

***Columbia-Shuswap Regional District,
Mosquito Control Program for
Electoral Area 'A'/Town of Golden, B.C.***

2017 Mid-Season Report

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Introduction

This report will summarize the mosquito control program activities conducted by Morrow BioScience Ltd. (MBL) for the Town Golden, BC and Electoral Area 'A' for the 2017 season through early July. 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 remainder 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 2017 final report, to be submitted in October.

Significant Regional Environmental Conditions

Snowpack

Snowpack in basins influencing Area 'A'/Golden rivers (i.e., Columbia River and Kicking Horse River) is an important environmental variable to track, as it can reveal how severe the freshet may be at varying points in the season. The main basin that influences the Columbia River and Kicking Horse freshet in the Area 'A'/Golden area is the Upper Columbia snow survey basin. Within that basin, snow pack reported from the Molson Creek (2A21P), Colpitti Creek (2A30P), and Wildcat Creek (2A32P) snow survey stations are most relevant.

Immediately preceding the start of the 2017 mosquito monitoring season, the April 1st snowpack within the Upper Columbia basin was reported to be at 100% of normal¹. Snow basin indices for this basin had increased considerably from the March 1st indices due to unstable and relatively cool weather across the southern portion of BC in March. Arctic air contributions to the region resulted in much of the precipitation received as snow at high-elevation snow gauge stations, thus increasing snowpack late in the season. The most recent and final snow basin indices (June 15th Bulletin²) for the Upper Columbia basin were reported at 99% of normal. Based on these indices, 2017 was considered a normal snowpack year.

A more current perspective of the residual Snow Water Equivalent (SWE) in each of the three stations within the Upper Columbia basin reveal 0% SWE in each³. The significant snow depletion between the June 15th Bulletin and the real-time SWE updates is a result of recent higher ambient temperatures recorded throughout the southeastern portion of

¹ http://bcrfc.env.gov.bc.ca/bulletins/watersupply/archive/2017/2017_April1.pdf

² http://bcrfc.env.gov.bc.ca/bulletins/watersupply/archive/2017/2017_Jun15.pdf

³ <http://bcrfc.env.gov.bc.ca/data/asp/realtime/index.htm>

the province. Given the depletion of SWE in the region's high-elevation snow stations, it's fair to state that the freshet is finished for the 2017 season.

Weather

When precipitation accumulation is significant, it can considerably affect certain rivers or seepage areas proximate to Area 'A'/Golden. However, precipitation in April through early July is considered either lower-than-average or average and, therefore, it's unlikely that precipitation accumulation during the mosquito season augmented either the Columbia River or Kicking Horse River in the program area. Additionally, seepage sites created by the increased water table in the area were also not augmented by precipitation in 2017. Precipitation in July, thus far, has been considerably low⁴.

The 2017 mosquito season began with cooler-than-average weather across southern British Columbia. According to the May 1st Snow Survey and Water Supply Bulletin⁵ ambient temperatures were 0.5°C – 1.5°C below average for April in southern BC. Cooler weather through April meant that the snowmelt and freshet were delayed by approximately two weeks, when compared to the normal freshet peak. Since then, maximum ambient temperatures have been normal, with the peak at this point occurring on 7 July (35.3°C).

According to Environment Canada, neutral El Nino Southern Oscillation conditions are present in the Pacific Ocean and expected to persist through the spring. Summer may bring stronger El Nino conditions, which can result in above-average ambient temperatures from May and into July. Indeed, warming weather in May and June assisted with depleting the snowpack at higher elevation stations. Additionally, the warmer weather will increase the rate of development for mosquitoes. Thus, if mosquitoes could hatch, their adult life cycle will also be quickened, resulting in fewer days for adult mosquito presence.

Regional Columbia River and Kicking Horse River Levels

The Columbia River and the Kicking Horse River primarily affect the floodwater mosquito abundance in the area around Area 'A'/Golden. To a large degree, river levels in both systems fluctuate similarly (Figure 1). In May and June, river levels were mainly influenced by mid and high-elevation snowmelt. The warmer weather experienced in May and June brought out the remainder of regional snowpack and resulted in a peak in the Kicking Horse River at Golden on 9 June (4.925 m; Figure 1). Following suite, the Columbia River at Donald and Nicholson peaked on 10 June (4.805 m) and 11 June (3.6 m), respectively

⁴ http://climate.weather.gc.ca/historical_data/search_historic_data_e.html

⁵ http://bcrfc.env.gov.bc.ca/bulletins/watersupply/archive/2017/2017_May1.pdf

(Figure 1). Regional river levels receded following the peaks, but have continued to oscillate at considerably high levels.

The 2017 peak Columbia River levels (at Donald) were over a meter higher than the peak of 2016; 2017 River levels as of 6 July were still higher than the 2016 peak at Donald (Figure 1). Floodwater mosquito eggs are laid on damp substrate proximate to water bodies with flooding potential. They can remain dormant for numerous seasons, as the eggs wait for floodwater - and other environmental variables - to trigger hatching events. Thus, high water years which have been preceded by low-water will likely trigger the hatching of a compounded number of mosquito eggs from many seasons. These were the conditions present for the 2017 season. Additionally, the sustained high water in the two river systems since the peak has created the potential for further seepage sites to develop.

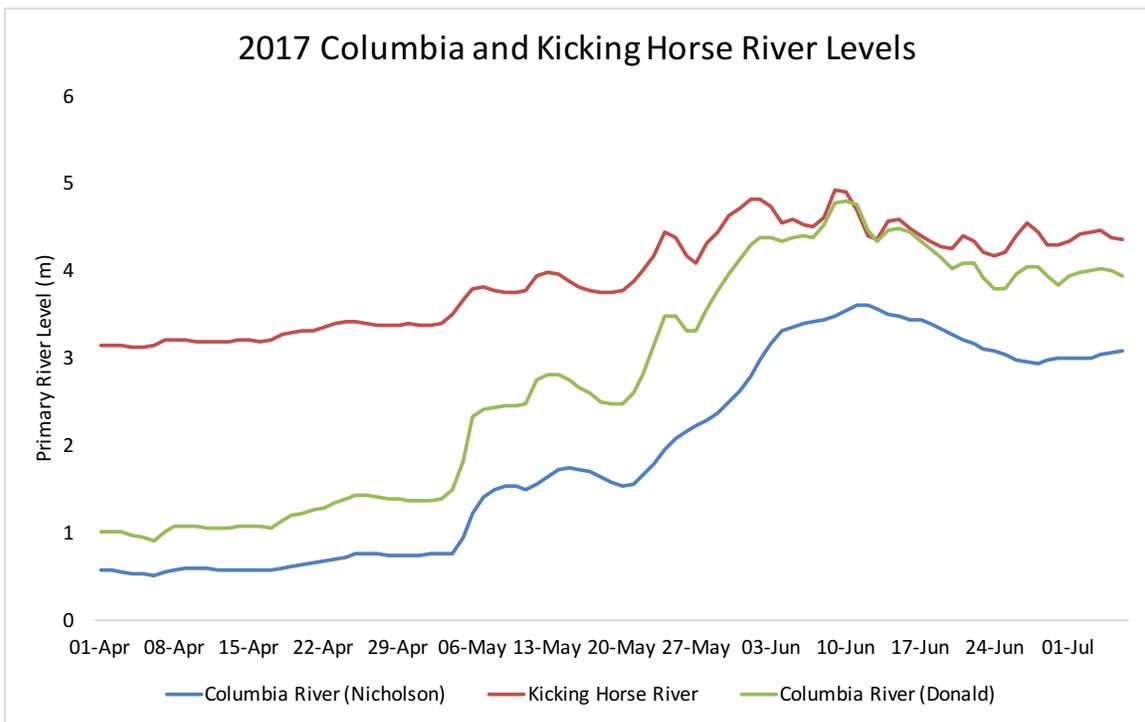


Figure 1. Columbia River and Kicking Horse River levels (m), 1 April - 31 August. Columbia River measurements were taken from the 'Columbia River at Donald' and 'Columbia River at Nicholson' station and Kicking Horse River measurements were taken from the 'Kicking Horse River at Golden' station.

Larval Treatment

Monitoring began in on 31 March and the first ground treatment took place on 17 April (Figure 2). Warm weather and melting snow prompted the first treatment, which was primarily focused on the benches associated with the Columbia River. Ground treatments were highly concentrated through May, prior to large-scale hatching events and while

mosquito development sites were safely accessible. The last ground treatment took place on 22 June (Figure 2). Treatments since then have been unnecessary as regional river levels have receded, no remarkable precipitation has accumulated, and most of the mosquito development sites have been successfully treated. The mosquito species in the Area 'A'/Golden region are univoltine, meaning that the species only go through one hatch and require one well-timed treatment.

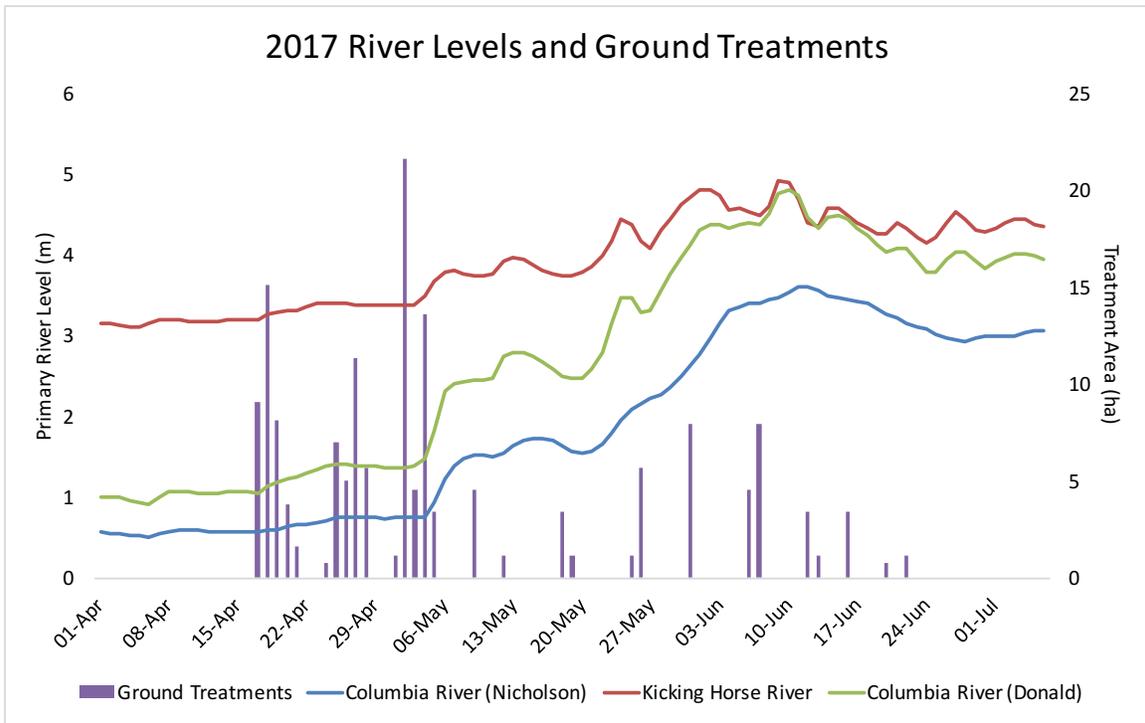


Figure 2. Ground (hand/blower) treatments (ha) with respect to the daily peak of the Columbia River at Donald, Nicholson and Kicking Horse River at Golden for the 2017 season. Note: ground treatments are indicated on the alternate y-axis.

A total of approximately 159 ha have been treated by ground, thus far, in 2017 (Figure 3). Because ground treatments are conducted at a rate of approximately 5 kg/ha, a total of 799 kg of Aquabac® (i.e. Bti) has been used as of 4 July. As Columbia River and Kicking Horse River levels decline into July, viable mosquito development sites will become dry, and ground treatments will decline, as well. Monitoring will continue into August.

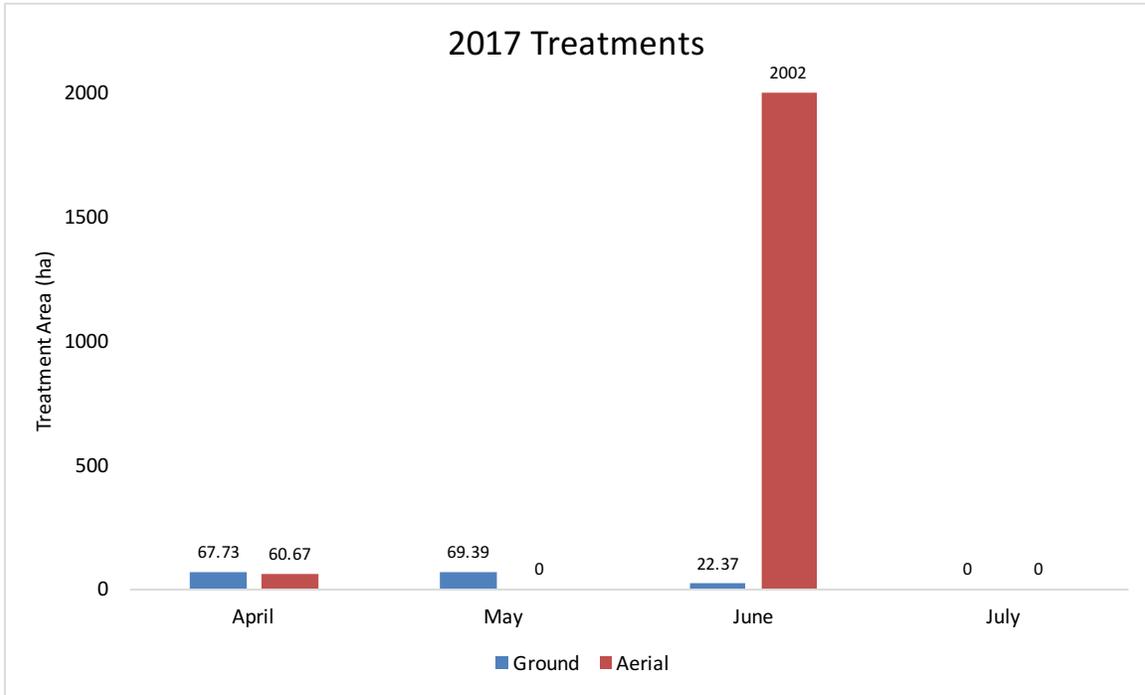


Figure 3. Total ground (blue) and aerial (red) treatments for May, June, and July, 2017. Note that treatments are current through 4 July.

The regional river levels rose high enough in late April, and were accompanied by warm enough ambient temperatures, to necessitate an aerial treatment of the Columbia River benches (Figure 4). The additional four aerial events took place on 2, 8, 9, and 16 June (Figure 4). The latter four aerial events were required due to the high or peak-level regional river levels. The prolonged peak river levels, coupled with the high peak and warm weather resulted in a large surge in larval mosquito presence at most sites within Area 'A'/Golden. Aerial treatments were required from early to mid-May due to the large extent of and simultaneous larval hatching events. A total of 1,063 ha were treated aerially, which equates to a total of 8,372 kg of Bti applied (Figure 3).

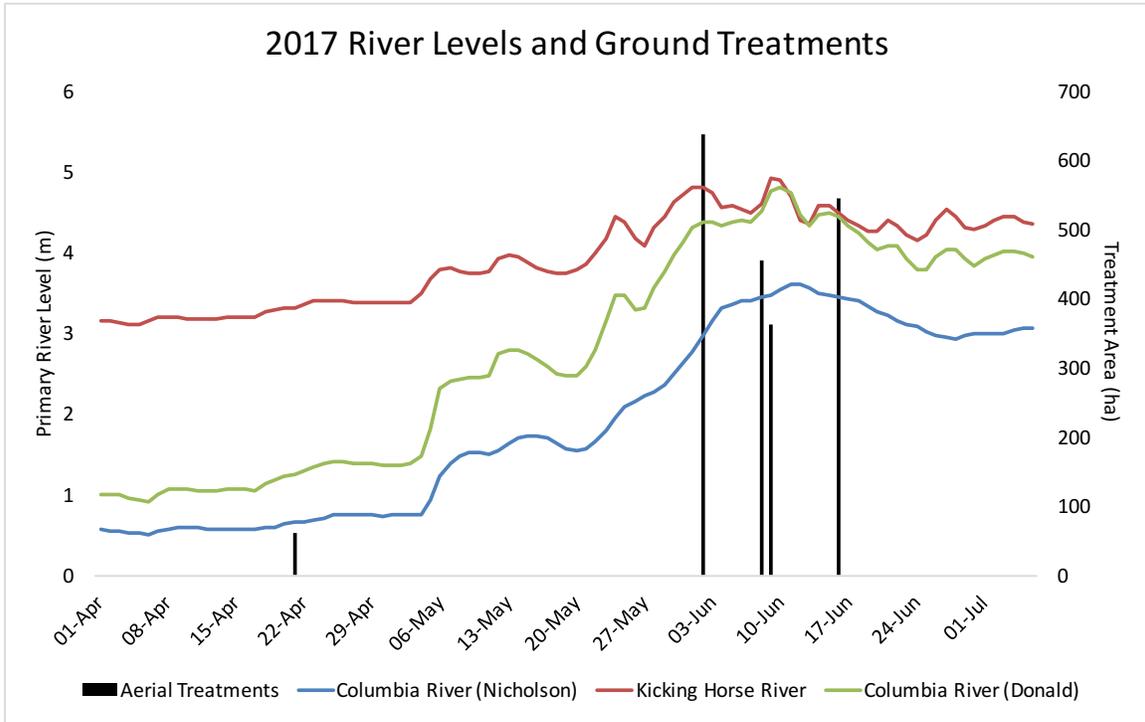


Figure 4. Aerial treatments (ha) with respect to the daily peak of the Columbia (at Donald and Nicholson) and Kicking Horse (at Golden) rivers for the 2017 season. Note: aerial treatments are indicated on the alternate y-axis.

Public Relations

Annoyance Reports/Inquiries

While monitoring or treating, field technicians regularly encounter residents enquiring about what the outlook is for the mosquito season and whether their properties will be monitored again this season. Additionally, concerned residents can access MBL field technicians through the mosquito hotline.

As of 10 July, a total of 15 calls have been made by Area 'A'/Golden residents. Of those, 11 were mosquito adult annoyance reports; the other four were inquiries. The annoyance reports began in late June, which corresponds with the timing of the dispersal of mosquitoes that emerged from peak regional river levels. All calls were returned within 24 hours of receipt.

Public Education Efforts

Regular updates continue to be made to all of MBL’s social media sites (i.e. Facebook: facebook.com/MorrowMosquito, Twitter: @MorrowMosquito, website: www.morrowbioscience.com). Additionally, field technicians regularly interact with

residents regarding questions about the mosquito control program, mosquito biology, and the control product used. MBL staff members are dedicated to maintaining a communicative, positive relationship with all interested residents.

To provide further information about the Area 'A'/Golden program, an outreach booth will be attended by MBL field technicians at a local Farmer's Market event in August. MBL field technicians will provide information pamphlets specific to MBL's treatment methods, product, and how to reduce mosquito habitat around residential homes. The booth will also include a large map of the program, with the intent of engaging residents on mosquito activity they may have noticed in the area.

No press presentations or interviews have been conducted.

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