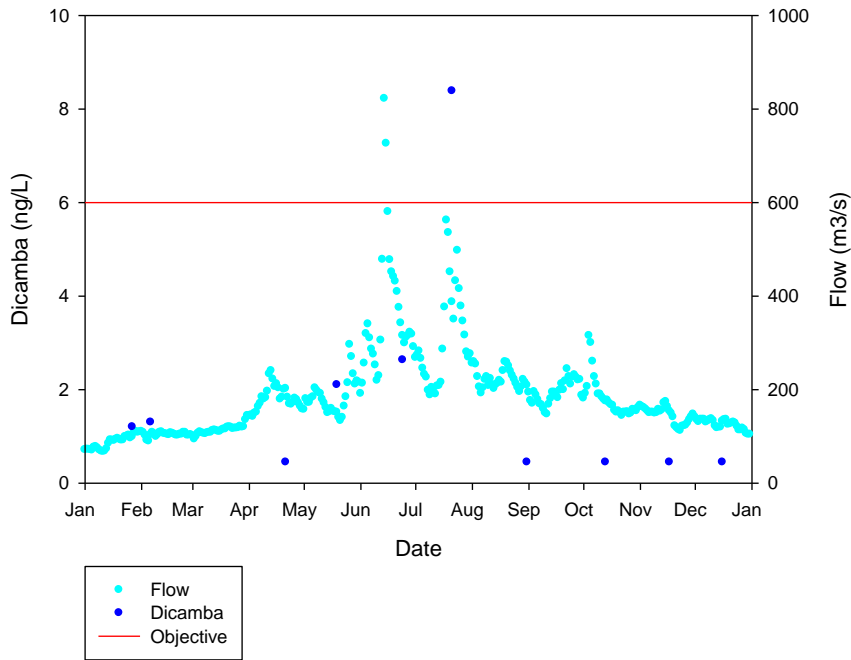


Figure 33: Dicamba versus date and flow rate versus date in North Saskatchewan River in 2010.

Dicamba in Red Deer River near Bindloss in 2007

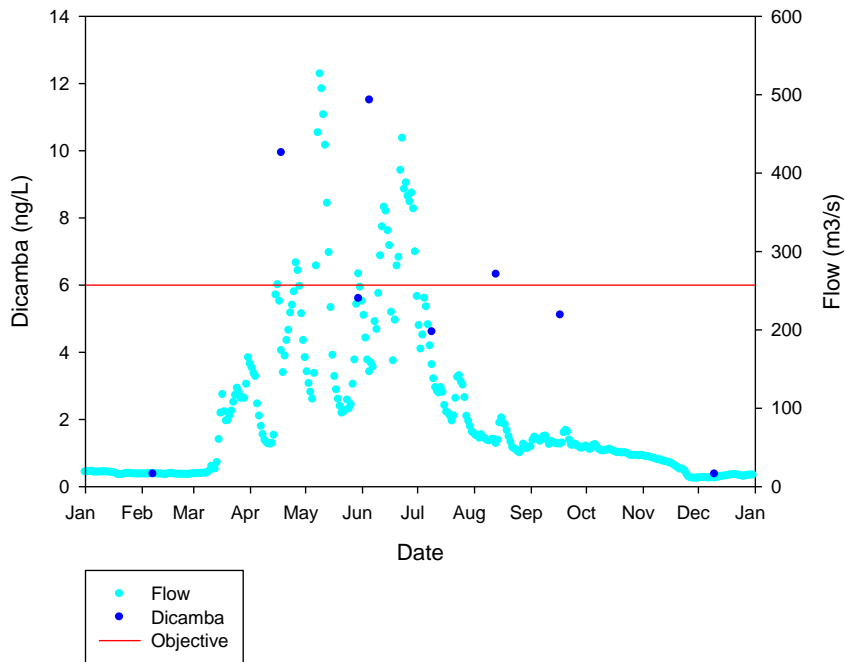


Figure 36: Dicamba versus date and flow rate versus date in Red Deer River near Bindloss in 2007.

Dicamba in Red Deer River near Bindloss in 2011

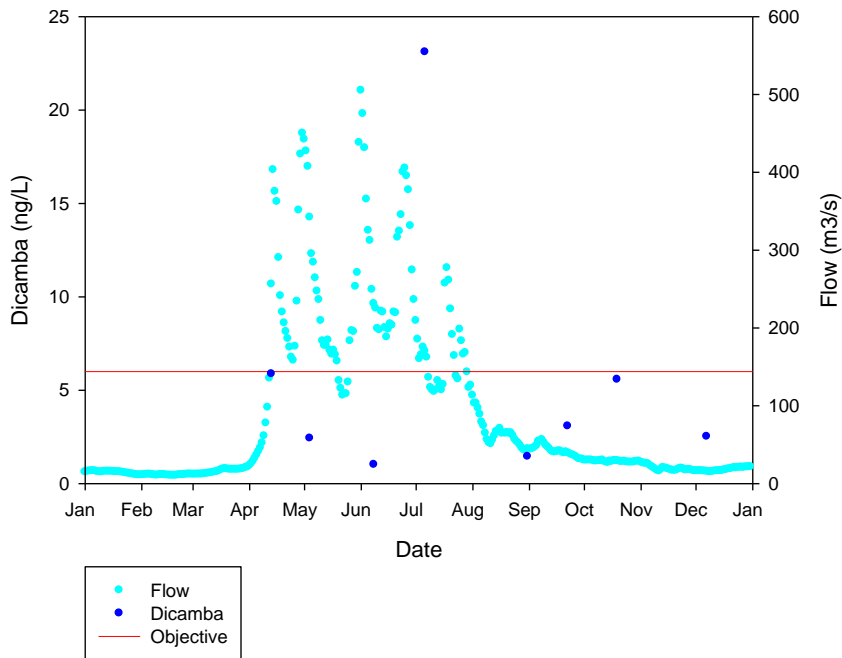


Figure 37: Dicamba versus date and flow rate versus date in Red Deer River near Bindloss in 2011.

Dicamba in South Saskatchewan River in 2006

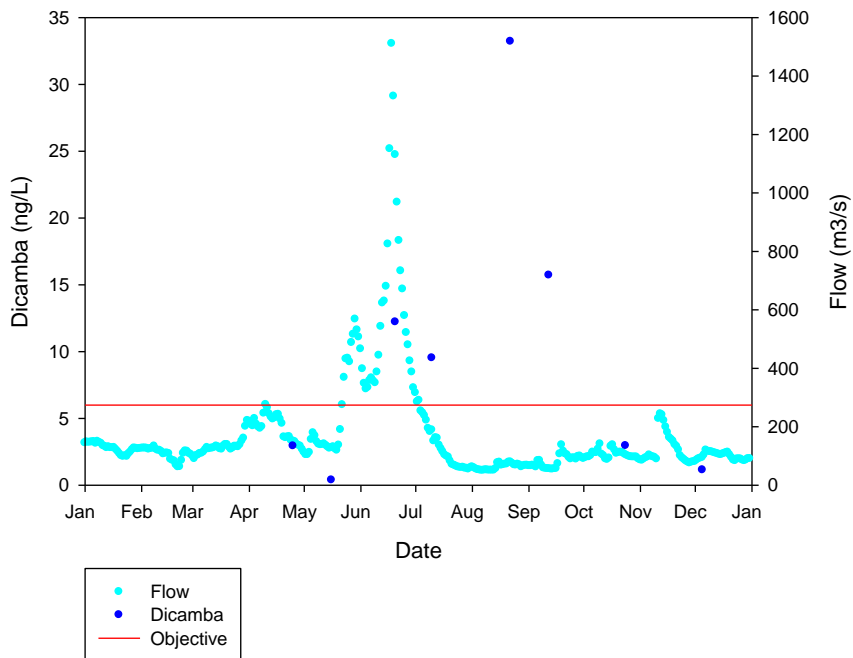


Figure 45: Dicamba versus date and flow rate versus date in South Saskatchewan River in 2006.

Dicamba in South Saskatchewan River in 2010

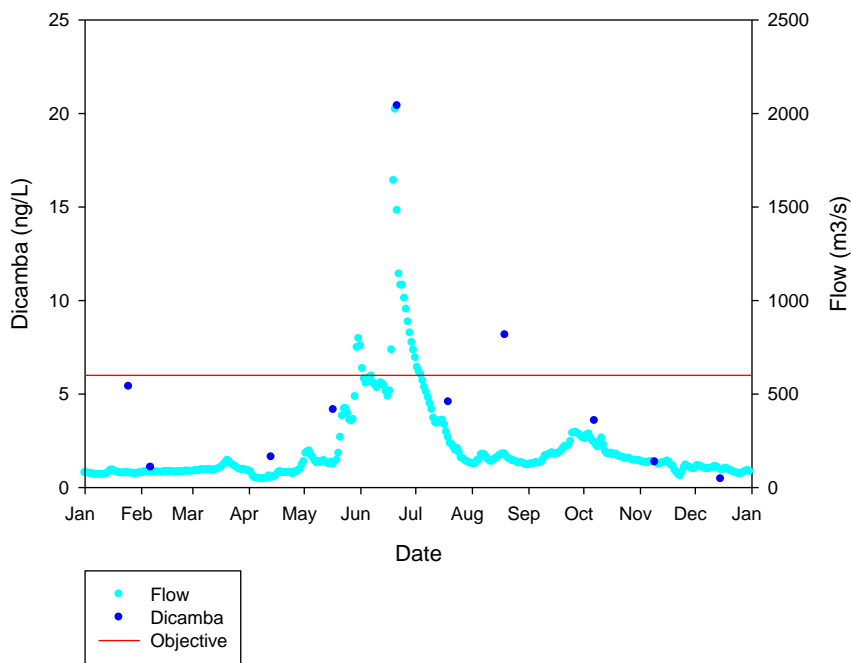


Figure 46: Dicamba versus date and flow rate versus date in South Saskatchewan River in 2010.

Dicamba in South Saskatchewan River in 2013

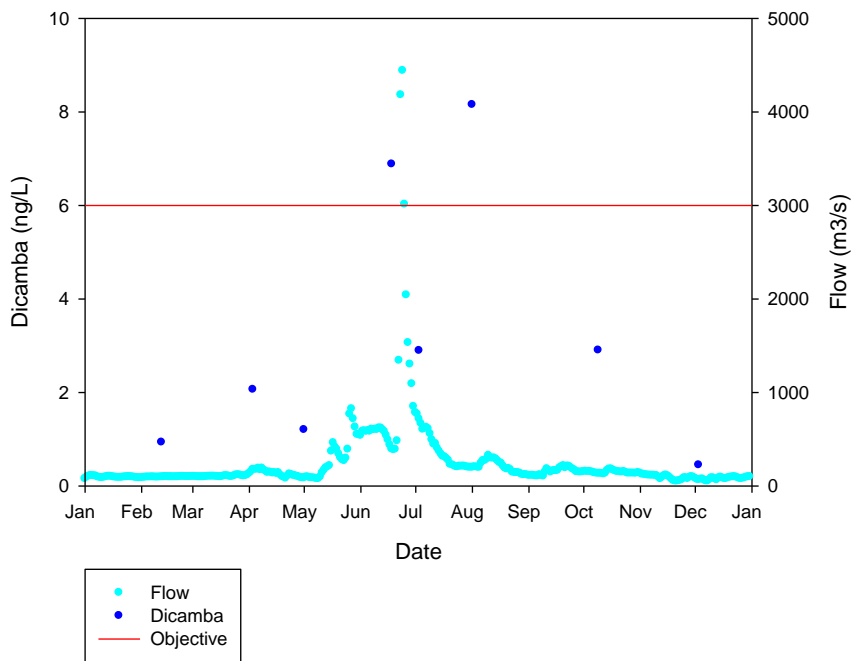


Figure 47: Dicamba versus date and flow rate versus date in South Saskatchewan River in 2013.

Dicamba in Assiniboine River in 2000

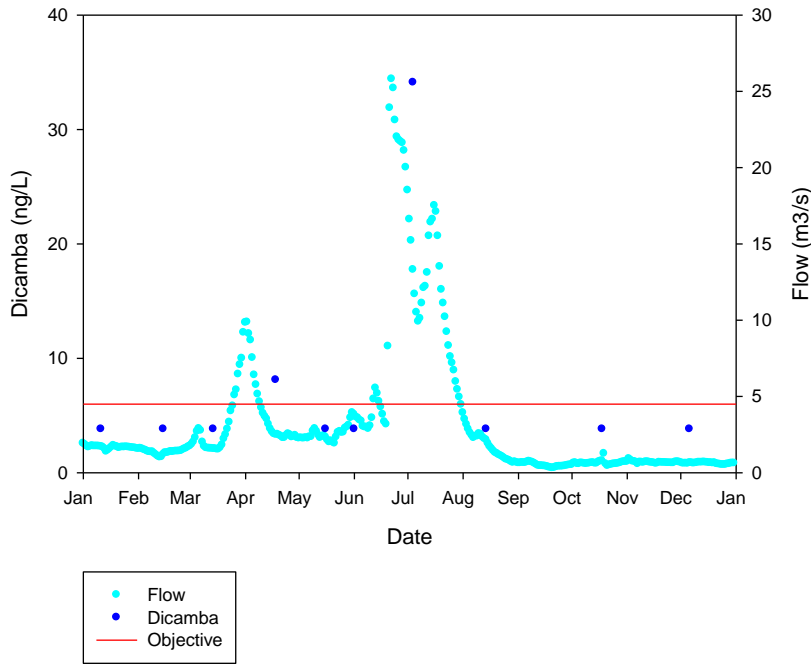


Figure 1: Dicamba versus date and flow rate versus date in Assiniboine River in 2000.

Dicamba in Assiniboine River in 2001

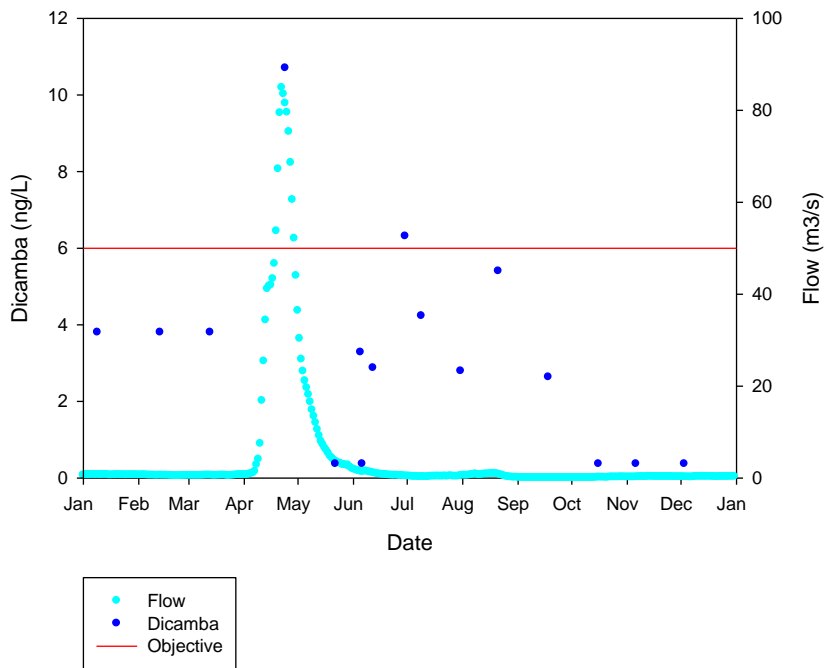


Figure 2: Dicamba versus date and flow rate versus date in Assiniboine River in 2001.

Dicamba in Assiniboine River in 2002

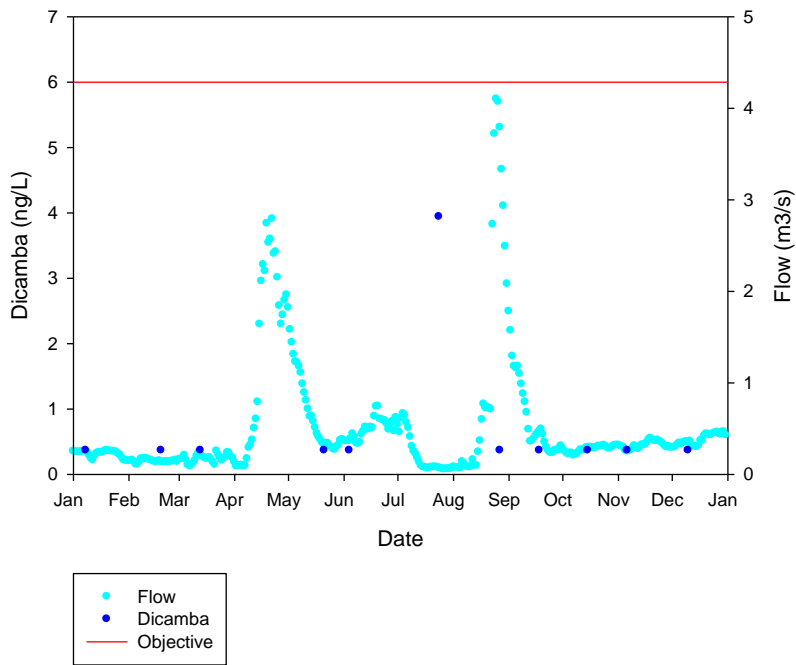


Figure 3: Dicamba versus date and flow rate versus date in Assiniboine River in 2002.

Dicamba in Assiniboine River in 2003

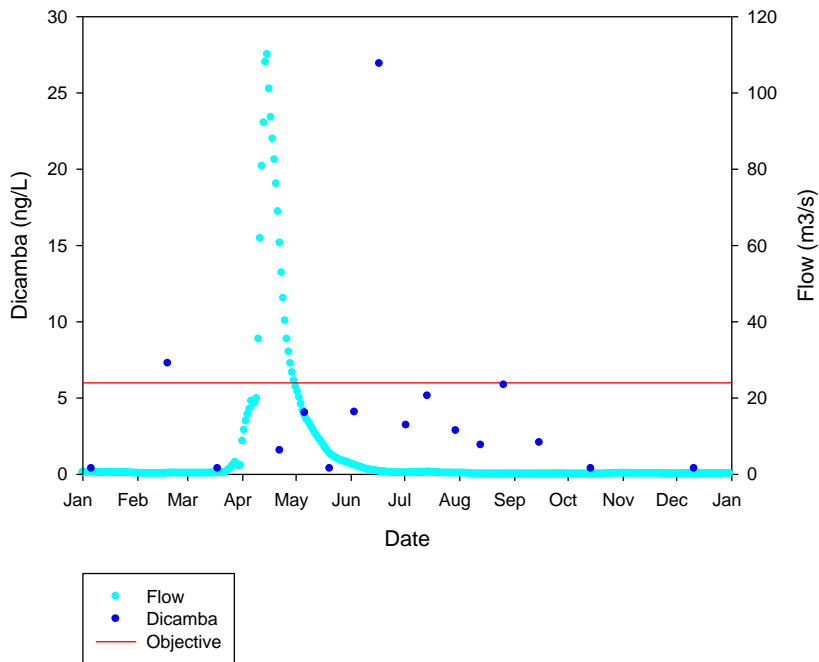


Figure 4: Dicamba versus date and flow rate versus date in Assiniboine River in 2003.

Dicamba in Assiniboine River in 2004

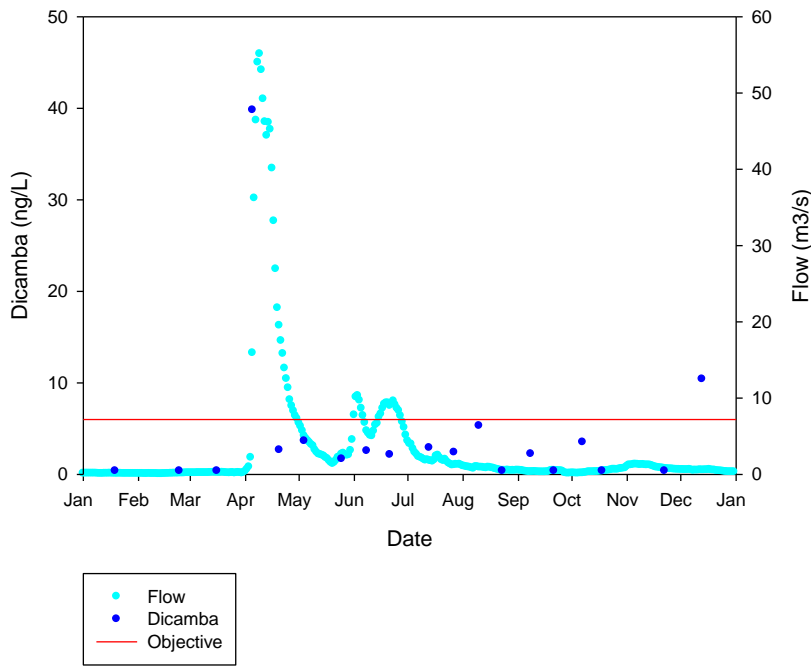


Figure 5: Dicamba versus date and flow rate versus date in Assiniboine River in 2004.

Dicamba in Assiniboine River in 2005

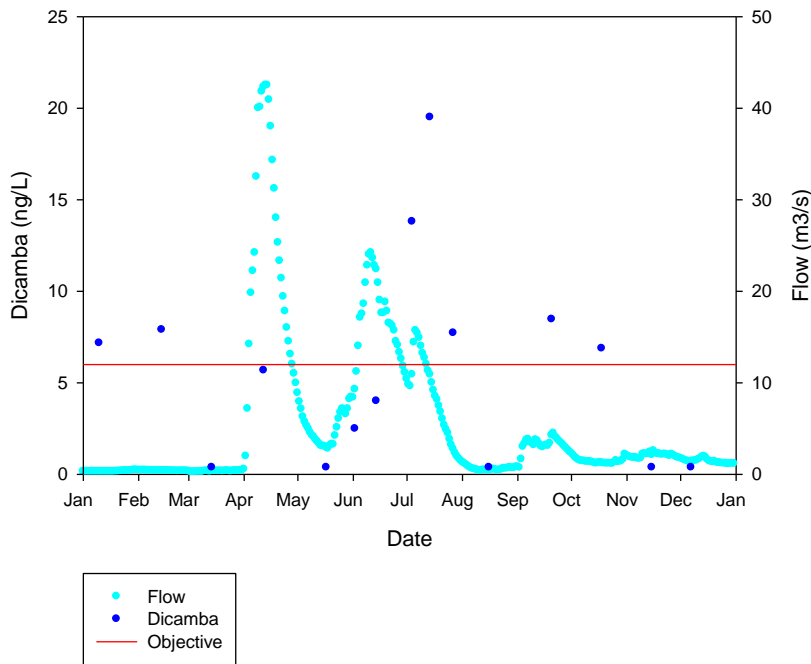


Figure 6: Dicamba versus date and flow rate versus date in Assiniboine River in 2005.

Dicamba in Assiniboine River in 2006

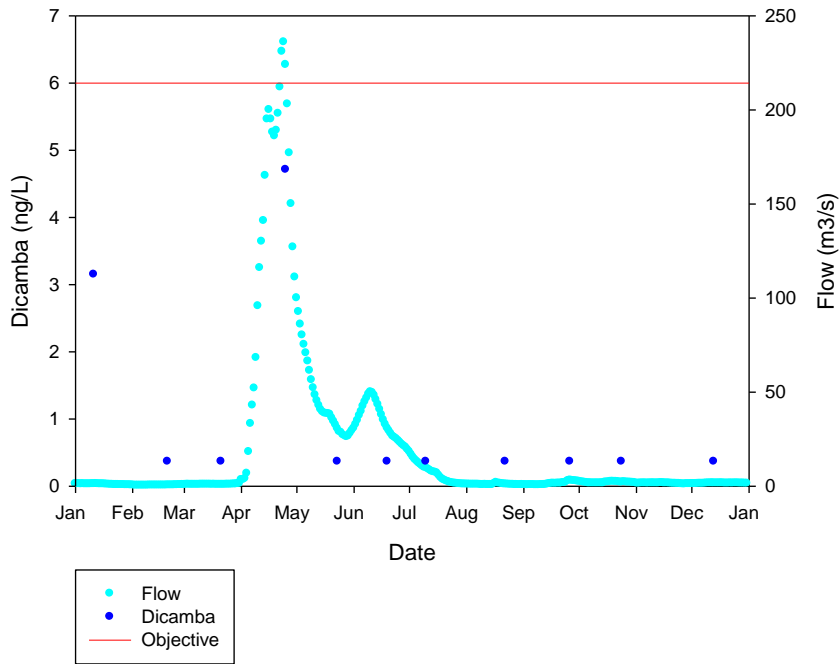


Figure 13: Dicamba versus date and flow rate versus date in Assiniboine River in 2006.

Dicamba in Assiniboine River in 2007

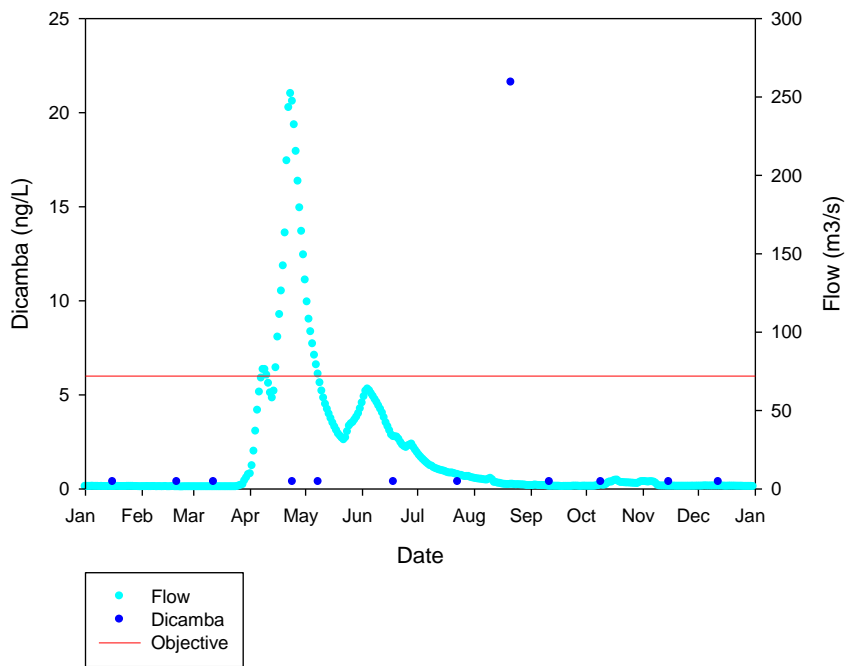


Figure 8: Dicamba versus date and flow rate versus date in Assiniboine River in 2007.

Dicamba in Assiniboine River in 2008

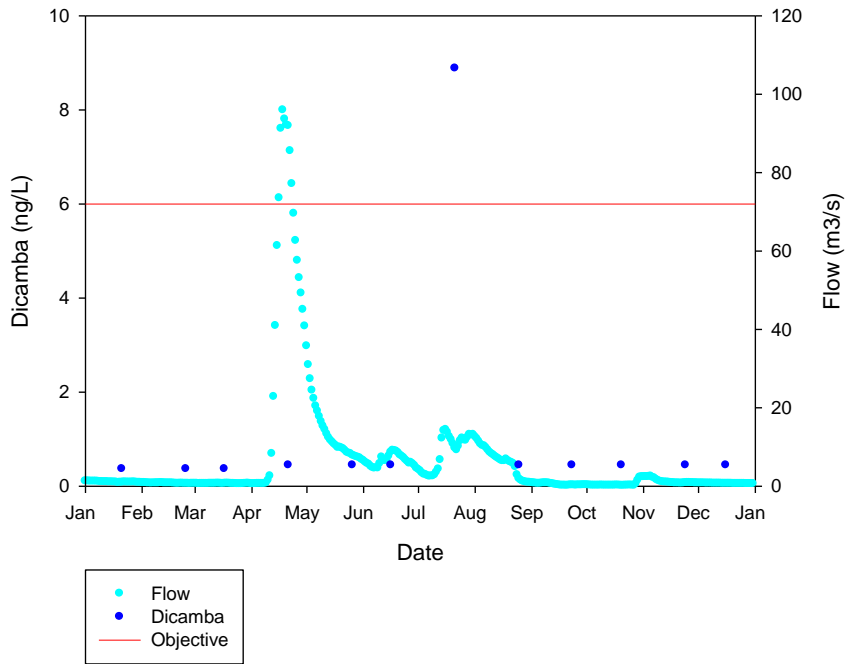


Figure 9: Dicamba versus date and flow rate versus date in Assiniboine River in 2008.

Dicamba in Assiniboine River in 2009

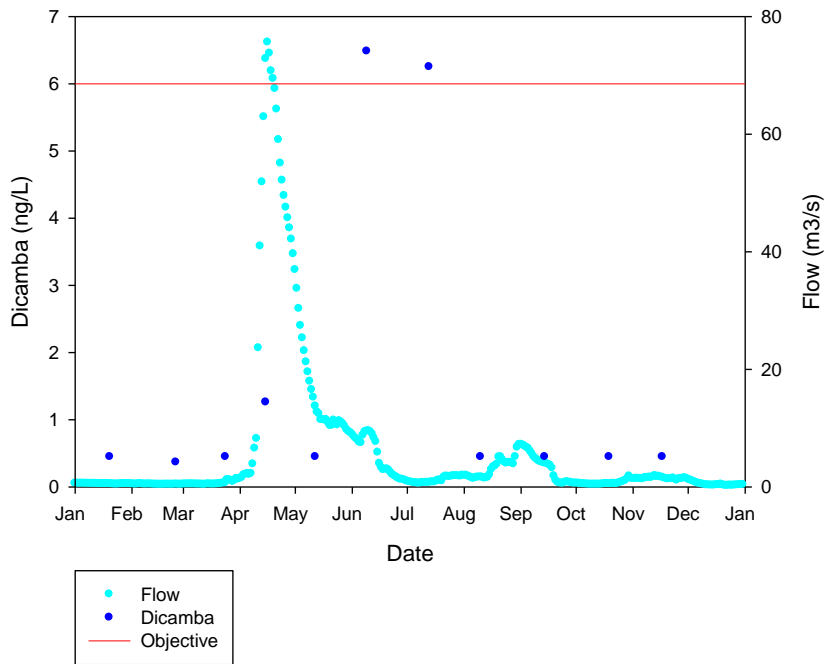


Figure 10: Dicamba versus date and flow rate versus date in Assiniboine River in 2009.

Dicamba in Assiniboine River in 2010

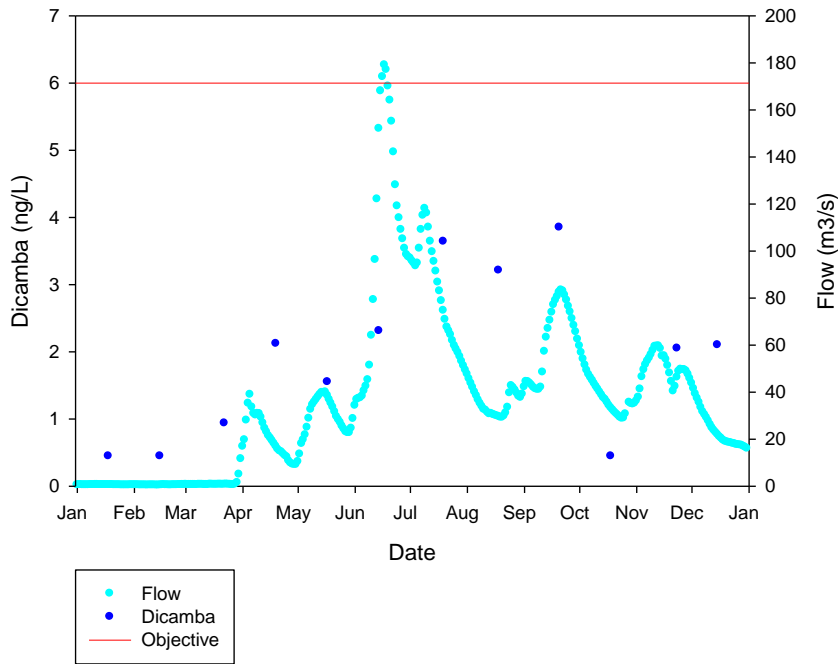


Figure 11: Dicamba versus date and flow rate versus date in Assiniboine River in 2010.

Dicamba in Assiniboine River in 2011

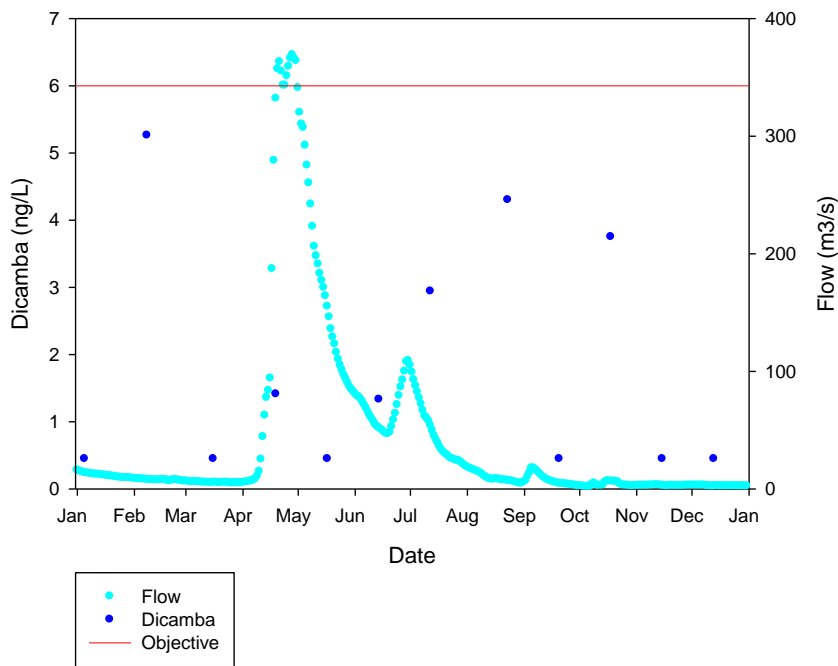


Figure 12: Dicamba versus date and flow rate versus date in Assiniboine River in 2011.

Dicamba in Assiniboine River in 2012

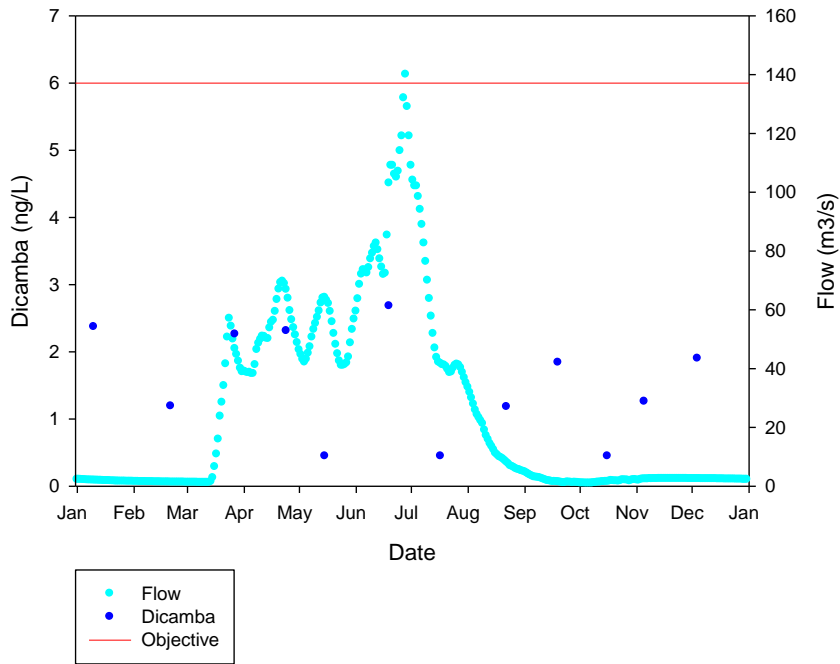


Figure 13: Dicamba versus date and flow rate versus date in Assiniboine River in 2012.

Dicamba in Assiniboine River in 2013

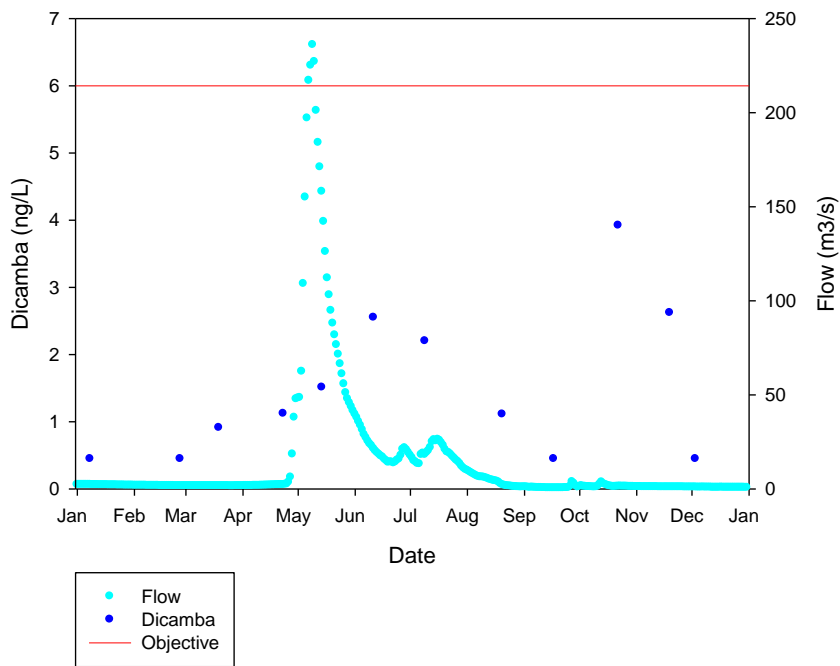


Figure 14: Dicamba versus date and flow rate versus date in Assiniboine River in 2013.

Dicamba in Carrot River in 2000

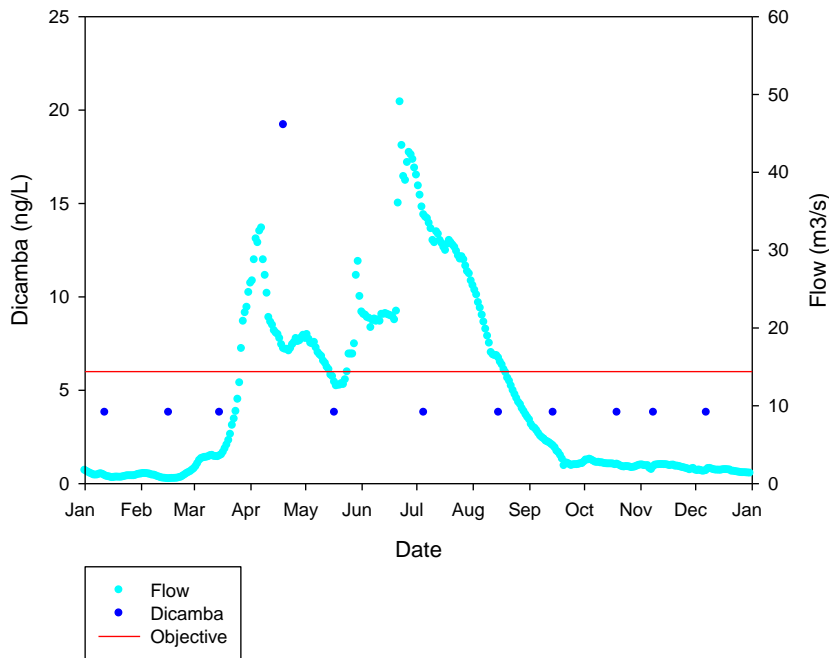


Figure 18: Dicamba versus date and flow rate versus date in Carrot River in 2000.

Dicamba in Carrot River in 2001

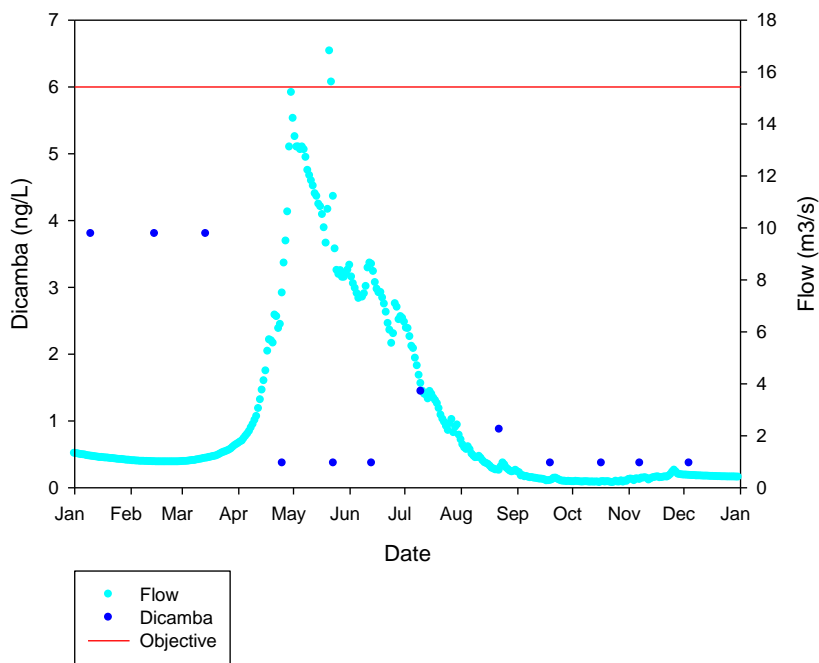


Figure 19: Dicamba versus date and flow rate versus date in Carrot River in 2001.

Dicamba in Carrot River in 2002

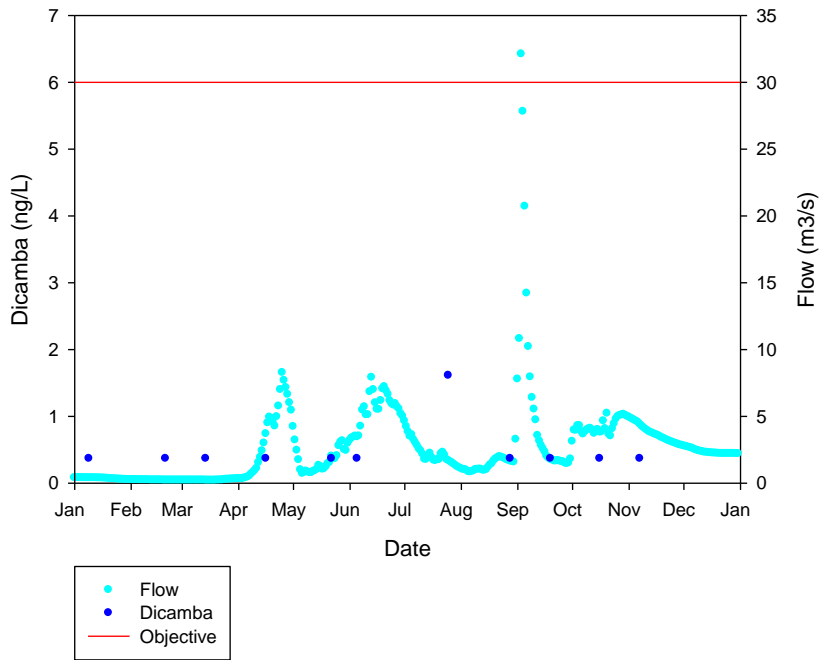


Figure 20: Dicamba versus date and flow rate versus date in Carrot River in 2002.

Dicamba in Carrot River in 2003

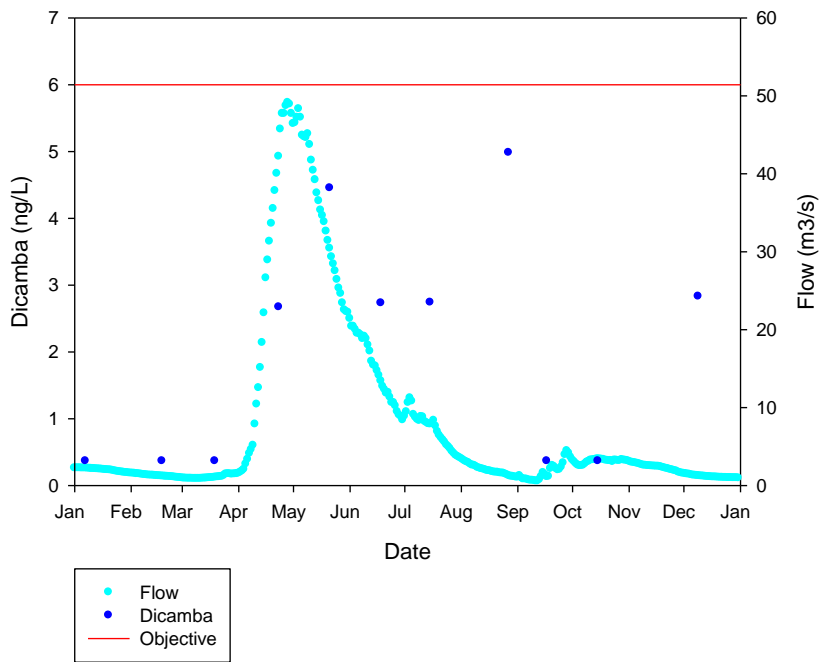


Figure 21: Dicamba versus date and flow rate versus date in Carrot River in 2003.

Dicamba in Carrot River in 2004

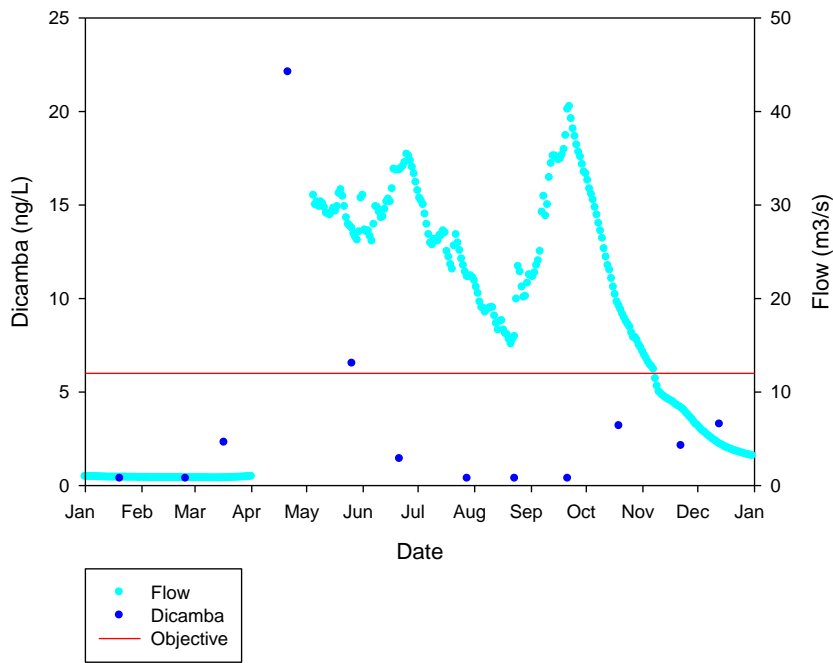


Figure 22: Dicamba versus date and flow rate versus date in Carrot River in 2004.

Dicamba in Carrot River in 2005

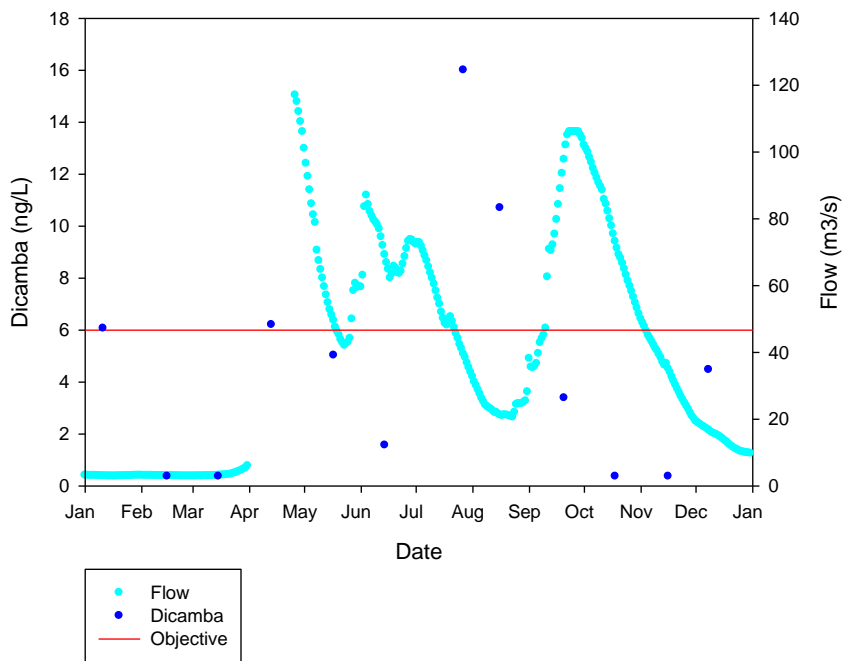


Figure 23: Dicamba versus date and flow rate versus date in Carrot River in 2005.

Dicamba in Carrot River in 2006

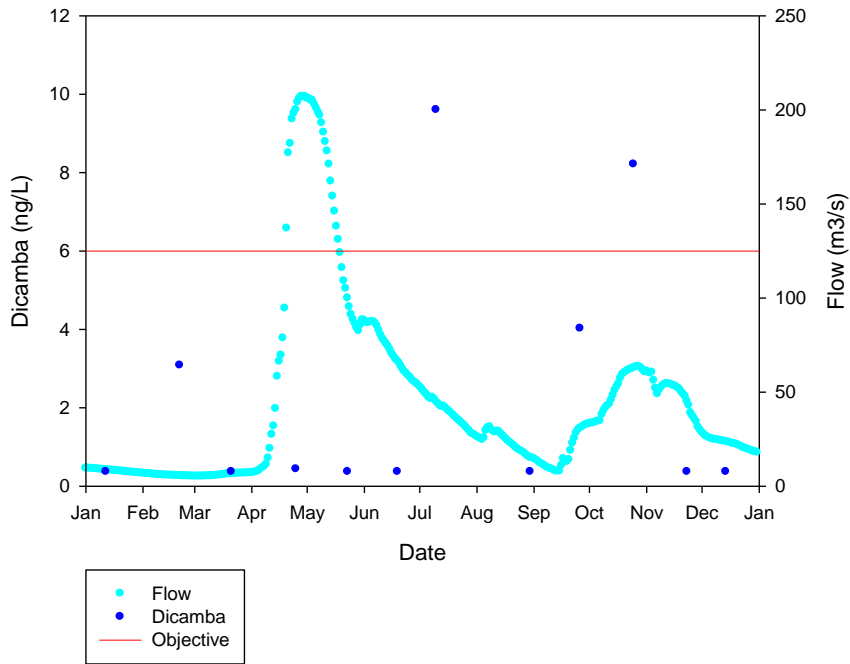


Figure 24: Dicamba versus date and flow rate versus date in Carrot River in 2006.

Dicamba in Carrot River in 2007

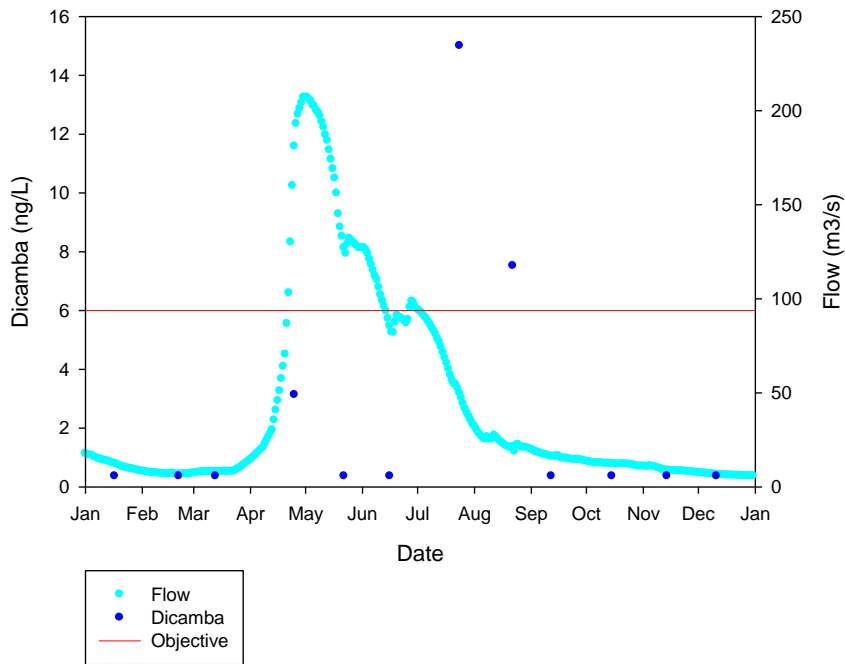


Figure 25: Dicamba versus date and flow rate versus date in Carrot River in 2007.

Dicamba in Carrot River in 2008

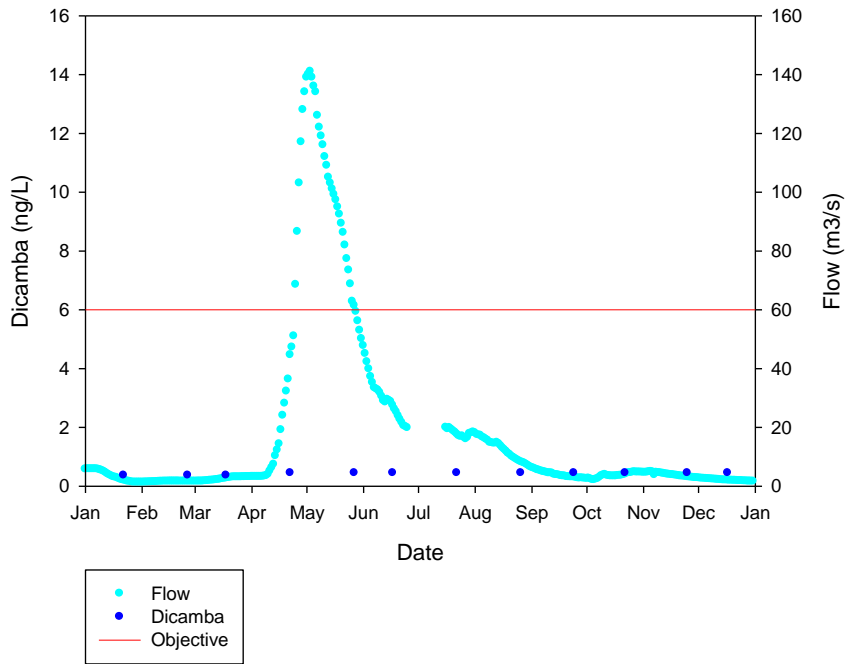


Figure 26: Dicamba versus date and flow rate versus date in Carrot River in 2008.

Dicamba in Carrot River in 2009

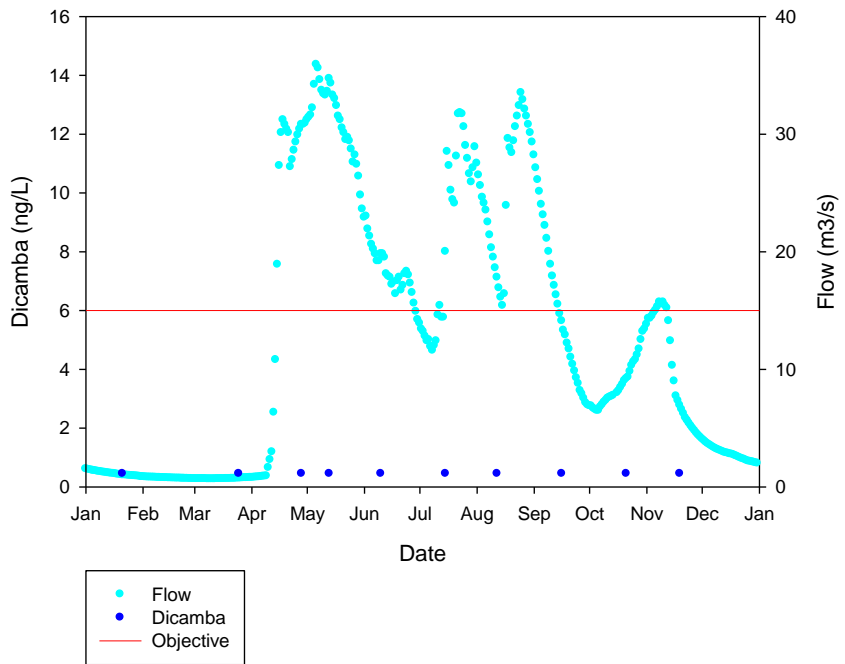


Figure 27: Dicamba versus date and flow rate versus date in Carrot River in 2009.

Dicamba in Carrot River in 2010

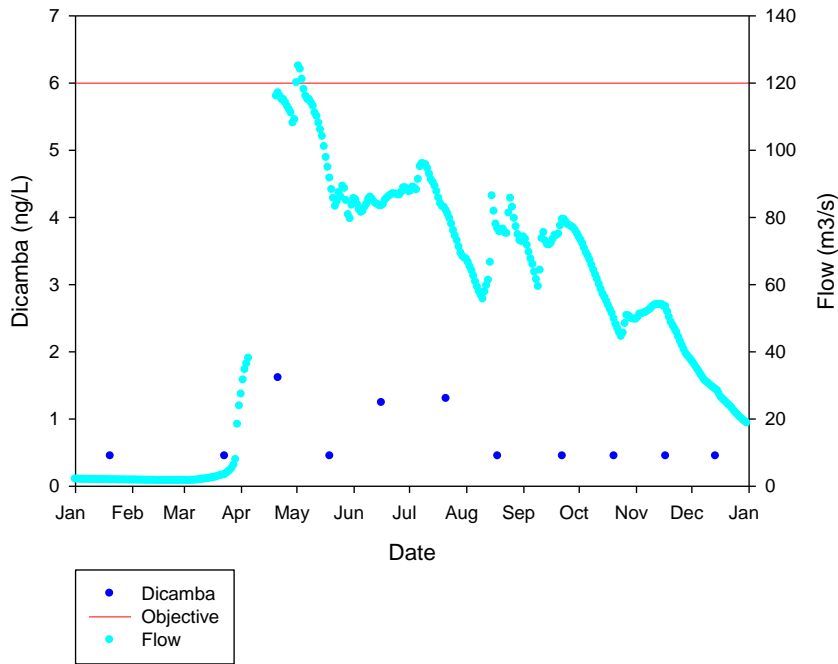


Figure 28: Dicamba versus date and flow rate versus date in Carrot River in 2010.

Dicamba in Carrot River in 2011

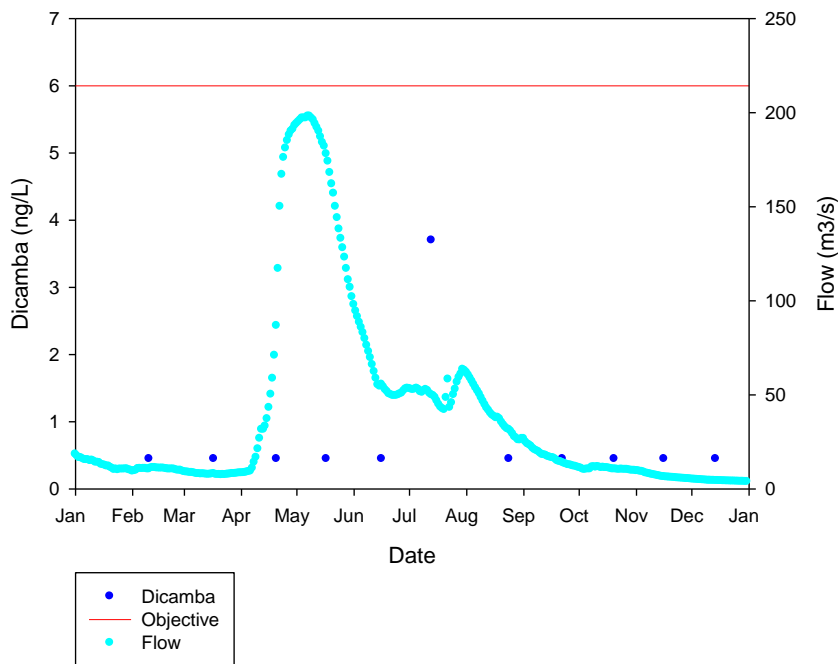


Figure 29: Dicamba versus date and flow rate versus date in Carrot River in 2011.

Dicamba in Carrot River in 2012

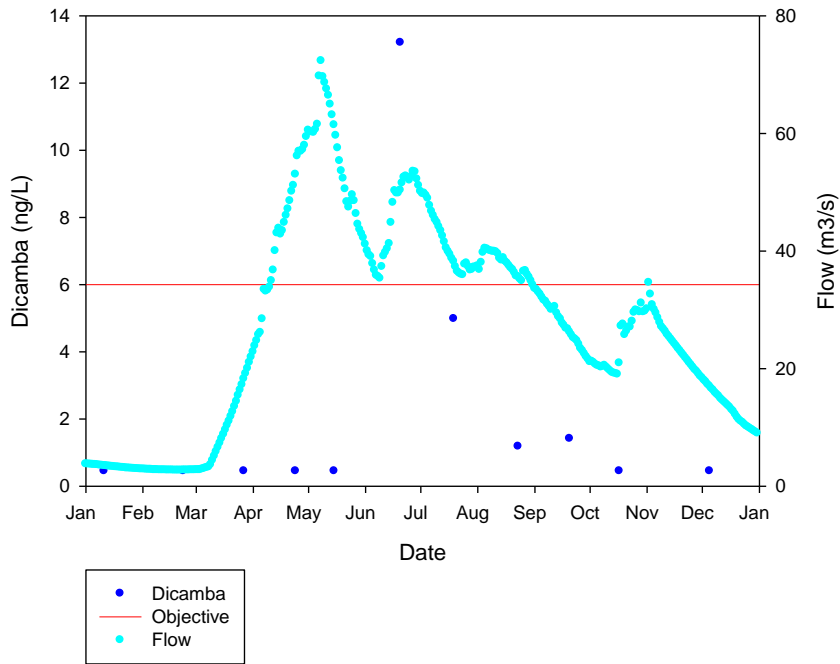


Figure 30: Dicamba versus date and flow rate versus date in Carrot River in 2012.

Dicamba in Carrot River in 2013

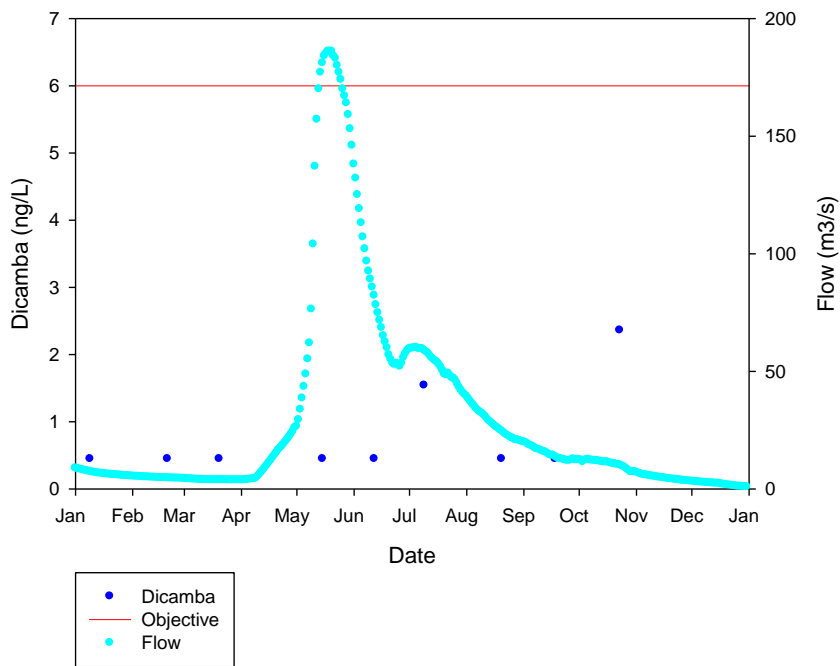


Figure 31: Dicamba versus date and flow rate versus date in Carrot River in 2013.

Dicamba in Qu'Appelle River in 2008

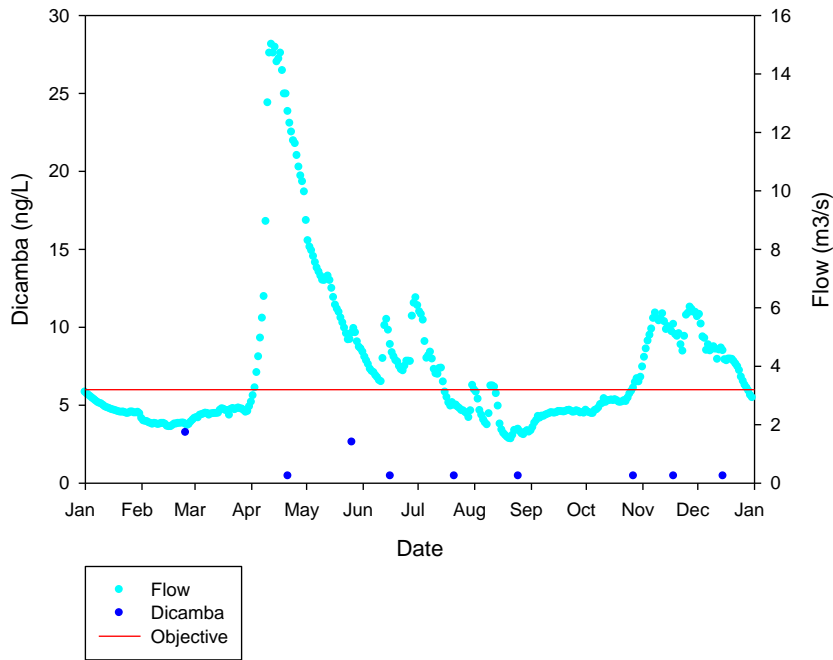


Figure 34: Dicamba versus date and flow rate versus date in Qu'Appelle River in 2008.

Dicamba in Qu'Appelle River in 2012

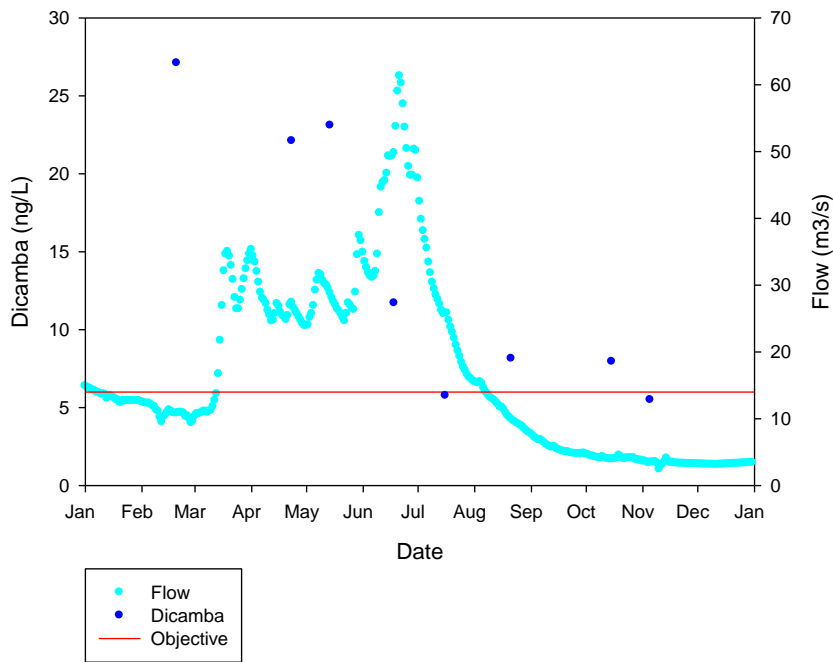


Figure 35: Dicamba versus date and flow rate versus date in Qu'Appelle River in 2012.

Dicamba in Saskatchewan River in 2000

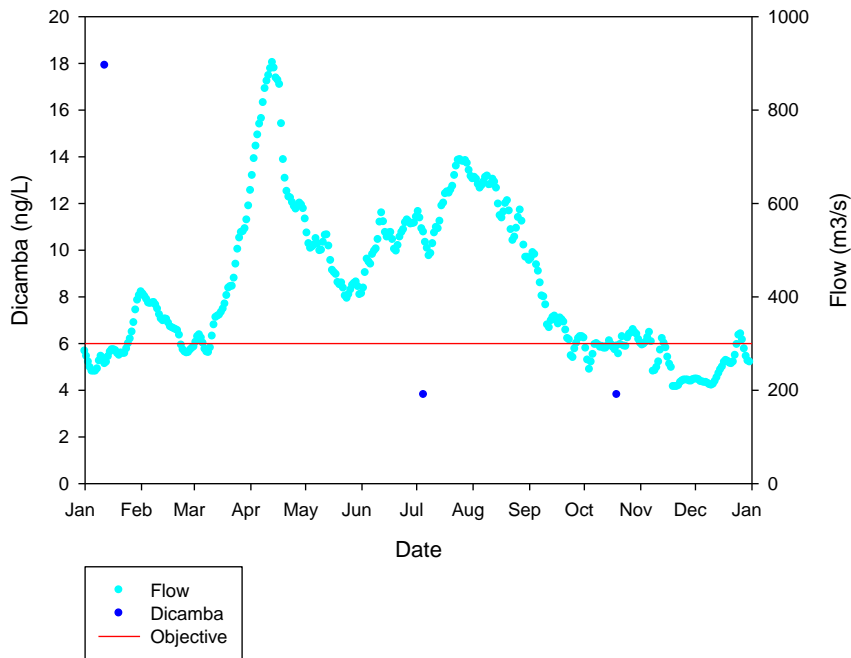


Figure 38: Dicamba versus date and flow rate versus date in Saskatchewan River in 2000.

Dicamba in Saskatchewan River in 2001

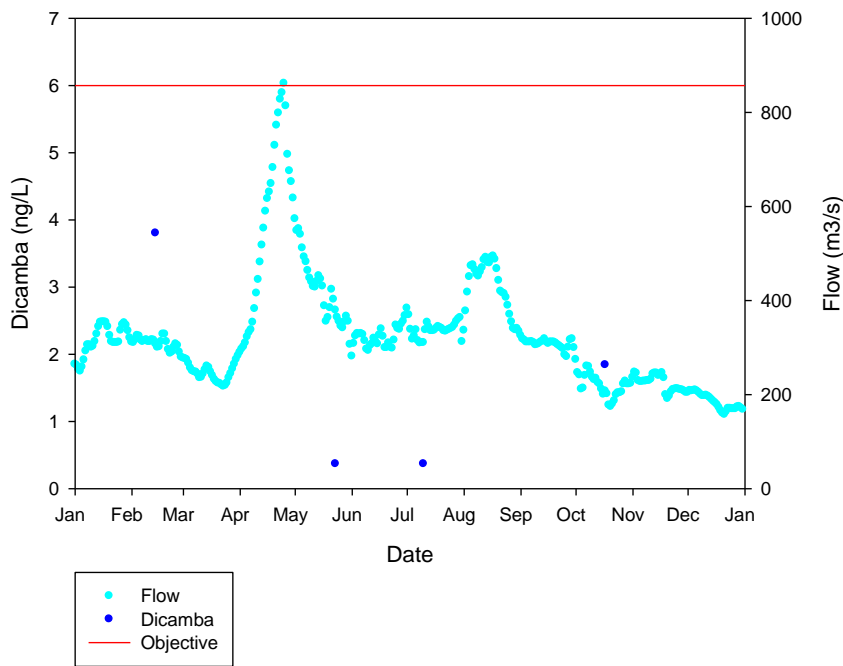


Figure 39: Dicamba versus date and flow rate versus date in Saskatchewan River in 2001.

Dicamba in Saskatchewan River in 2002

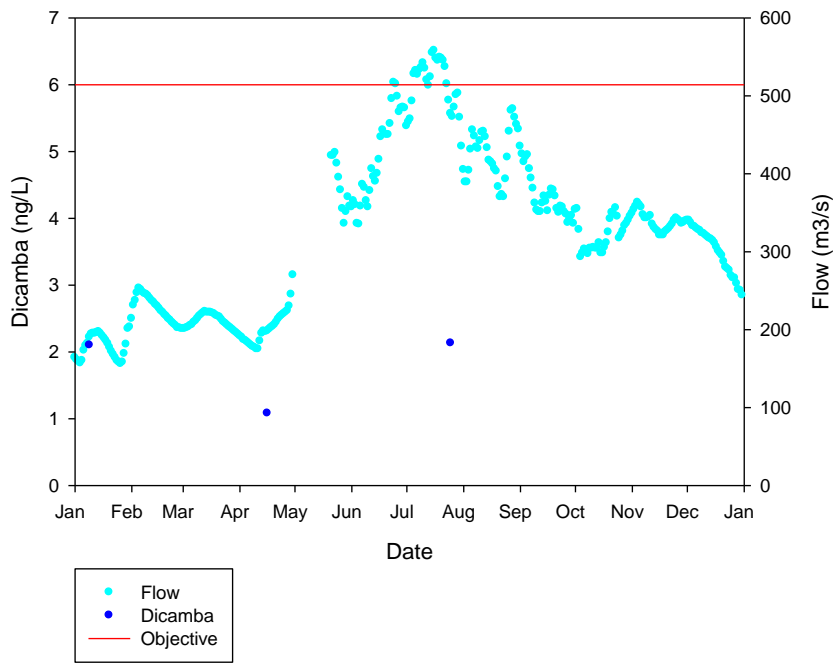


Figure 40: Dicamba versus date and flow rate versus date in Saskatchewan River in 2002.

Dicamba in Saskatchewan River in 2003

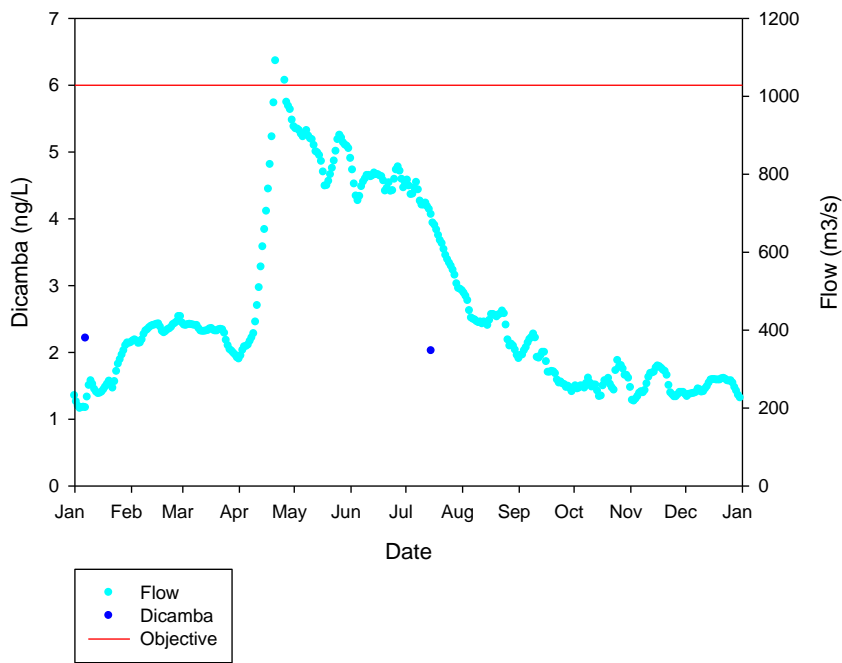


Figure 41: Dicamba versus date and flow rate versus date in Saskatchewan River in 2003.

Dicamba in Saskatchewan River in 2004

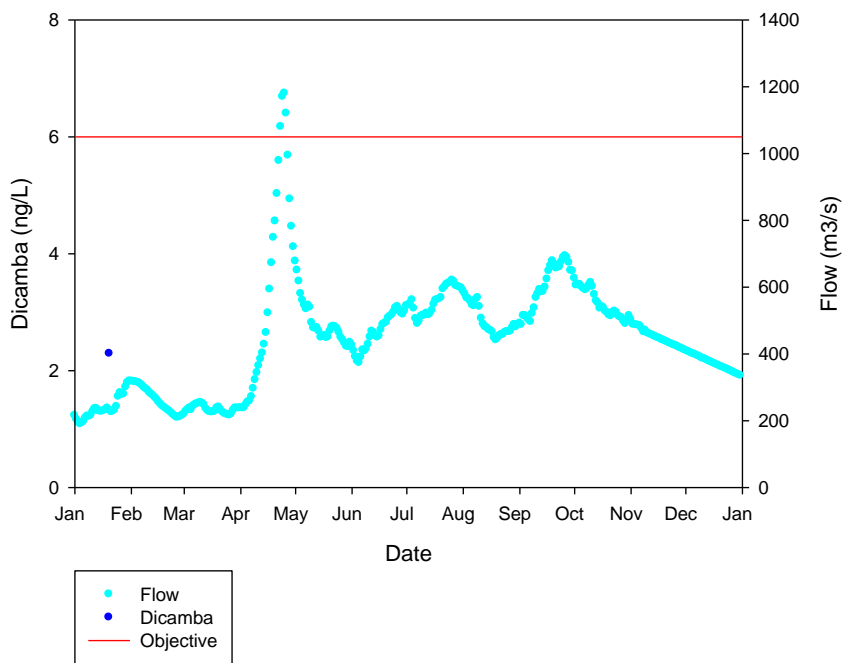


Figure 42: Dicamba versus date and flow rate versus date in Saskatchewan River in 2004.

Dicamba in Saskatchewan River in 2008

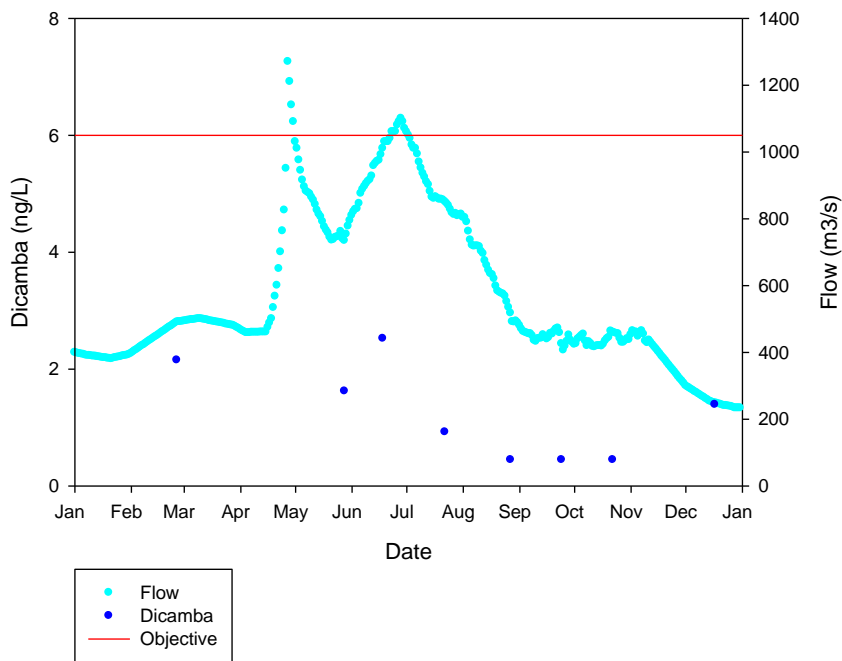


Figure 43: Dicamba versus date and flow rate versus date in Saskatchewan River in 2008.

Dicamba in Saskatchewan River in 2012

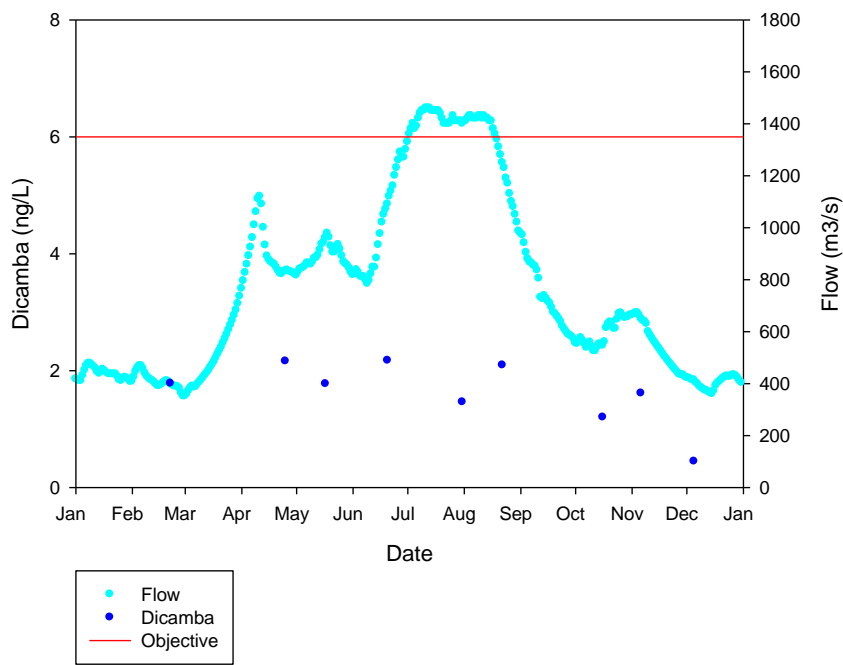


Figure 44: Dicamba versus date and flow rate versus date in Saskatchewan River in 2012.



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