

**Columbia Shuswap Regional District
Electoral Area 'A' – Town of Golden
Mosquito Control Program**

**Mid-Season Update
June 2018**

Submitted to:

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Executive Summary

Columbia River and Kicking Horse River levels near Area A – Town of Golden began to consistently increase in late April 2018. The levels rose at a rapid rate until late May when the Kicking Horse River (Golden), Columbia River (Donald), and Columbia River (Nicholson) peaked on 26, 29, and 31 May, respectively. The peaks occurred earlier-than-normal and reached levels last recorded in 2017, an abnormally high-water year. Warm weather at the end of April through mid-May led to the rapid decline of snow packs in low and middle elevation snow stations. The snow basin indices for contributing basins indicate below normal snow in each for this point in the season. Some high-elevation snow is still present within contributing basins. The Columbia River and Kicking Horse River are still at flooding levels and receding slowly. High elevation snow is likely to be depleted from associated basins by the end of June, given the prediction for warmer-than-normal ambient temperatures within those areas for June through August.

The local precipitation accumulation in April was higher than normal for the past four years, but likely did not contribute to the creation of mosquito development sites, given the relatively low regional river levels at that time. May and early June accumulation was low and likely did not considerably augment the freshet-governed peak. Precipitation is predicted to be lower-than-normal from June through August, so it is unlikely that significant precipitation events will cause secondary peaks in regional rivers in 2018.

A total of four aerial events were required in May and early June due to abnormally high local Kicking Horse River and Columbia River levels. All aerial treatments occurred between 2 May and 4 June. Ground treatments started on 23 April, shortly after monitoring commenced. Ground treatments occurred frequently through the beginning of June. Given sustained regional river levels, monitoring and possible treatment will continue through August.

A total of 122 ha has been treated by ground, as of 8 June. A total of 8,663 ha has been treated aerially, as of 8 June. Aerial and ground applications are typically applied at rates varying between 4 kg/ha and 10 kg/ha depending on the vegetation density and method. A total of approximately 9,151 kg of Aquabac® (Active Ingredient - *Bacillus thuringiensis* var *israelensis*) was required for treatment through early June.

Only one call has been received as of 14 June. The call was classified as an inquiry. No emails have been received, thus far. A public outreach event will be conducted in early July to assist interested residents in reducing mosquito development micro-habitats around their homes and to provide insight into the current mosquito control program.

MBL will continue to update social media sites in an effort to inform concerned citizens throughout the height of the season. MBL will also continue to make every

effort to remain accessible to the public’s questions on social media sites, via phone contacts, through email, and at public events.

Introduction

This report will summarize the Area ‘A’ – Town of Golden mosquito control program activities conducted by Morrow BioScience Ltd. (MBL) for the Columbia Shuswap Regional District (CSRD) through early June 2018. Specifically, this report will discuss current environmental conditions affecting mosquito populations and monitoring efforts, outline the progress to date for the proposed deliverables, present any preliminary data, and identify potential issues for the duration of the mosquito season. The information presented herein is meant to provide a snapshot of the season, thus far. An in-depth review of each reporting category will be included in the 2018 final report, to be submitted by October.

Significant Regional Environmental Conditions

River Levels

The Columbia River and the Kicking Horse River primarily affect the floodwater mosquito abundance in the area around Area ‘A’/Golden. The water levels of both river systems are governed by two main influences: 1) local snowmelt and 2) the freshet from the Upper Columbia basin. Frequent and large amounts of precipitation can also affect local river levels, though typically to a lesser degree than the primary factors listed above.

The Columbia River (Nicholson and Donald gauges) began consistently increasing in late April (Figure 1). The majority of the contributing snowpack has moved through the Columbia River and Kicking Horse River (see ‘Snow Levels’ below). Thus, it is likely that the peak noted in May will be the seasonal peak. Consequently, the majority of floodwater mosquito eggs were also triggered to hatch in accordance with the regional river peaks.

The Columbia River at the Nicholson gauge peaked on 31 May (3.475 m). The Columbia River at the Donald gauge peaked on 29 May (4.42 m). The Kicking Horse River at Golden peaked on 26 May (4.55 m).

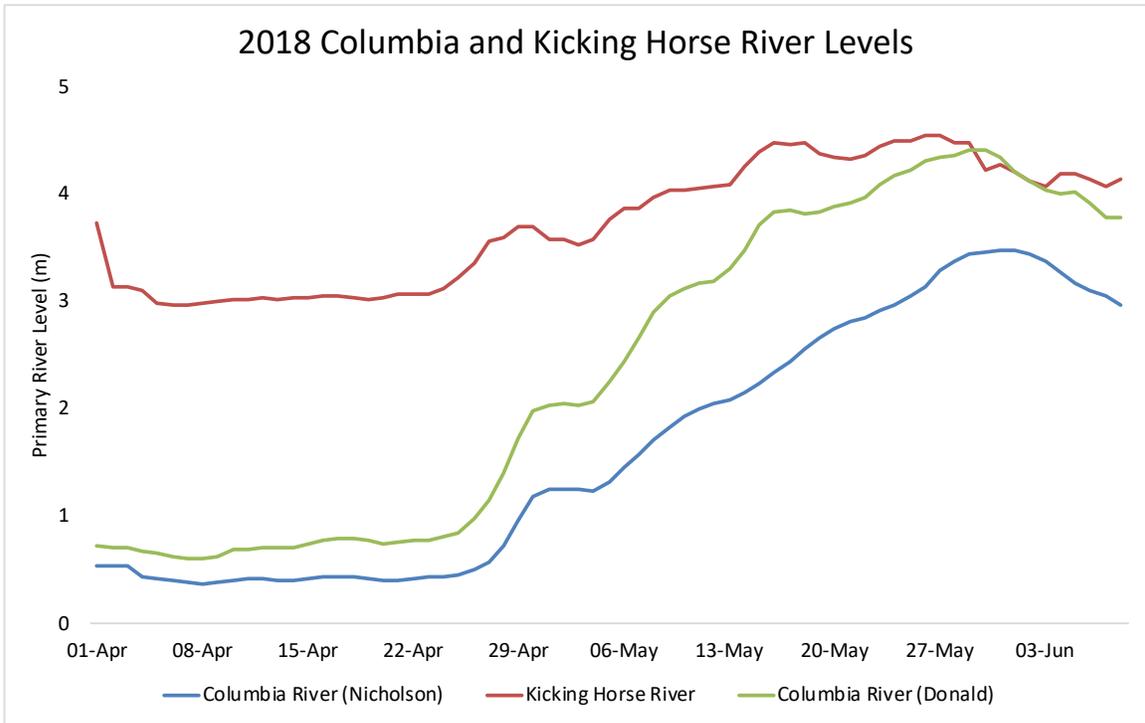


Figure 1. 2018 Columbia River and Kicking Horse River levels (m), 1 April – 8 June. Columbia River measurements were taken from the ‘Columbia River at Donald’ and ‘Columbia River at Nicholson’ stations. Kicking Horse River measurements were taken from the ‘Kicking Horse River at Golden’ station.

The timing of the respective regional river peaks in 2018 was experienced approximately two weeks prior to the average over the previous four seasons, based on measurements taken at the Columbia at Donald gauge (Figure 2). Through June, local Columbia River and Kicking Horse River levels are expected to slowly reduce, given remaining snowpack at high elevation snow stations (Figure 1; see ‘Snow Levels’ below). Local precipitation accumulation can considerably augment regional river levels (see ‘Precipitation’ below), thus making it difficult to predict how long high-waters may be present within the Area ‘A’ – Town of Golden.

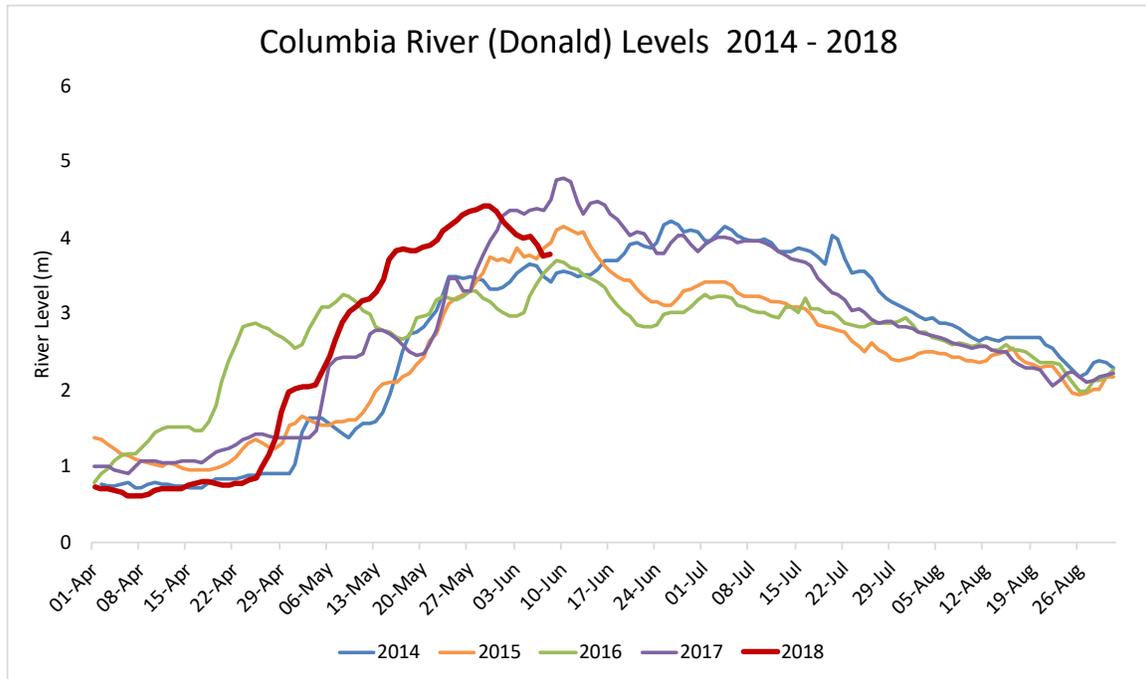


Figure 2. 2014 - 2018 Columbia River levels (m) as taken from the ‘Columbia River at Donald’ gauge.

The Columbia River at Donald levels are shown for 2014 – 2018 in order to compare the peak of the previous four seasons to the current 2018 season (Figure 2). While the Columbia River at Nicholson is at a different level than the Columbia River at the Donald gauge and the Kicking Horse River at Golden gauge, the general trends remain the same. Because the Columbia River at Donald gauge incorporates Kicking Horse River input, it is used as a representative gauge within this report to compare inter-annual trends.

Floodwater mosquito eggs laid on substrates at various river levels have optimal environmental conditions and adequate time within which to hatch when the river rises at a slower rate. When river levels rise at high rates, mosquito eggs typically lack sufficient environmental cues due to the pulse of cold, highly oxygenated water moving through the system. However, despite regional river levels rising at a relatively high rate, ambient temperatures were warm enough to trigger mass mosquito hatching events. The quick rate that the Columbia River and Kicking Horse River rose, coupled with considerably high water, resulted in an increased treatment requirements at mosquito development sites.

The Columbia River’s (at Donald station) peak height relative to recent seasons is another predictive variable that may help explain an associated year’s larval abundance. If the current year’s river levels far exceed that of preceding seasons, mosquito eggs laid between the high-water mark of both years could have remained dormant until current-year flood waters trigger their hatching. Given the fact that 2018 Columbia River levels do not exceeded the 2017 peak (Figure 2), it is likely that a normal abundance of mosquito eggs will likely have already been triggered to hatch

with peak river levels. As such, a normal larval abundance was noted at Area ‘A’ – Town of Golden sites in 2018.

Snow Levels

In April 2018, immediately preceding the commencement of the mosquito larvae monitoring season, the snowpack within the greater Columbia River and Kicking Horse River basins near Golden was 111 percent of normal (Table 1)¹. Snow basin indices for this basin increased during April due to a series of unstable weather patterns and lower-than-normal ambient temperatures across the British Columbia Interior. A warming trend in early May caused a large amount of snow to melt from basins contributing to Columbia River and Kicking Horse River, resulting in decreased snow packs in comparison to April percentages (Table 1). The May 15th Snow Basin and Water Supply Bulletin reported that the Upper Columbia Snow Basin indices were 97 percent of normal (Table 1)². Another significant warming trend within vicinity of Area ‘A’ led to mid and high-elevation snow melting and caused the local peak experienced in both river systems in late-May. In confirmation of that large-scale melting event, the most recent Bulletin indicates that the Upper Columbia basin was at just 71 percent of normal (Table 1)³.

Some high elevation snow still exists within the basins affecting regional river levels near Area ‘A’. With a spike in ambient temperature predicted for those regions in June it is likely that the SWE in those stations will be depleted by the end of June (see ‘Ambient Temperature Records’ below). While local Columbia River and Kicking Horse River levels may continue to be higher-than-normal as the rest of the snowmelt moves through the contributing river systems, most of the snow has melted from these regions.

Table 1. 2018 snow basin indices from 1 April – 1 June for the Upper Columbia snow basin.

Date	Upper Columbia Snow Basin Indices
1 April 2018	111
1 May 2018	116
15 May 2018	97
1 June 2018	71

Precipitation

While not the primary contributor to local Columbia River and Kicking Horse River levels, significant precipitation accumulation within the region may elevate river

¹ https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2018_apr1.pdf

² https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2018_may15.pdf

³ https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2018_june1.pdf

levels. The precipitation accumulation in April of 2018 was high, in comparison to the previous three seasons (Figure 3). However, the peaks in both regional river systems did not occur until late May, when relatively low amount of precipitation accumulated. Thus, it is unlikely that localized precipitation accumulation in April or May measurably augmented Columbia River or Kicking Horse River levels.

Temperature and Precipitation Probabilistic Forecasts for Canada⁴ for June – August show a 50%-70% likelihood that precipitation for the Area ‘A’ region of the CSRD will be below normal. Given this prediction, it is unlikely that significant precipitation events will increase Columbia River and Kicking Horse River levels beyond the peak experienced in late May. However, MBL technicians are aware of the potential development of new sites given localized precipitation events and will continue to monitor current and possible sites.

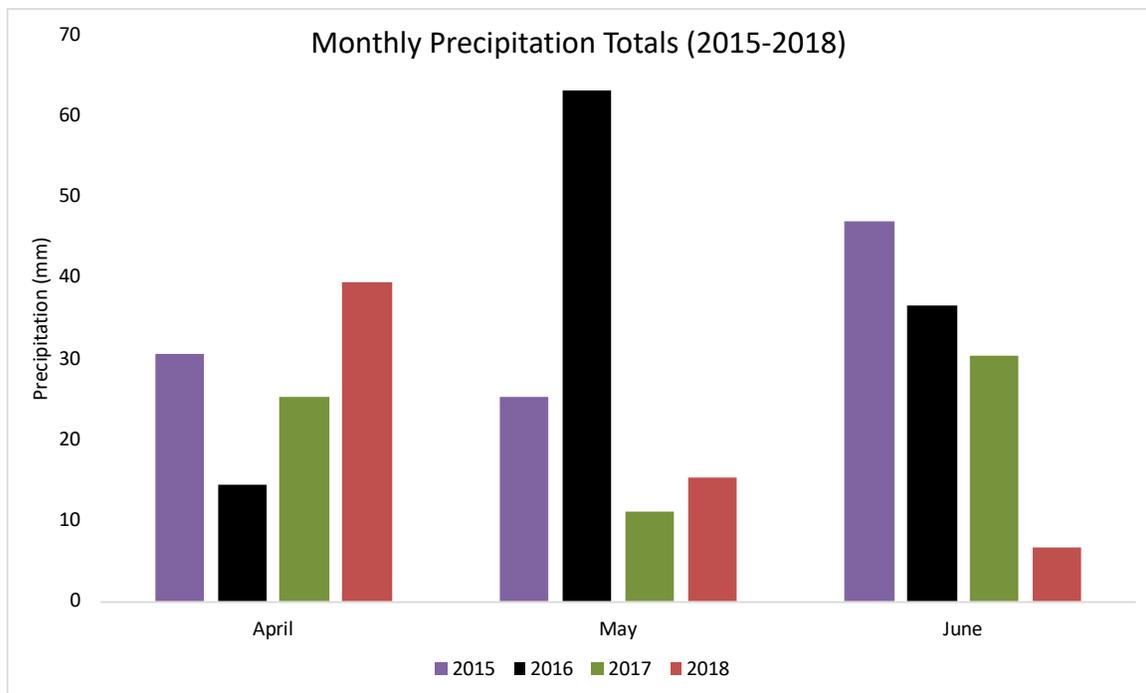


Figure 3 Monthly total precipitation accumulation (mm) as recorded at the at the Golden, BC Airport (Climate ID: 1173220) between 1 April – 8 June, 2015-2018.

Ambient Temperature Records

The 2018 mosquito season began with cooler-than-normal ambient temperatures within snow basins contributing to the Columbia River and Kicking Horse River. According to the May 1st Snow Survey and Water Supply Bulletin⁵, ambient temperatures were approximately 1°C – 2°C below normal for April within the interior. However, that trend quickly reversed in early May when the average

⁴ https://weather.gc.ca/saisons/prob_e.html

⁵ https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2018_may1.pdf

temperature across the majority of the province were 5°C – 10°C above normal. Thus, snow basins accumulated and maintained snow packs into early May when a significant melting period occurred, contributing large amounts of water to associated river systems.

The ambient temperature trend at the Golden Airport weather station is largely representative of weather experienced within basins contributing to the Columbia River and Kicking Horse River during May. A significant amount of snowmelt occurred within late April through the first week of May due to spikes in ambient temperature across southern BC (Figure 4). Unstable weather conditions were present for portions of mid-May, but spikes in the latter part of the month prompted considerable mid-elevation snow melt (Figure 4). A late-May spike in ambient temperature likely brought out the rest of the mid-elevation snow and some high-elevation snow, which created the spike in local river levels.

The daily maximum temperatures recorded in Area ‘A’ of the CSRD during the month of May were sufficient, when coupled with other environmental cues, for mosquito hatching events. If ambient temperatures continue to increase as they are predicted to, then larvae may develop quickly in warmer water, necessitating additional treatments. Once suitable environments disappear for floodwater mosquitoes, temperature is no longer correlated with hatching rates, but instead is directly related to the adult mosquito lifespan if not controlled.

Temperature and Precipitation Probabilistic Forecasts for Canada⁶ for June – August show a 60-80% likelihood that ambient temperatures for Area ‘A’ will be above normal. Warmer conditions will increase snow melt in high-elevation basins, present favourable environmental conditions for mosquito hatching, and increase the rate of development for mosquitoes. Above normal temperatures with a lack of precipitation also means that mosquito development sites may become dry sooner than normal.

⁶ https://weather.gc.ca/saisons/prob_e.html

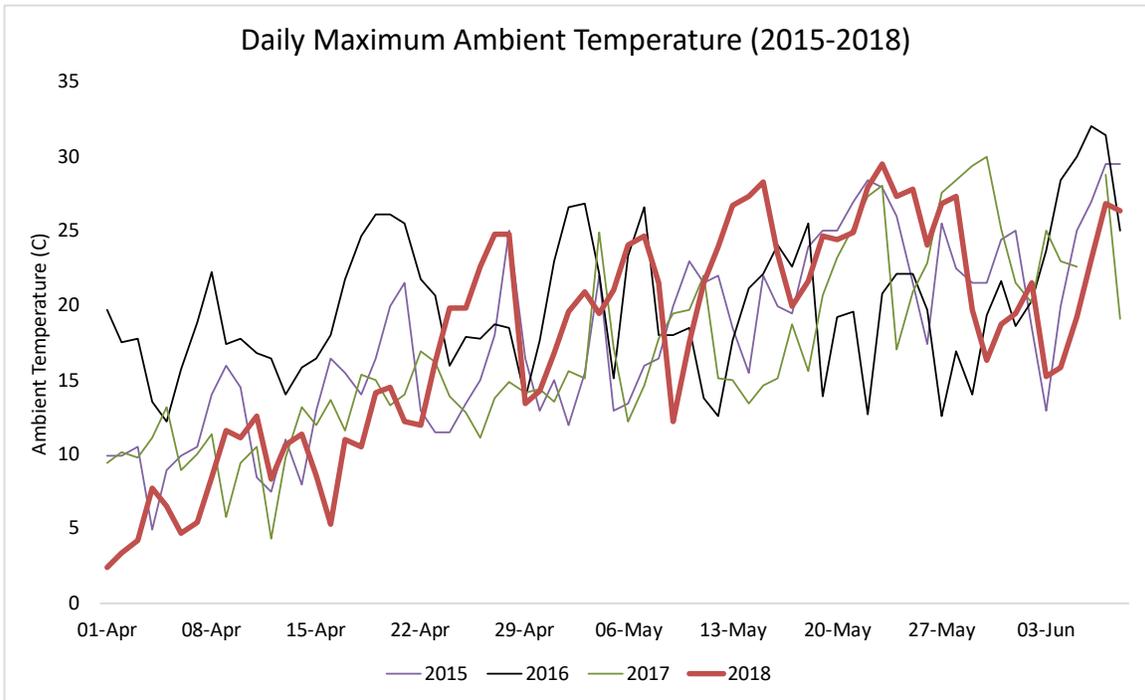


Figure 4. Maximum daily temperature (°C) as recorded at the Golden, BC Airport (Climate ID: 1173220) between 1 April – 8 June, 2015-2018. Gaps in the data represent days wherein the monitoring station was not functioning properly.

Nuisance Control

Progress to Date

Seasonal mosquito development site monitoring begins when spring ambient temperatures begin to rise steadily in contributing basins and when the local Columbia River and Kicking Horse River begin to rise consistently. Consequently, the 2018 mosquito-monitoring season started in mid-April (Figure 1).

Spikes in late April through mid-May ambient temperatures exceeded normal, melting low and mid-elevation snow packs in contributing basins, and resulting in high regional Columbia River and Kicking Horse River levels. High river levels created large mosquito development sites, in close comparison to those created in the most-recent high-water year of 2017. Warm temperatures and considerable habitat triggered large-scale mosquito larvae hatches. As such, a greater-than-normal number of treatment events and higher-than-normal quantity of treatments were required. As of 8 June, a total of approximately 122 ha have been treated by ground and 1,444 ha have been treated aerially (Figure 5).

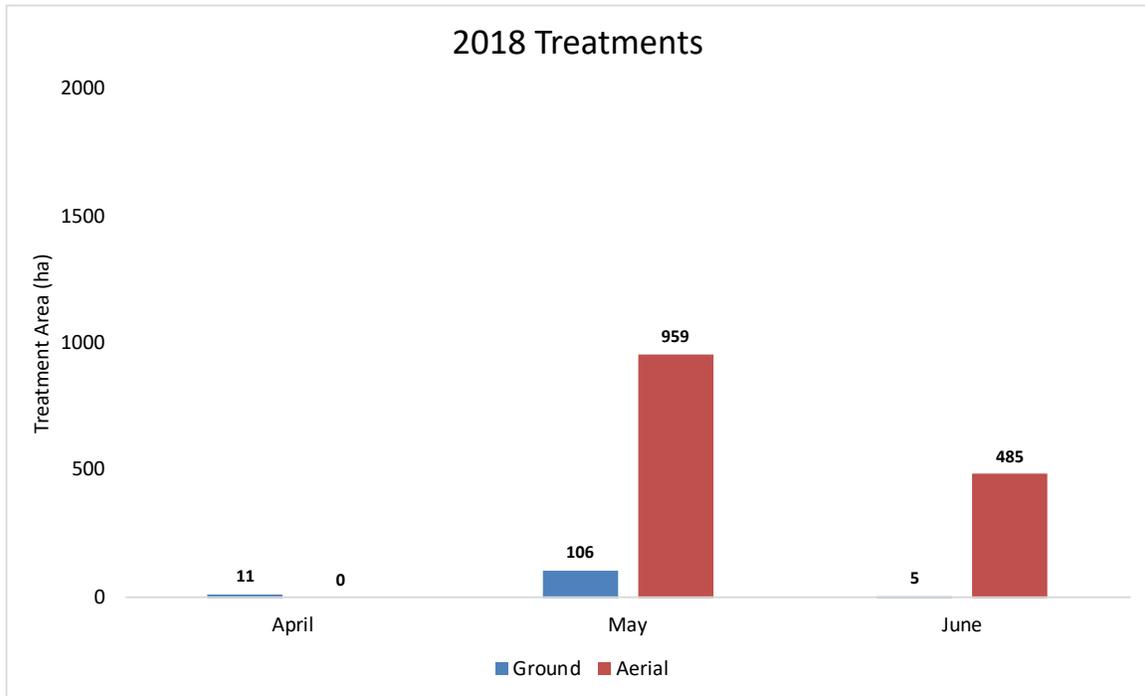


Figure 5. Mosquito larvicide treatments (ha) using AquaBac® (Bti) for mosquito development sites in the Area ‘A’ – Town of Golden, from 1 April – 8 June 2018.

Aerial Application Summary

The 2018 mosquito season was considered a high and early water year. In low-water years, the aerial application portion of the Area ‘A’ – Town of Golden program becomes less important because field staff can access most sites throughout the season. However, once local river levels exceed a certain threshold, certain sites become harder to treat by hand. Additionally, most sites became active with high mosquito abundance at the same point, making multiple large-scale aerial campaigns a necessity.

A total of four aerial events have been required, thus far, in 2018. Aerial treatment campaigns took place on 2, 18, 28 May and on 4 June (Figure 6). Ideally, aerial events take place immediately after the regional river levels have peaked or they are at plateaus prior to peaks. These times are generally targeted because the Aquabac® (i.e. Bti) is able to reach mosquito larvae before they disperse with rising water. Sometimes mosquito abundance is too high to wait for a river’s plateau or peak before treating. The aerial treatments conducted on 2 May were dictated solely by excessively high larvae abundance in later instar stages along the bench sites. Highly specialized GPS devices aboard the contracted helicopter is able to target active mosquito development areas that emerged following a previous aerial application. The aerial treatment that occurred on 28 May was timed optimally because local Columbia River and Kicking Horse River levels had reached a sustained peak, meaning that the mosquito larvae were more easily confined for treatment reach (Figure 6). The subsequent treatment on 4 June occurred during a brief lull in two of

the three local receding river levels. Follow-up monitoring at all accessible sites treated by air revealed high rates of efficacy.

Aerial application rates vary between events due to differences in site canopy cover. Where canopy cover is greater, a higher application rate close to 10 kg/ha is necessary. However, an average application rate of 6 kg/ha is required for Area ‘A’ – Town of Golden sites. A total of 1,444 ha has been aerially treated, as of 8 June, amounting to a total of approximately 8,663 kg of Aquabac® (i.e. Bti) applied (Figures 5, 6). Shapefiles of aerial treatment areas have been provided to the CSRD and real-time data from this event is available through MBL’s client-registered Fulcrum web map portal.

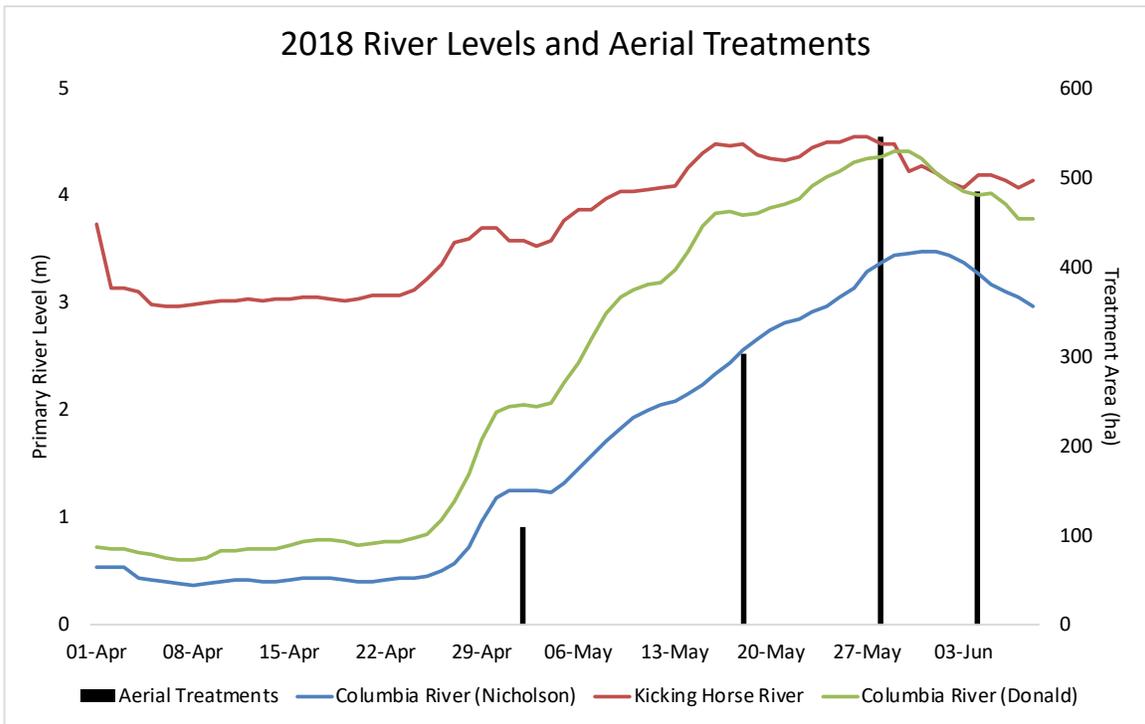


Figure 6. Aerial treatments (ha) with respect to the daily peak of the Columbia (at Donald, Nicholson) and Kicking Horse (at Golden) rivers for the 2018 season. The secondary x-axis shows treatment area (ha).

Ground Application Summary

MBL field staff visited mosquito development sites starting in mid-April and first treated sites on 23 April (Figure 7). Early treatments focused on bench sites. Frequent, large-scale treatments became necessary in early May due to a high freshet that occurred earlier than normal and rose steadily. Ground applications increased into early June, as a result of large-scale, sustained flooding, triggering mosquito eggs to hatch (Figure 7).

The application rate for ground treatments can vary depending on plant density in the target area. Certain sites in Area ‘A’ – Town of Golden require an application rate of 6 kg/ha, although the clear majority require 4 kg/ha. Ground treatments (i.e., hand, backpack blower treatments) are applied at lower rate than that of aerial treatments because a higher percentage of Aquabac® (i.e. Bti). is expected to reach target areas when there is no canopy to take into consideration. The total area treated by ground from April – early June was approximately 122 ha, which equates to about 488 kg of Bti (Figure 4). Real-time data associated with each treatment is available through MBL’s client-registered Fulcrum web map portal.

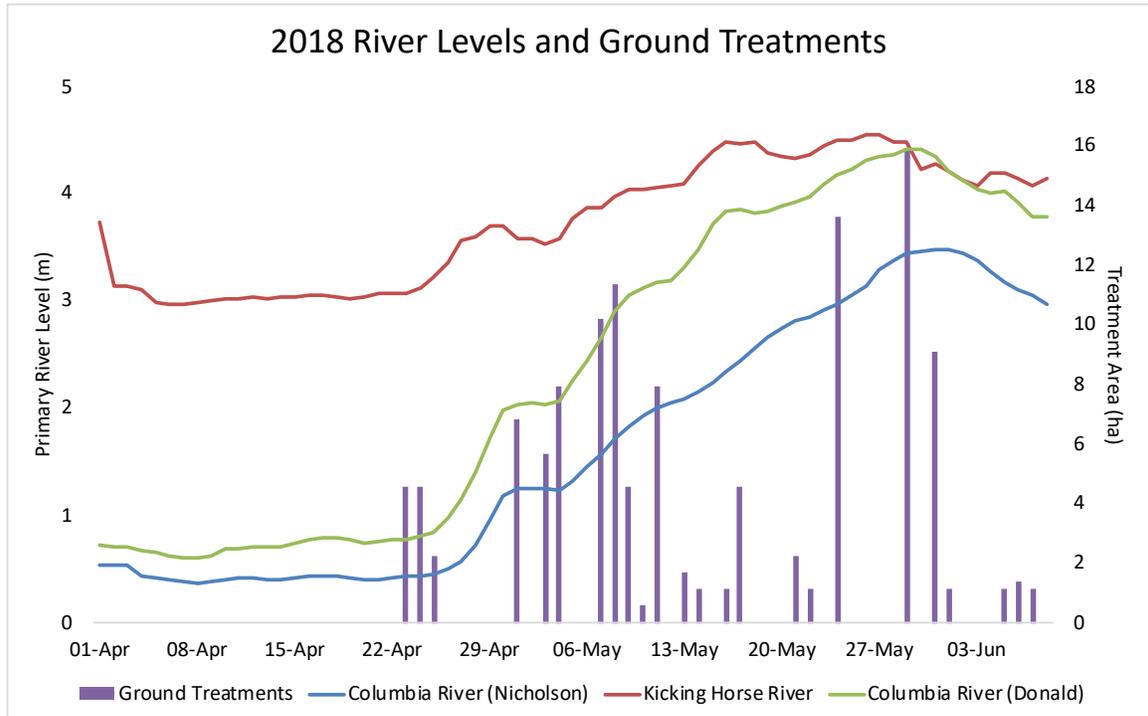


Figure 7. Ground (hand/blower) treatments (ha) with respect to the daily peak of the Columbia River at Donald (08NB005, green), Columbia River at Nicholson (08NA002, blue) and Kicking Horse River at Golden (08NA006, red) for 1 April – 8 June 2018.

Public Relations

Annoyance Reports/Inquiries

By the middle of June 2018, the total number of calls to the Mosquito Hotline from Area ‘A’ – Town of Golden is one. The call was received on 5 June from a resident requesting additional information regarding MBL’s treatment of the area near them in 2018. No emails have been received, to date. Calls and emails are returned within 24 hours and/or a site visits are made, if the resident requests an assessment of larval habitat or adult mosquito abundance.

Public Education Efforts

Public education is a key aspect to MBLs mosquito program. Public education can arm people with knowledge about how to reduce their exposure to mosquitoes, thus reducing health concerns and general mosquito annoyance. Public education can be presented in numerous forms: in person, through media interviews, and via social media sites. When the public is informed about the efforts being made to reduce mosquito abundance, fewer complaints are logged.

For the 7th consecutive year, MBL has included its public education reach to include social media. MBL has a Facebook account (facebook.com/MorrowMosquito), Twitter account (@MorrowMosquito), and Instagram account (linked to Facebook) which are regularly updated. Each site includes posts on where monitoring events are taking place, what the environmental conditions are, and general larval abundance. By the end of May (2018), the MBL Facebook page was up to 232 followers, which is an increase of 77 followers since this time in 2017. The highest reach value for the 2018 season so far is 3,340 (6 May). The posts that received the highest impact were directly relating to the expected higher mosquito abundance throughout southern BC due to flooding.

A public engagement event will be scheduled for early July within the Town of Golden. The event will focus on providing information to Area ‘A’, Golden residents on mosquito habitat reductive measures that can take place around homes. Additionally, the event will provide information on mosquito biology, control measures, and relevant research.

No media interviews have been requested, to date. MBL managers met with Tourism Golden staff in early April, at their request. The intent of the meeting was to describe the mosquito program and set-up a framework for maintaining contact throughout the mosquito season. Tourism Golden staff offered to assist in relaying tips for reducing container mosquito environments.

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