COLUMBIA SHUSWAP REGIONAL DISTRICT
ELECTORAL AREA A – TOWN OF GOLDEN
MOSQUITO CONTROL PROGRAM
2021 YEAR-END REPORT

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Executive Summary

Morrow BioScience Ltd. (MBL) has now completed the fifth year of a five-year contract as mosquito control contractor for the Columbia Shuswap Regional District (CSRD). This is the 10th consecutive year providing mosquito control for the CSRD. The mosquito control program reduces floodwater and some snowmelt mosquito abundance within Electoral Area 'A' – Town of Golden. Most control activity takes place along the Columbia River near Donald, Blaeberry, Golden, and Nicholson. Snowmelt and floodwater mosquito development site knowledge has been acquired in low and high-water years and through early and late freshet seasons.

In April, immediately preceding the mosquito season, the snowpack in the Upper Columbia basin was 108 percent of normal. A regional warming trend in mid-April within the Upper Columbia Basin led to low-elevation snowmelt. Secondary warming stints at the in mid-May and late-May/early-June triggered the melting of the rest of the mid-elevation and some high-elevation snowpack. On 15 June, the Upper Columbia Basin snowpack was 133 percent of normal, indicating the anomaly of having residual snow at that point in the season. The late June record-breaking heat experience throughout much of the province resulted in the quick and complete depletion of all remaining snow. This heat event also led to the Kicking Horse River peak (29 June; 5.25 m), the Columbia River at Donald peak (2 July; 4.95 m) and the Columbia River at Nicholson peak (3 July; 3.863 m). The 2021 peaks were approximately 2 weeks later than normal. All peaks were the highest since 2012, at least. Regional precipitation accumulation was lower than average from April – July and, thus, likely did not measurably augment regional river levels during their peaks. August precipitation accumulation was higher-than-average and may have contributed to local container mosquito development. Mosquito egg abundance compounded from previous seasons led to greater hatching in 2021. No known sites were missed in 2021. However, a large island northwest of Golden was not included in the program purview and likely resulted in the significant production of adult floodwater mosquitoes. As the annual water level increases, creating additional mosquito development habitat, increasing the purview extent may help reduce adult mosquito annoyance. Only five concern calls were received, with two additional inquiry-based calls. No human cases of West Nile virus or Zika virus were reported by the BCCDC in 2021.

Between 21 April and 7 July, a total of 1,847 hectares were treated by ground and helicopter. Treatment efficacy was assessed as high. Five aerial events targeted larval mosquito development throughout the 2021 season: one (1) snowmelt-specific aerial campaign and four (4) floodwater-specific aerial campaigns. A real-time monitoring and treatment data dashboard was provided to the CSRD program manager. The dashboard enables the manager to view up-to-date treatment information and ensure quality control.

Two adult trapping events were conducted in 2021 in the Blaeberry area and at the Kicking Horse Mountain Resort. Trap contents were relatively high and entirely comprised of *Aedes vexans* specimens. All adult mosquitoes collected were likely a result of dispersal from peak river-associated hatching events.

Communications with in-program residents remains a priority for MBL. Education outreach efforts included making available a re-vamped website with a prominent reference and contact tab. Following CSRD approval, MBL provided a media release to a local radio station and had a brief interview regarding mosquito abatement efforts and personal protective recommendations. The reach of social media posts continues to increase annually, meaning that more residents around Area 'A'/Golden are aware of mosquito abatement efforts and personal protective tips.

Season Highlights

- The average snowpack in the Upper Columbia basin was 108 percent of normal in April, immediately preceding the onset of the mosquito season.
- A region-wide warming event within the Upper Columbia basin prompted considerable low-elevation snow melt conditions in mid-May increasing Columbia River levels beyond 2.5 m on 17 May.
- Additional warming events in late-May/early-June prompted further mid-elevation and some high-elevation snowmelt.
- Record-breaking heat contribute to the quick and complete depletion of the Upper Columbia Basin snowpack by late June/early July and resulted in the peaks of regional rivers.
- The peak Kicking Horse River level at the Golden gauge occurred on 29 June at 5.25 m.
- The peak Columbia River level at the Donald gauge occurred on 2 July at 4.95 m m and at the Nicholson gauge on 3 July at 3.863 m.
- The peaks were the highest since, at least, 2012.
- One (1) aerial campaign was required to treat mountain snowmelt sites on 4 May.
- Four (4) aerial campaigns were required to treat floodwater mosquito development habitat on 11, 24, 30 June and 7 July.
- Total Aquabac® ground treatments were 350 kg (88 ha).
- Total Aquabac® aerial treatments were 10,192 kg (1,759 ha).
- Hotline calls/emails were considerably low (i.e., 7 total).
- MBL's real-time data management and mapping portal provided CSRD program managers with improved ability to target areas and gave quality control assurance for clients.
- On 7 June, 104.3 FM EZRock (Bell Media) was provided with a CSRD-approved media release. A MBL staff member conducted a brief interview with a Bell Media staff member. The interview included an update on general mosquito control activities occurring within Area 'A'/Golden and personal protective measures.

Introduction

Morrow BioScience Ltd. (MBL) is the longest-operating mosquito control firm in British Columbia, having conducted mosquito control in this province for nearly four decades. MBL has been the mosquito control providers for the Electoral Area A – Town of Golden (Area 'A'/Golden) within the Columbia Shuswap Regional District (CSRD) since 2012. In 2017, MBL started a renewed five (5) year contract; this season – 2021 – is the fifth and final year of the contract.

The considerable mosquito habitat, program reach, and interannual regional river peak variations make the Area 'A'/Golden mosquito control program complex. However, throughout the ten seasons as contractors for this program, MBL staff has acquired thorough knowledge of the area and how Area 'A'/Golden-specific environmental conditions affect mosquito development sites. In addition to having built a program knowledge base, numerous improvements have been made to the program since its inception, including:

- extensive site survey along floodplain benches,
- identification of new mosquito development sites,
- the addition of a real-time data collection and review portal,
- increased public engagement through social media, radio and in-person events,
- improved environmental awareness of program impacts through annual carbon offset purchases, and
- increased community involvement through annual MBL volunteer commitments.

MBL's goal is to continue to provide effective mosquito control to the Area 'A'/Golden residents, while remaining socially and environmentally responsible.

Carbon Offsets

The spatial reach of the CSRD mosquito program is such that driving is an inevitable requirement. The accumulated mileage over the course of 2021 was approximately 10,805 km (ground transportation only).

As an estimation, the driving requirements for this program result in the production of approximately 1.67 tonnes of CO_2 emissions. To compensate for this addition of CO_2 to the environment, MBL has committed to purchasing carbon offsets. Carbon offsets are purchased through the West Kootenay EcoSociety[1]. When the carbon offsets are purchased, a proof of purchase and certificate from the offset provider will be delivered to the CSRD.

[1] https://www.ecosociety.ca

Methodology

The primary targets of the Area 'A'/Golden mosquito control program are floodwater mosquito larvae. Unlike container mosquitoes (e.g., *Culex pipiens*), female floodwater mosquitoes (e.g., *Aedes vexans*, *Ae. sticticus*) deposit their eggs on damp substrate. Within the program purview, floodwater mosquito development sites primarily exist along the flooding corridors of the Columbia River and Kicking Horse River, including associated seepage sites. When water floods these sites, due to the freshet and/or significant localized precipitation, the result is large-scale floodwater mosquito egg hatching (Image 1). If numerous seasons have passed between high-water years, then high river levels may trigger a compounded number of mosquito eggs to hatch.

The secondary target of the Area 'A'/Golden mosquito program is snowmelt mosquitoes. Snowmelt mosquitoes hatch early in the spring (i.e., March – April) within the area. Snowmelt mosquito habitats consist of smaller depressions in the landscape where snowmelt mosquito eggs were laid the previous summer. The smaller depressions collect water in the fall and freeze. Just as the site begins to thaw, snowmelt mosquito eggs hatch. These species typically hatch early to ensure their development habitat remains wet from hatching to emergence and also to reduce inter-species habitat competition as they develop (Clements 1992). Certain snowmelt mosquito species begin to hatch at a water temperature of approximately 4°C and can complete development to adult emergence at 10°C (Clements 1992). Snowmelt mosquito development sites are mainly located along the mountain benches within Area 'A'.

Image 1. Standard dip (350 ml) from mosquito development site showing 3rd instar mosquito larvae (2021)

MBL field technicians begin monitoring all known mosquito development sites within Area 'A'/Golden as the snowmelt sites begin to show signs of thawing. Mosquito development sites are adaptively managed, meaning that the regional river levels and environmental conditions largely dictate frequency of visits, as opposed to a prescribed monitoring schedule. At the height of the mosquito season, MBL staff may monitor highly productive sites multiple times a week. Adaptive management techniques allow MBL staff to most accurately time treatments, if necessary. Prescribed monitoring methods increase

the risk of missing optimal treatment windows due to accelerated mosquito development rates with rising temperatures (Read and Moon 1996). Hence, as regional river levels and ambient temperatures begin to rise consistently, monitoring efforts increase.

Larval mosquitoes in sufficient number (i.e., >4/dip) are treated by ground applications of the microbial larvicide product Aquabac®. This product has the active ingredient *Bacillus thuringiensis israelensis* (Bti), which is carried in a corncob formulation. The mode of action for Bti inherently includes a high degree of species selectivity. Receptors within the mid-gut region of the mosquito larvae are specific to the toxin proteins that are produced alongside each bacterial spore. After the mosquito larvae ingest the toxin protein, it causes considerable damage to the larval gut wall and quickly results in death (Boisvert and Boisvert 2000).

As the season progresses and more mosquito development sites become either flooded or thawed, it is increasingly difficult to treat sites by ground due to access challenges and concurrent site activation. At this point, a helicopter is used to conduct aerial treatments. The aerial treatments use the same pesticide as ground applications, although typically with a higher application rate to permeate canopy cover. High water years may require 2-day aerial treatment campaigns (treatment of the entire Area 'A'/Golden region). All sites are checked within 1 or 2 days of the initial treatment to ensure treatment efficacy. If necessary, touch-up treatments are conducted.

It is important to time treatments according to the correct stage of larval development (i.e., 3rd and 4th instar). If treatments are applied too early, the larvae will not have advanced to their highest feeding rate yet and if applied too late, the larvae molt into pupae (i.e., non-feeding stage). Both circumstances may result in the development of adult mosquitoes. Additionally, by waiting until mosquito larvae are in the 3rd and early 4th instar stages, early instar larvae are available as food sources within the ecosystem.

Environmental Conditions

The three primary environmental conditions that affect floodwater or snowmelt mosquito larval production throughout the mosquito season (i.e., April – August) within Area 'A'/Golden are: 1) local ambient temperature and ambient temperature in snow basins contributing to either the Columbia River or Kicking Horse River, 2) local precipitation, and 3) the snowpack in the Upper Columbia Basin.

Snowpack

Floodwater mosquito abundance within Area 'A'/Golden is largely governed by the regional Columbia River, measured at the Donald (ID: 08NB005) and Nicholson (ID: 08NA002) gauges. The Kicking Horse River (ID: 08NB006) also contributes water to the Columbia River near the Town of Golden, affecting down-stream flows. The water levels of those systems are governed by the freshet released from Upper Columbia Basin. When snowpack within the Upper Columbia Basin exceeds 100 percent of normal, higher-than-

average Columbia River and Kicking Horse River levels are expected during the mosquito season.

The Upper Columbia Basin had a snowpack of 108 percent of normal at the start of the mosquito monitoring season[2]. The Basin received additional snow in the early half of April. The augmentation of the snowpack at that time resulted in peak Snow Water Equivalent (SWE) values for numerous areas of the Basin in early April. A ridge of high-pressure settled over much of the province from 14-18 April and led to unseasonably warm ambient temperatures and some low-elevation snowmelt toward the end of the month[3].

The weather in May was generally stable and Upper Columbia Basin snowpack was not measurably augmented in that month. Continued warm weather in early June resulted in the further depletion of all middle-elevation and some high-elevation snow within the Upper Columbia Basin. A brief stint of cool weather slowed the regional snowmelt in mid-June. The 15 June Snow Survey and Water Supply Bulletin note that the average snowpack within the Upper Columbia Basin was 133 percent of normal[4]. The River Forecast Centre suggested cautious interpretation of the reported percentage. However, the considerably high 'percent of normal' snowpack remaining as of 15 June reflected the rarity of late-season snowpack persistence. Record-setting heat was recorded for much of the province in late June. The heat dome effect resulted in the quick and complete depletion of all high-elevation snow in the Upper Columbia Basin.

The Colpitti Creek snow survey station (ID: 2A30P) is the closest station to the program purview (Figure 1). It serves as a representative site for the regional snowmelt trajectory. The Snow Survey data show a brief melting stint occurred toward the end of April[5]. It also shows the first measurable melting trend in mid-May, with the lower and middle-elevation SWE dropping significantly. The data show the impact of the heat dome in late June, resulting in the depletion of the Colpitti Creek station's snowpack by the end of June (Figure 1). Other snow survey stations throughout the Upper Columbia Basin show similar trends[6]. Thus, by early July any fluctuations in the regional Columbia River and Kicking Horse River levels were likely not due to regional snowmelt contributions.

[2] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2021_apr1.pdf
[3] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2021_may1.pdf
[4] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2021_june15.pdf
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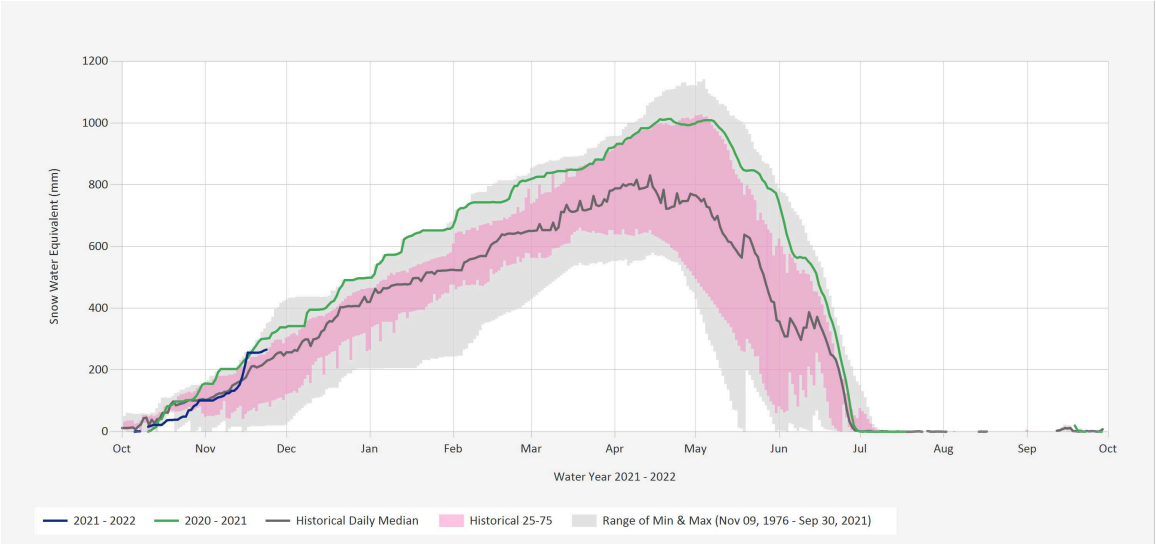

Figure 1. Snow Water Equivalent (SWE; mm) data from the Colpitti Creek snow survey (station ID: 2A30P) within the Upper Columbia Basin (green line).

Local Precipitation

Extensive temporally and spatially-concentrated precipitation accumulation may elevate regional Columbia River and Kicking Horse River levels. Local precipitation can also temporarily augment seepage site levels, where floodwater mosquito development habitat is located. Tracking local precipitation accumulation can aid MBL field staff in determining when mosquito sites become active and how long sites may require management. The Golden Airport weather station (ID:1173220) provides both historical precipitation accumulation averages (i.e.,1981 – 2010) and current-year totals, allowing for the comparison between the two. This comparison facilitates some level of prediction regarding larval mosquito hatching and treatment timing requirements. When more than average precipitation is received within peak hatching months, seepage site levels may be higher or sustained for longer. Both scenarios may lead to additional floodwater mosquito egg hatches.

Precipitation accumulation recorded at the Golden Airport weather station from April through July was lower than average (Figure 2). This is consistent with the frequent high-pressure weather systems noted within the province during that period. Precipitation received in April was only approximately 1 mm lower than average. However, precipitation accumulation received in May, June, and July was between 15-25 mm lower than the monthly averages (Figure 2). Given the relatively low amount of local precipitation during the height of the freshet, it is unlikely that precipitation augmented Columbia River and Kicking Horse River levels or associated seepage sites in those months.

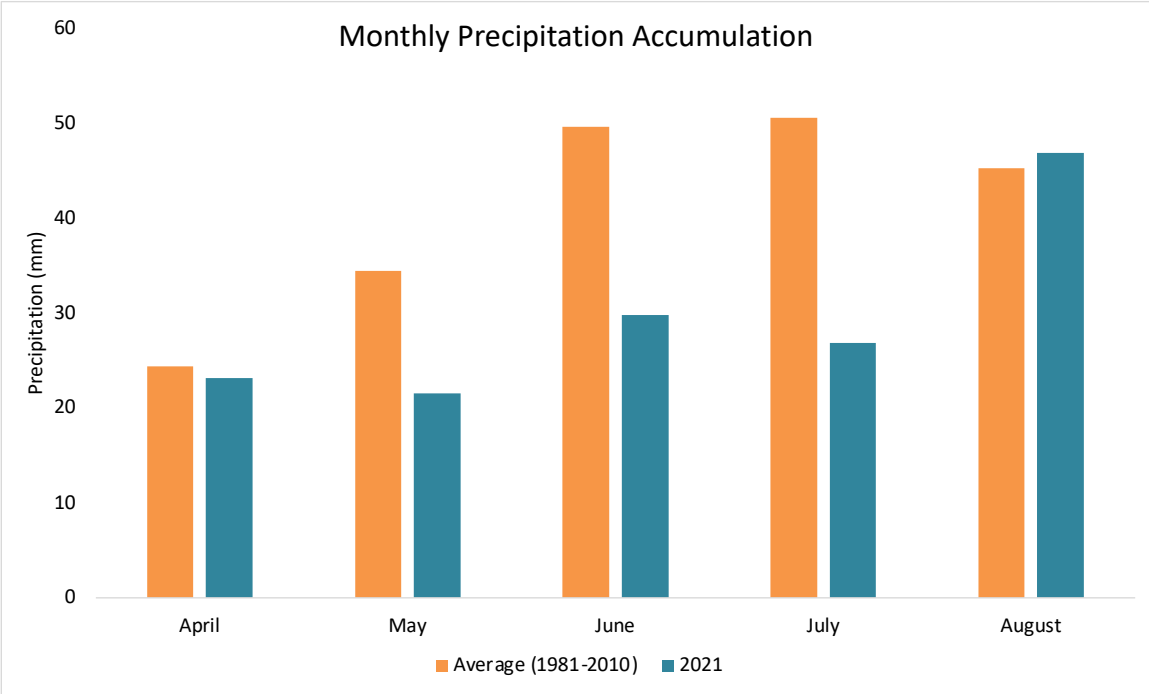

Figure 2. Precipitation values (rainfall and snow accumulation; mm) recorded at the Golden Airport weather station (ID: 1173220) for 01 April – 31 August 2021 (blue) and average station precipitation values (1981-2010; orange).

Considerable and above-average precipitation was recorded in August (Figure 2). The majority of precipitation was received in the latter half of August. At that point, precipitation was of little consequence to the regional river levels and associated mosquito development sites because the univoltine floodwater mosquito species had already hatched and/or floodwater mosquito development habitat had been reduced. However, it's possible that precipitation received in August did create habitat for container mosquito hatching. Thus, adult mosquito presence toward the end of the season was likely due to container mosquito hatches, not floodwater mosquito species in certain areas.

Ambient Temperature

Ambient temperature, both locally and within the contributing snow basin, is an important variable to track. Local ambient temperature fluctuations from April through August can affect mosquito egg hatching, larval development rates, adult dispersal, and adult survival in the Area 'A'/Golden region. Ambient temperature within Upper Columbia Basin dictates the commencement and often the intensity of the freshet.

Upper Columbia Basin Temperatures

Ambient temperatures for April were generally normal within the Upper Columbia Basin. The 1 May Snow Survey and Water Supply Bulletin[7] noted that temperatures averaged between -2ºC to +2ºC for the month. This normal range was recorded despite the ridge of

[7] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2021_may1.pdf

high pressure from 14-18 April that included warmer temperatures and resulted in low-elevation and some middle-elevation snowmelt.

Ambient temperatures in May within the Upper Columbia Basin were considered slightly above normal in comparison to monthly averages[8]. Warming and cooling events both occurred during the month. Notable warming stints took place in mid and late-May/early June, resulting in melting events in the Upper Columbia Basin. The late-May/early June ambient temperatures recorded within that basin would lead to a notable pulse of water recorded in regional river levels (i.e., 1-10 June).

Weather within much of the province during the first week of June was dominated by a high-pressure system[9]. The following low-pressure system present slowed the high elevations snowmelt within the Upper Columbia Basin. However, a strong high-pressure ridge was in place over most of the province in the latter half of June. The heat dome effect resulted in the shattering of many high-temperature records within the province and led to the depletion of high-elevation snowpack within Upper Columbia Basin. The pulse of water from that melting event led to the official peaks in the regional Kicking Horse River and Columbia River in late June and early July, respectively. Temperature data are consistent with 2021 automated snow station data depicting snowmelt points correlating with regional ambient temperature spikes[10].

Local Temperatures

If the ground proximate to the Columbia River and Kicking Horse River contains floodwater mosquito eggs and if hatching conditions are present (i.e., low dissolved oxygen, higher ambient temperatures), then floodwater mosquito egg hatching will commence (Mohammad and Chadee 2011). Thus, local ambient temperature is a predictive tool when gauging floodwater egg hatch commencement. Local ambient temperature data are acquired from the Golden Airport weather station (ID: 1173220).

To illustrate the effect of ambient temperature on mosquito developmental benchmarks, Trpis and Horsfall (1969) exposed submerged eggs of a regionally common floodwater mosquito species, *Aedes sticticus*, to various constant air temperatures and recorded hatching success. Results revealed that eggs began to hatch at 8°C, although larval development was slow and survivorship was low. Eggs held at 21°C provided the optimal temperature, of the five temperatures tested, for hatching and larval development (Figure 3). While *Ae. sticticus* is not the sole floodwater species present in Area 'A'/Golden, it is frequently caught in regional adult mosquito traps and serves as a representative species for control purposes.

[8] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2021_june1.pdf
[9] https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2021_june15.pdf
[10] https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-science-data/water-data-tools/snow-survey-data/automated-snow-weather-station-data

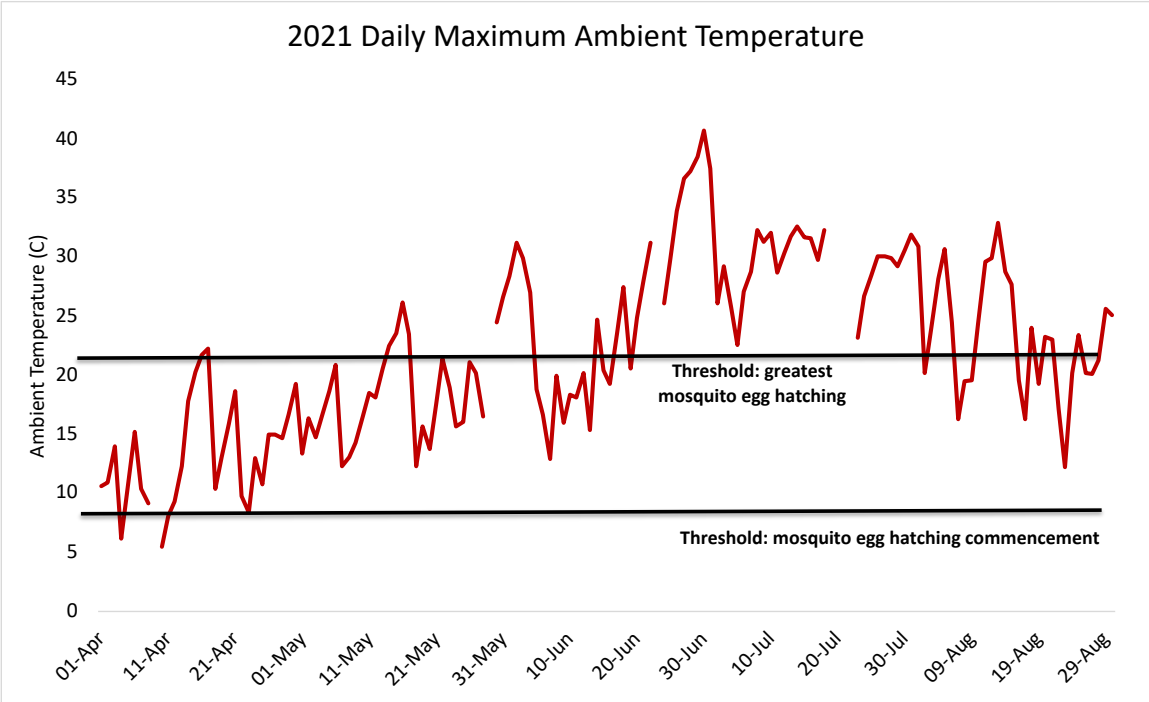

Figure 3. Maximum daily ambient temperatures (C) as recorded at the Golden Airport Station (ID: 1173220) 01 April – 31 August 2021. Lower line illustrates threshold at which *Ae. sticticus* eggs commence hatching; upper line illustrates threshold at which most *Ae. sticticus* eggs hatch.

Snowmelt mosquito eggs hatch earlier than floodwater mosquito eggs. Certain snowmelt mosquito species begin to hatch at a water temperature of approximately 4°C and can complete development to adult emergence at 10°C (Clements 1992). Thus, snowmelt mosquito eggs laid along the Columbia River bench area were triggered to hatch in April as sites began to show initial melting (Figure 3). Of note, Figure 3 shows ambient temperature, not water temperature. The delay in realized water temperature is likely a few days in relatively small, shallow sites, such as the majority of snowmelt-influenced sites found in along the mountain benches in Area 'A'/Golden.

April ambient temperatures were also sufficient to trigger floodwater mosquito egg hatching events if the eggs were exposed to flooding conditions (Figure 3). Mosquito egg development at that time of the season would have likely been slow and hatching success low. While temperatures in mid-April briefly surpassed the threshold for a high rate of mosquito egg hatching and survivorship, the regional river levels were low and, thus, the floodwater mosquito eggs were likely not exposed to water.

Local ambient temperatures in mid and late-May were relatively warmer and favourable for larval development conditions of floodwater mosquitoes (Figure 3). Accordingly, hatching and larval development rates increased significantly within those months. Ambient temperature decreased around 7 June, slowing floodwater mosquito larval development. Ambient temperatures rebounded in mid-June and significantly increased in late June as the heat dome settled over most of the province. The heat dome facilitated further mosquito hatching and increased larval development rates. Because numerous

floodwater development sites were at peak levels, the need to treat mosquito larvae in June was directly associated with ambient temperature.

Warmer-than-average ambient temperatures were documented from the latter half of June through mid-August. As regional river levels were also at their peak within this timeframe, considerable mosquito eggs were exposed to ideal environmental hatching cues, resulting in the need for large-scale treatment events. By mid-August, regional river levels were receding and ambient temperature was no longer directly related to floodwater larval mosquito abundance and treatments.

As August progressed, localized annoyance due to container mosquito presence may have occurred. Container mosquito habitats near residential homes can be created throughout the summer whenever water presence is coupled with high ambient temperatures. MBL technicians regularly inform residents that adult container-bred mosquitoes can be reduced around homes by ensuring container mosquito environments are either free of water or refreshed frequently.

River Levels

Within Area 'A'/Golden, the majority of floodwater mosquito development sites are found along the flooding corridors of the Columbia River, Kicking Horse River, and associated seepage sites. As the presence of water is the main hatching cue for floodwater mosquito eggs, springtime regional Columbia River and Kicking Horse levels provide predictions about the timing and extent of floodwater mosquito egg hatching.

Three river level gauges are consistently monitored from March – August: 1) Columbia River at Nicholson gauge: 08NA002, 2) Columbia River at Donald gauge: 08NB005, and 3) Kicking Horse River at Golden gauge: 08NB006. The Columbia River at Nicholson gauge is the farthest up-stream site. The Kicking Horse River contributes to the Columbia River at Golden, affecting the Columbia River at Donald gauge. Thus, the Columbia River at Donald gauge provides data associated with the north part of the program purview and the Columbia River at Nicholson gauge provides data associated with the south part of the program purview. The Nicholson and Donald gauge data mirror one another in regard to river level trajectory, but the Donald gauge commonly reports levels approximately 1 metre higher during the freshet season due largely to Kicking Horse River input.

The consistent rise in regional Columbia River and Kicking Horse River levels began when a small pulse of water came through both river systems in mid-April (Figure 4). The Columbia River at Donald exceeded 2.5 m on 17 May, after which point floodwater mosquito larval treatments typically become necessary (black line; Figure 4). It is important to note that this threshold is an approximation and may change slightly to reflect variations in interannual environmental conditions (e.g., water temperature, previous river peak:current river peak, years since comparable river peak, etc.).

River levels dropped briefly from 24-26 May due to cooler weather reducing the snowmelt. However, levels increased again in late May/early June. Following another brief cooling

trend, regional river levels increased significantly once more in late-June/early-July, due to the impact of the heat dome effect on residual high-elevation snow within the Upper Columbia Basin. As a result of this influx of water, the Kicking Horse River peaked on 29 June (5.25 m; Figure 4). The Columbia River at Donald peaked on 2 July (4.95 m) and the Columbia River at Nicholson peaked on 3 July (3.863 m). The 2021 peaks were approximately 2 weeks later than normal.

Floodwater mosquito eggs laid on substrates at various river levels have optimal environmental cues and adequate time within which to hatch when rivers rise 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. Both regional rivers rose at moderate rates in 2021. Thus, environmental cues were present to trigger mass mosquito hatching events at near-peak river levels.

It is important to track all noted river levels intra-annually to best determine treatment needs in different portions of the program purview. However, the Columbia River at Donald gauge provides a broader perspective for interannual regional freshet comparisons. Both rivers and all gauges show the same general trend regarding water level peaks and troughs within a season (Figure 4). In this way, the interannual peak trends in the Columbia River acts as representative indicators for Kicking Horse River interannual peak trends.

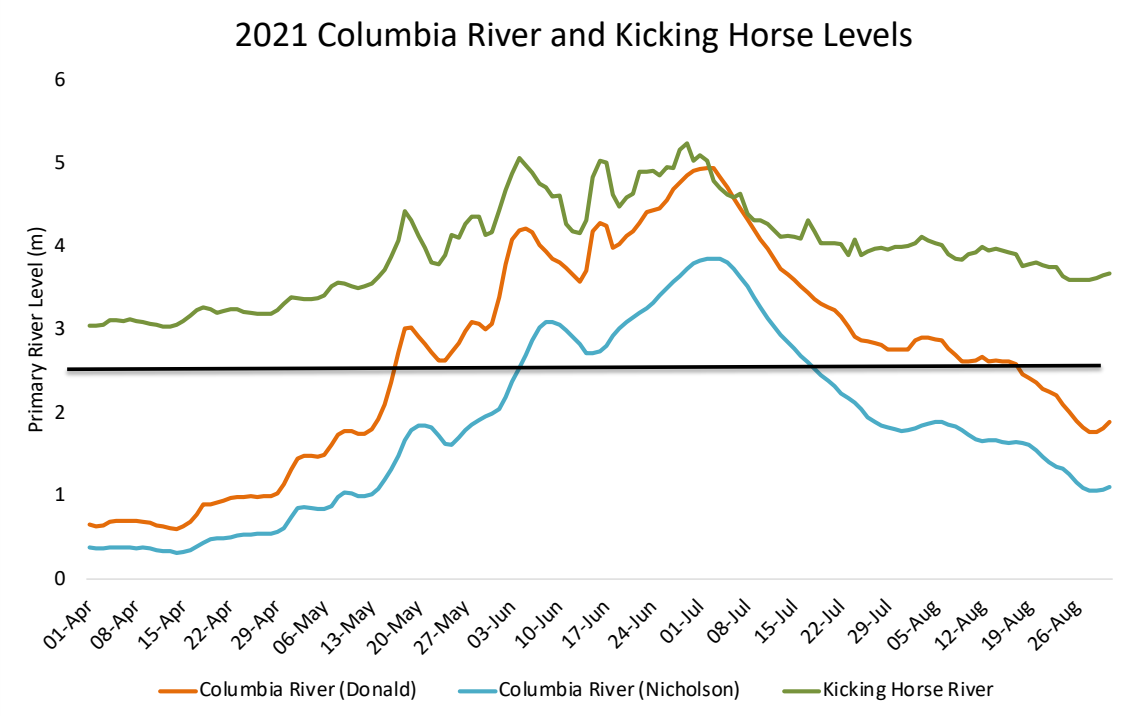

Figure 4. 2021 river levels (m) as recorded for the Columbia River (Donald gauge, 08NB005; orange) and Kicking Horse River (Golden gauge, 08NA006; Red). Horizontal black line indicates the level at which local Columbia River-associated mosquito development sites become active (2.5 m).

The Columbia River's peak height relative to recent seasons is a predictive variable that may help explain an associated year's larval abundance. If the current year's peak regional river levels far exceed those of preceding season's, mosquito eggs laid between the high-water mark of both years could have remained dormant until current-year flood waters trigger their hatching. Because the 2021 peak of the Columbia River at Donald was approximately 0.3 m higher than in 2020, it is likely that the 2021 peak level triggered dormant floodwater mosquito eggs to hatch (Figure 5). The 2021 Columbia River at Donald peak is the highest recorded during MBL's tenure as mosquito control contractors for this program (i.e., since 2012).

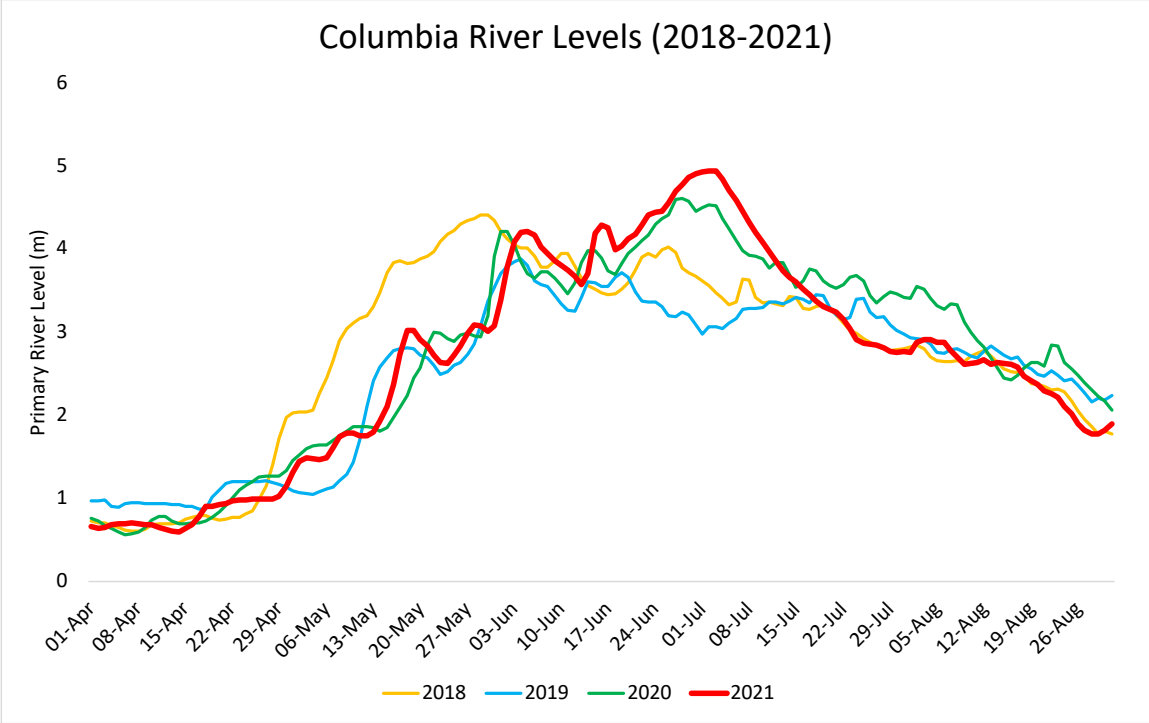

Figure 5. 2018-2021 river levels (m) recorded at the Columbia River Donald gauge (08MB005), as reported by the River Forecast Centre (01 April – 31 August).

By early-July 2021, the Upper Columbia basin was depleted of snow[11]. This depletion corresponds with a marked decline in the Columbia River and Kicking Horse River levels starting around 4 July (Figures 4, 5). By early-August many of the Area 'A'/Golden mosquito development sites associated with both regional rivers were greatly reduced or dry. The Columbia River at Donald was back below the 2.5 m mark by mid-August.

Larval Control

Monitoring within Area 'A/Golden began on 19 April and was primarily focused on the snowmelt mosquito development sites located on the mountain benches. Floodwater

[11] http://bcrfc.env.gov.bc.ca/data/asp/realtime/

mosquito development sites associated with the Columbia River and Kicking Horse River freshets were monitored starting in early May, although treatments would not take place within floodwater sites until mid-May, closer to the timeframe in which the Columbia River at Donald approached the 2.5 m mark. Appendix I shows a map of average larval densities found throughout the 2021 season. Larval abundance is assessed in the field using a system of ranges (0, 1-4, 5-49, 50+) for early and late instar mosquito larvae. In order to transfer these data to a map, data are summarized and assigned to a hexbin representing an area of 21.65 ha.

Only wet sites were included in the analysis. An intensity value representing the relative number and life stage of the larvae are assigned to each single sample. For each sample, late instar larvae ranges are weighted more heavily than early instar larvae ranges to indicate targeted life stage and treatment urgency. In this way, each sample is assigned an intensity value from 0 to 1. All sample intensity values are then averaged by hexbin. Thus, each hexbin is also assigned an average intensity value from 0-1. The intensity value thresholds within Appendix I denoting 'low', 'moderate', 'high', and 'very high' were assigned based on biological significance and operational urgency. Of note, the areas with highest recorded larval abundance amongst known sites were along Golden Donald Upper Rd., Golden, the Nicholson area, and the Parson area.

Hexbins are used to aggregate point data, making general data trends visible at large scales. The primary drawback and disclaimer to hexbin analysis is that generalizations must be made. In general, hexbins denoted as 'None Detected' (i.e. white) or 'Low' (i.e. light sandy colour) indicate the average sample contained < 5 larval mosquitoes per dip. In most cases, hexbins with a moderate frequency (0.2875 - 0.525 intensity value; light orange colour) or greater indicate those which had an average of > 5 mosquito larvae per dip. Hexbins can contain one or greater sample points, may contain sample points that lie directly on hexbin borders, or contain treatment area associated with a point that is officially housed within a neighbourng hexbin; each of these circumstances may create skewed results.

The first ground treatment occurred on 21 April (Figure 6). Treatments conducted in the early portion of the season (i.e., 21 April – 10 May 2021) took place at snowmelt sites northeast of Golden and just south of Blaeberry. Treatments conducted starting on 21 May took place at floodwater-associated sites. Floodwater mosquito development site treatments occurred between 21 May and 5 July (Figure 6; Table 1).

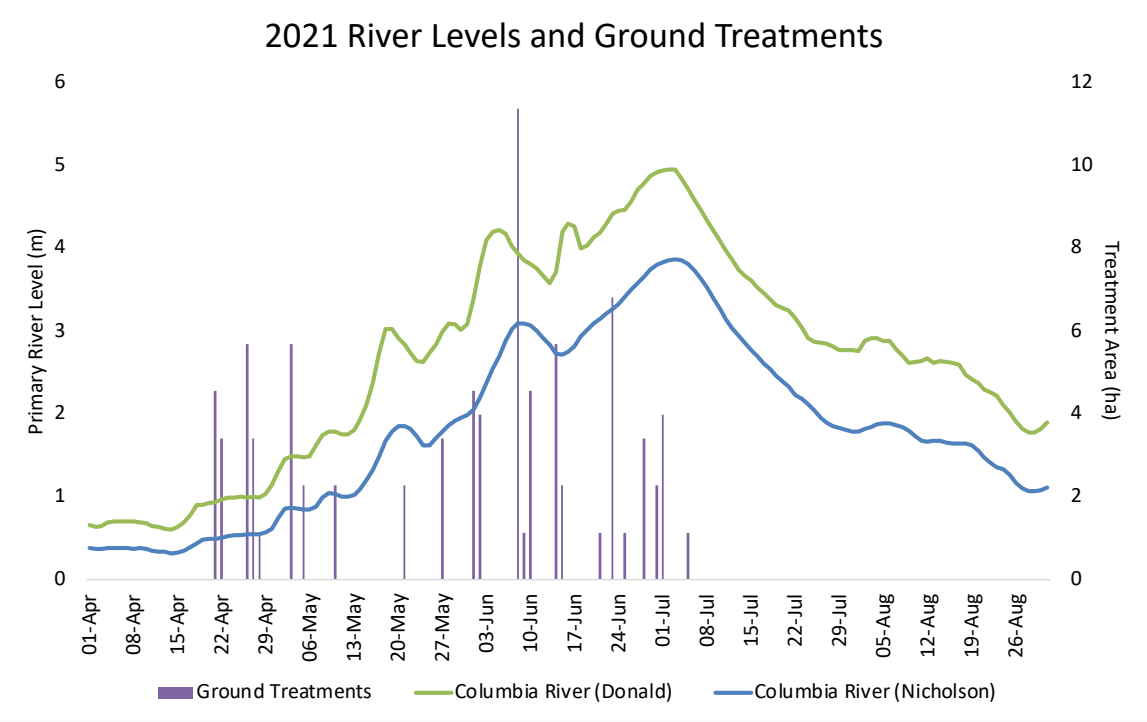

Figure 6. Columbia River levels (m; Donald gauge and Nicholson gauge) with total mosquito development area treated by ground (ha) from 1 April – 31 August 2021. Note ground treatments (ha) are recorded on the alternate y-axis.

Mosquito habitat was increased in 2021 in comparison to 2020 due to high snowpack in regional basins contributing to Columbia River and Kicking Horse River levels. The record-breaking heat wave at the end of June led to a significant pulse of snowmelt to regional rivers may have also resulted in the exceptionally high river peaks in 2021. Both rivers peaked during a period of warming or high ambient temperatures which created ideal mosquito hatching environments. River levels started to recede in early-July. Although river levels remained high through early August, treatments had successfully targeted the sole seasonal mosquito development events for univoltine floodwater mosquito species (Figure 6; Table 1). By mid-August, mosquito development areas were considerably reduced or dry and lacked larval mosquito presence.

Table 1. 2021 treated area (ha) by method (i.e., ground vs. aerial) and month from April - August.

	April	May	June	July	August
Ground	18.2	15.9	48.3	5.1	0.0
Aerial	0.0	182.0	1334.7	242.7	0.0
TOTAL	18.2	197.9	1383.0	247.8	0.0

Ground treatments were applied at a rate of 4 kg/ha. A total of approximately 88 ha was treated by ground, equating to a total of approximately 350 kg of granular Aquabac® used (Figure 6). Despite having more floodwater mosquito habitat than 2020, the 2021 treatment area total is slightly lower than it was in 2020. Typically, sites only require one treatment per season unless additional mosquito larvae are pushed into the site due to the movement

of water. If additional treatments at a site are required they occur at increased water levels, hence the treatment overlap is minimal.

Aerial treatments were applied at an average rate of 5.6 kg/ha. Aerial treatments are applied at higher rates than ground treatments if considerable canopy cover is present. Treating at a higher rate by air allows the granules to reach under-canopy sites more reliably. A total of 1,759 ha was treated by air, equating to a total of 10,192 kg of granular Aquabac® used (Figure 7). As with ground treatments in 2021, the total area treated by air was less than that treated in 2020. Five (5) aerial campaigns were required within the Area 'A'/Golden in 2021 on 4 May, 11, 24, and 30 June and 7 July (Figure 7). Efficacy assessments revealed 90-95 percent control; touch up treatments were conducted by ground around certain sites. The first aerial campaign targeted snowmelt mosquito sites along the mountain benches. All other aerial treatments targeted floodwater mosquito sites. A large island northwest of Golden was not treated in 2021 and was likely a considerable source of adult mosquito annoyance later in the summer. Increased treatment area allowances for this program may reduce this annoyance in high-water years. No new sites were identified in 2021.

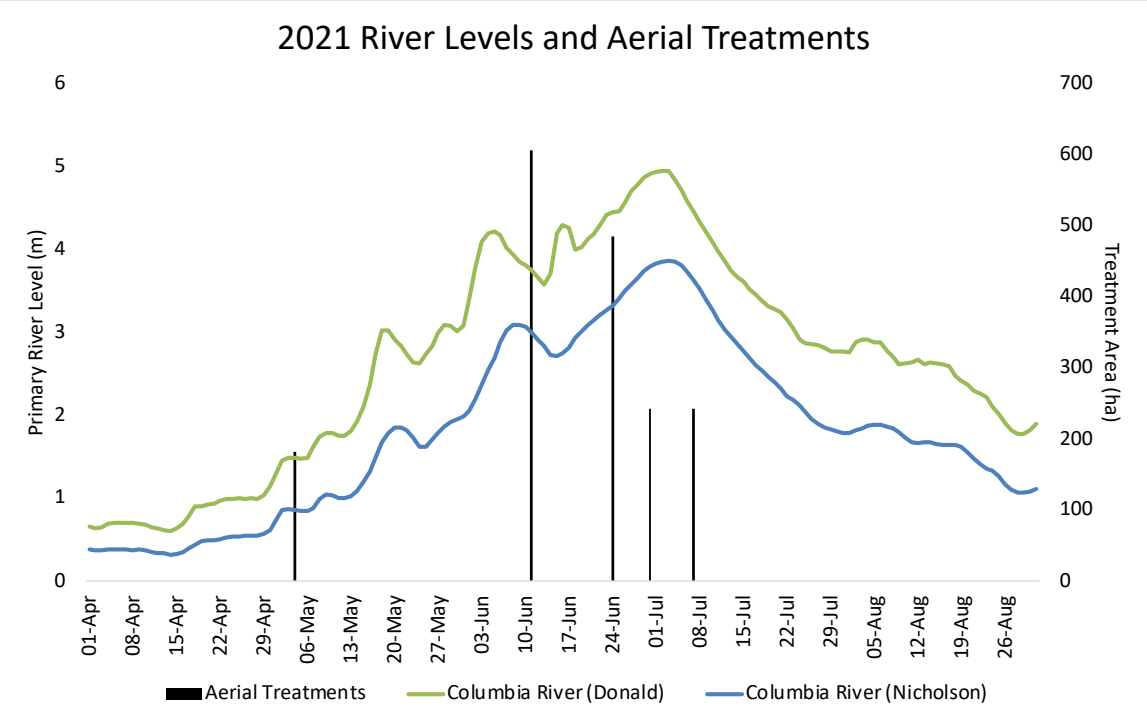

Figure 7. Columbia River levels (m; Donald gauge and Nicholson gauge) with total mosquito development area treated aerially (ha) from 1 April – 31 August 2021. Note aerial treatments (ha) are recorded on the alternate y-axis.

The total amount of area treated in 2020 is the highest since, at least, 2009 (Figure 8). While treatment area is typically directly related to peak river level, treatment area is also a function of how long the river level remains high. The record high treatment amount and area in 2020 is due to the higher-than-average snowpack in contributing basins, the

prolonged snowmelt resulting in consistently high Columbia River levels, precipitation received locally during freshet peak(s), and the primary peak occurring during high ambient temperatures.

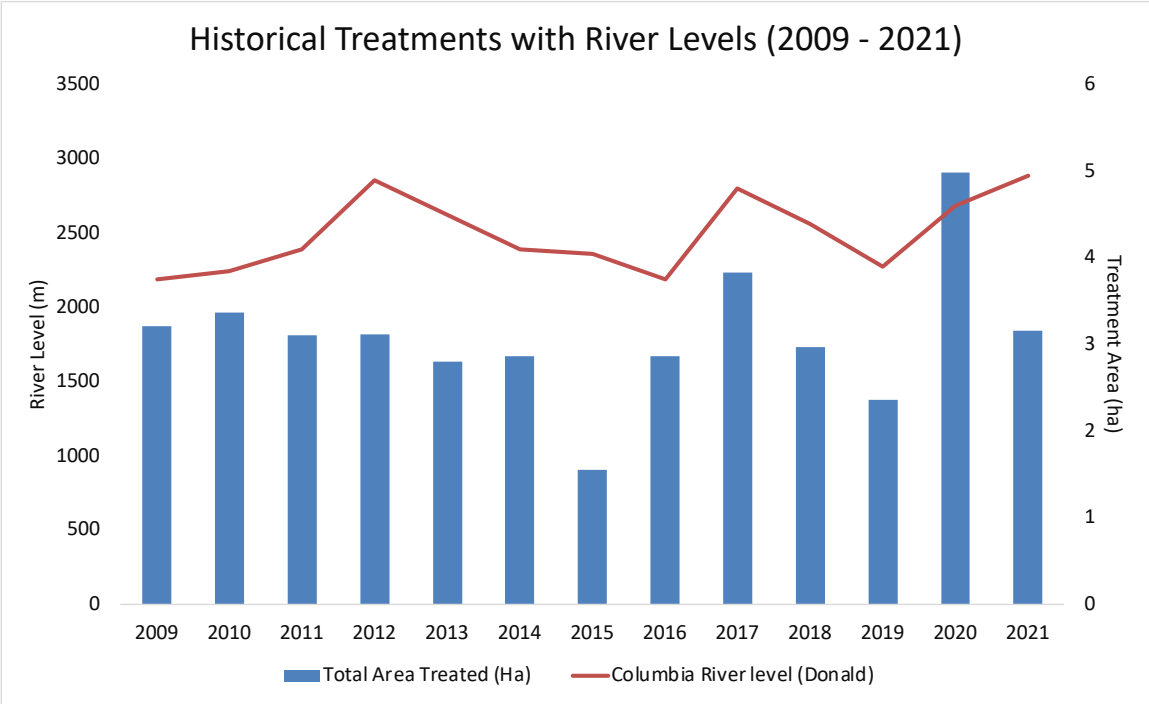

Figure 8. Columbia River levels (m; Donald gauge) with total mosquito development area treated aerially and by ground (ha) for 2009-2021. Note aerial treatments (ha) are recorded on the alternate y-axis.

Appendix II is a map depicting where and how frequently treatments took place in 2021. In certain cases, hexbins denoted as 'Non-Detected' or 'Low' do have treatments associated with them (Appendix II). In these cases, treatments may have been triggered by the larval activity of a representative site. Typically, sites that are difficult to access may be associated with representative sites. Historically, when representative sites become active the other sites in the area have proven to also be active. Thus, sites with a previous designation of 'Non-Detected' or 'Low' may require a later treatment due to representative sites' activity level without the need to sample. Appendix III shows associated tabular treatment information specific to site, treatment timing, and extent of treatment.

Adult Mosquito Trapping

Adult mosquito trapping was conducted at two locations, Kicking Horse Mountain Resort and Blaeberry, in 2021 to address the expressed concern regarding adult mosquito annoyance in those areas. The primary intention of the mosquito trapping efforts is to determine relative adult mosquito abundance, which serves as a quality assurance/quality control measure for larval mosquito control activities conducted by MBL technicians. Additionally, species composition data elucidates species present in the region, their

primary habitat, and contributes to the general knowledge bank of mosquito science in the region.

Adult mosquitoes were collected using battery operated Center for Disease Control (CDC) traps with dry ice as bait. A black light (night-operating only) and dry ice (i.e., CO_2) act to attract adult mosquitoes. A continuously working fan ensures that attracted mosquitoes are pulled into an attached basket. Basket contents were collected the following morning.

Adult traps were set-up in late-July. At each set-up, trap functions were assessed. Unfortunately, the Kicking Horse Mountain Resort trap accumulated a considerable amount of mould and Blaeberry trap malfunctioned part-way through the trap night. Mould is present when water gets into the collection bag. This may have occurred during the collection event.

Adult mosquito specimen identification was conducted using a 60X microscope. Mosquito identification was conducted by a trained professional using keys developed from Wood et al (1979) and Darsie and Ward (2005). A total of 111 adult mosquito specimens were collected from the two traps in 2021. One hundred were collected from the Kicking Horse Mountain Resort and 11 were collected from the Blaeberry trap. All adult mosquito specimens were *Aedes vexans*, a common floodwater mosquito found in the province.

The relatively high number of *Ae. vexans* detected at these locations confirms the presence of floodwater mosquito habitat likely near the valley bottom. Typically, adult mosquitoes begin to disperse 2-3 weeks after the spring peak in the regional Columbia River and Kicking Horse River levels. Depending on weather conditions (i.e., wind direction, wind velocity, ambient temperature, precipitation) the dispersal may be accelerated or decelerated. Because the regional rivers peaked in late June and early July, the traps were set-up at an appropriate time to capture dispersing adult mosquitoes from that flooding event. In a mark-recapture study conducted by Sudaric Bogojevic et al. (2011) results showed that *Ae. vexans* traveled from 0.95-7.7 km from the release point. The Kicking Horse Mountain Resort is about four kilometers (direct route) from the valley bottom, so adult mosquito annoyance at that time of year can be attributed to peak river level-associated dispersal. The Blaeberry adult mosquito trap site is also well-within this range.

Public Relations

Maintaining positive public relations remains a high priority for MBL. Public relations occur on several levels: in-person communication with members of the public, the mosquito hotline, presentations to staff and politicians, responding to e-mails, and continuing our social media presence. MBL continues to look for new areas to expand this aspect of our program and to improve our communication techniques.

Phone Calls and Emails

Area 'A'/Golden residents have multiple venues to lodge calls or emails with MBL. MBL has a company-maintained Mosquito Hotline (877-986-3363) and email form, outlined

prominently on the contact tab of the MBL website. Additionally, residents may interact with MBL staff through social media platforms. The total number of calls and emails received from Area 'A'/Golden residents in 2021 was seven (7). Of those, the total number of concern calls and emails received was five (5). Two calls were inquiry-based, with questions specific to mosquito habitat on private property or other areas of the program purview (Appendix IV). The total number of resident calls/emails was the same as was recorded in 2020. There was one more concern call documented in 2021 than in 2020. This was likely due to the additional floodwater mosquito habitat from the record-high Columbia River levels.

All concern calls and emails were received between 5 and 20 July (Appendix IV). This timeline coincides with 2-3 week delay in adult mosquito dispersal due to hatches associated with peak, or near-peak, regional Columbia River levels. The majority of calls were received from the Blaeberry area and Anderson Rd., northwest of Golden. These areas are heavily impacted by adult mosquitoes dispersing from habitat along the Columbia River. All calls were returned within 24 hours of receipt if a phone number was provided. All emails were responded to within the same timeframe. Often, follow-up visits were also made to residents.

Direct Communications

Direct communication between MBL staff and the public can occur in many situations. The most common direct interfacing with the public occurs when technicians are in the field. While conducting site visits, MBL technicians are often asked questions by landowners or residents. These encounters provide an excellent opportunity for public relations. An important outcome of these interactions can be the identification of new sites.

Image 2. MBL education outreach pamphlet.

MBL contact information is disseminated when field technicians have direct communication with the public. Contact information for MBL includes the website address, an email, phone number, and social media sites (Twitter, Facebook). Additionally, MBL staff may provide residents with an outreach pamphlet (Image 2). The pamphlet includes information about the larval control product used, mosquito biology, and personal protective tips.

Social Media

MBL maintains a presence on social media with a Facebook account (facebook.com/MorrowMosquito), Twitter account (@MorrowMosquito), and Instagram account (linked to Facebook) which are regularly updated. There are five goals for MBL's social media presence: 1) provide timely and up-to-date information regarding conditions pertinent to mosquito production, 2) relay MBL's current efforts to control mosquitoes, 3) inform the public about MBL's efforts at environmental sustainability, 4) provide the community with opportunities to get involved with related public events, and 5) offer a platform for mosquito-related discussion amongst program residents and the MBL team. The number of MBL social media site followers increases annually.

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MBL Website

The MBL website (**www.morrowbioscience.com**) was launched in 2015 and redesigned in 2021 (Image 3). This site was developed to allow clients and the public to have access to information about MBL's background, activities, outreach, and company. To further support residents in contract areas, the homepage includes visible tabs for resources and the contact information. The 'Contact' tab allows users to directly send a message to MBL. Additionally, there are links to MBL's Facebook account and Twitter feed, so residents have access to real-time updates on MBL's activities.

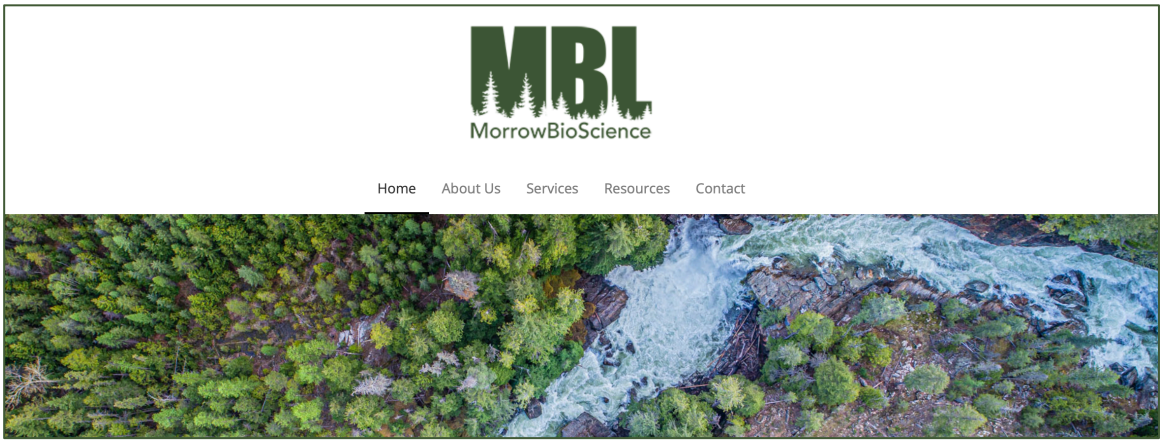

Image 3. Morrow BioScience Ltd. new homepage (www.morrowbioscience.com; April 2021)

Education Outreach

Given the continued provincial restrictions regarding large gatherings to reduce the spread of COVID-19, MBL relied on previously created virtually-available education outreach material instead of attending public events. As such, the MBL website (www.morrowbioscience.com) has highlighted two sets of FAQ documents focused on (1) mosquito biology and disease transmission and (2) the active ingredient used in control efforts (*Bacillus thuringiensis* var. *israelensis*). Both FAQ documents were provided to the CSRD program manager in April. Additionally, a blog dedicated specifically to mosquitoes and COVID-19 was published on the MBL website.

A media release was generated and approved by the CSRD program manager for distribution to 104.3 EZ (Bell Media) on 7 June. The station has coverage in the Golden and Electoral Area A purview. An off-air interview was conducted with MBL staff and the DJ. The DJ committed to airing the details of the press release on air within the week of 7 June. Future public engagement should be expanded to include local print news media.

West Nile virus Summary

Although floodwater mosquito species in Canada are not the main West Nile virus (WNv) vectors, it is important to remain current in regional mosquito-related diseases. Along with their partners, Health Canada compiles on-going provincially reported surveillance data of WNv cases in humans, animals, and mosquito pools between 1 January and 29 September. As of 12 October, no human case of WNv were reported to Health Canada from British Columbia[12]. Similarly, no horse or bird cases were reported from British Columbia within 2021. Of note, mosquito pool surveillance data are not reported to Health Canada from British Columbia and it is possible that other information was not reported by the BCCDC to Health Canada.

As Washington State and Idaho State share a border with British Columbia, it is important to follow WNv activity in those areas, as well. As of 17 October, there were three human cases of WNv reported in Washington State; all were acquired in-state within counties in the southern area of the state[13]. Additionally, 51 mosquito pools and 11 horses/other mammals tested positive for WNv. No birds tested positive for WNv in 2021. Of note, historically high temperatures experienced throughout the Pacific Northwest from June through August contributed to a greater number of degree days and translated to an increase in state-wide WNv activity.

As of 17 October, 11 human WNv cases were identified in Idaho[14]. Additionally, multiple mosquito pools and animals tested positive for WNv. All cases were identified within counties in the southern and southwestern portion of Idaho.

Zika Virus Summary

No information regarding Canadian Zika cases has been reported by the Public Health Agency of Canada for 2021. HealthLinkBC reports that no Zika cases have originated in Canada due to presumed lack of vector mosquito species[15]. There have been human Zika cases reported in Canada prior to 2021, although those were determined to have been acquired while traveling.

According to Peach (2018), the primary Zika mosquito vectors (i.e., *Aedes aegypti*, *Ae. albopictus*) are not found in British Columbia. *Ae. albopictus* has been found on east coast, but tested negative for Zika. There is currently a low risk for Zika virus to circulate within British Columbia.

[12] https://www.canada.ca/en/public-health/services/publications/diseases-conditions/west-nile-virus-surveillance/2021/week-37-38-september-13-26.html
[13] http://www.doh.wa.gov/DataandStatisticalReports/DiseasesandChronicConditions/WestNileVirus
[14] https://www.cdc.gov/westnile/statsmaps/preliminarymapsdata2021/index.html
[15] https://www.healthlinkbc.ca/health-feature/zika-virus

2022 Program Recommendations

A number of important issues must be addressed at the start of each season:

- Continued reconnaissance efforts should take place within the Blaeberry region and the area northwest of Golden within the City limits (i.e., Anderson Rd. area).

- Future adult trapping efforts should be conducted during forecasted periods of no rain and low wind to reduce mould challenges with specimens and to improve capture rates.

- If provincially restricted due to gathering size potential, education outreach efforts should continue to include providing media releases to local radio stations and print news outlets.

- A program expansion to the north of the current purview may help address mosquito abundance issues associated with higher regional river levels (Blaeberry region, Kicking Horse Mountain Resort area).

- Notify the Ministry of Environment of the CSRD intent to treat mosquitoes in 2022 under the CSRD Pest Management Plan. Notification should take place 2 months before the start of the season (the end of February, at the latest).

- It is important to attach copies of all the mosquito development site maps with the Notice of Intent to Treat (NIT). NOTE: all sites have been re-mapped. This new data should be used to reprint maps for the purposes described above.

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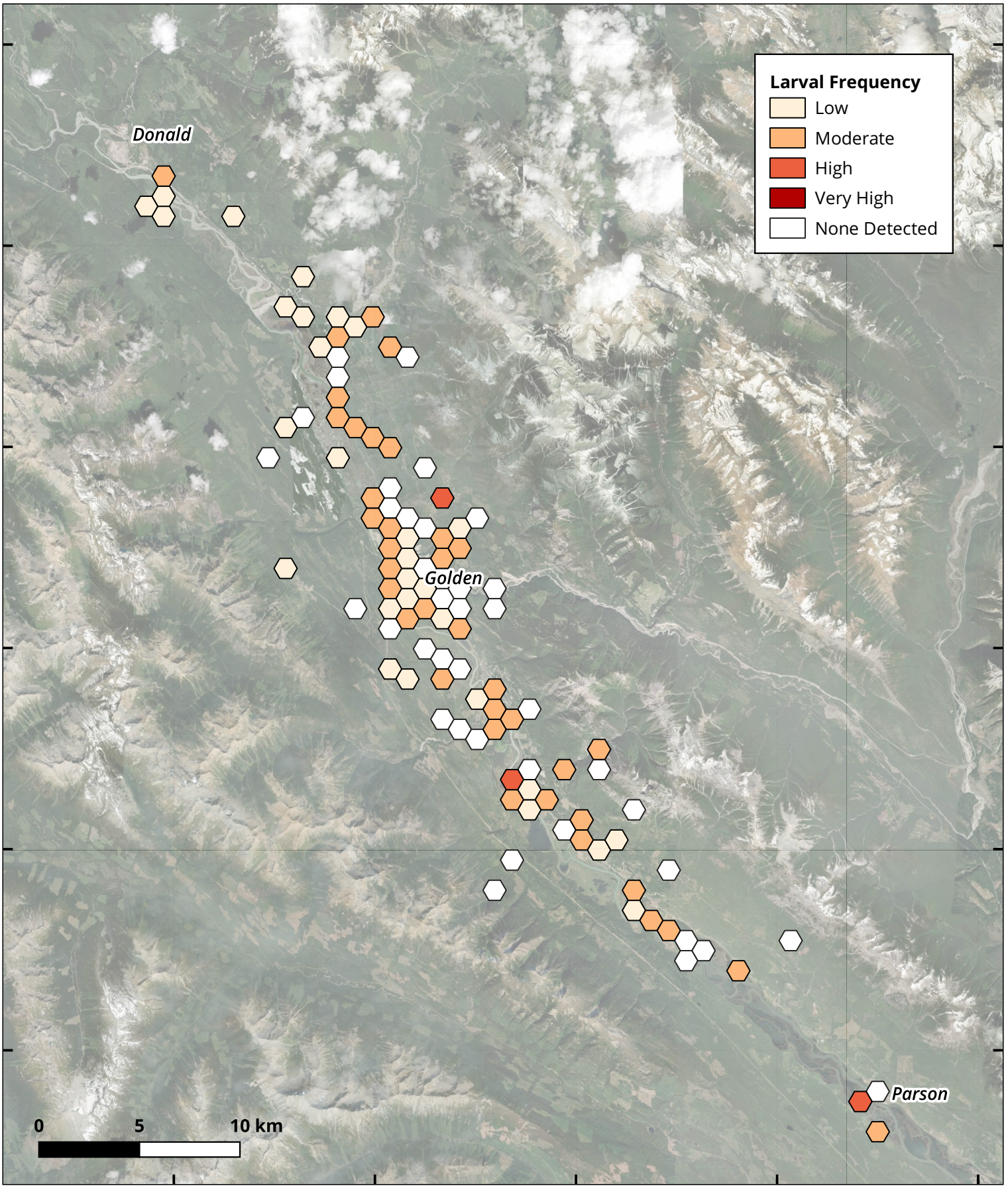
2021 Mosquito Larval Frequencies at Sample Locations

Appendix I-A

Morrow BioScience Ltd
PO Box 1013 Rossland, BC V0G 1Y0
gis@morrowbioscience.com 1(877)986-3363

Scale = 1 : 250,000 CRS = NAD83 UTM Zone 11N



2021 Mosquito Larvicide Treatments

Appendix II

Morrow BioScience Ltd
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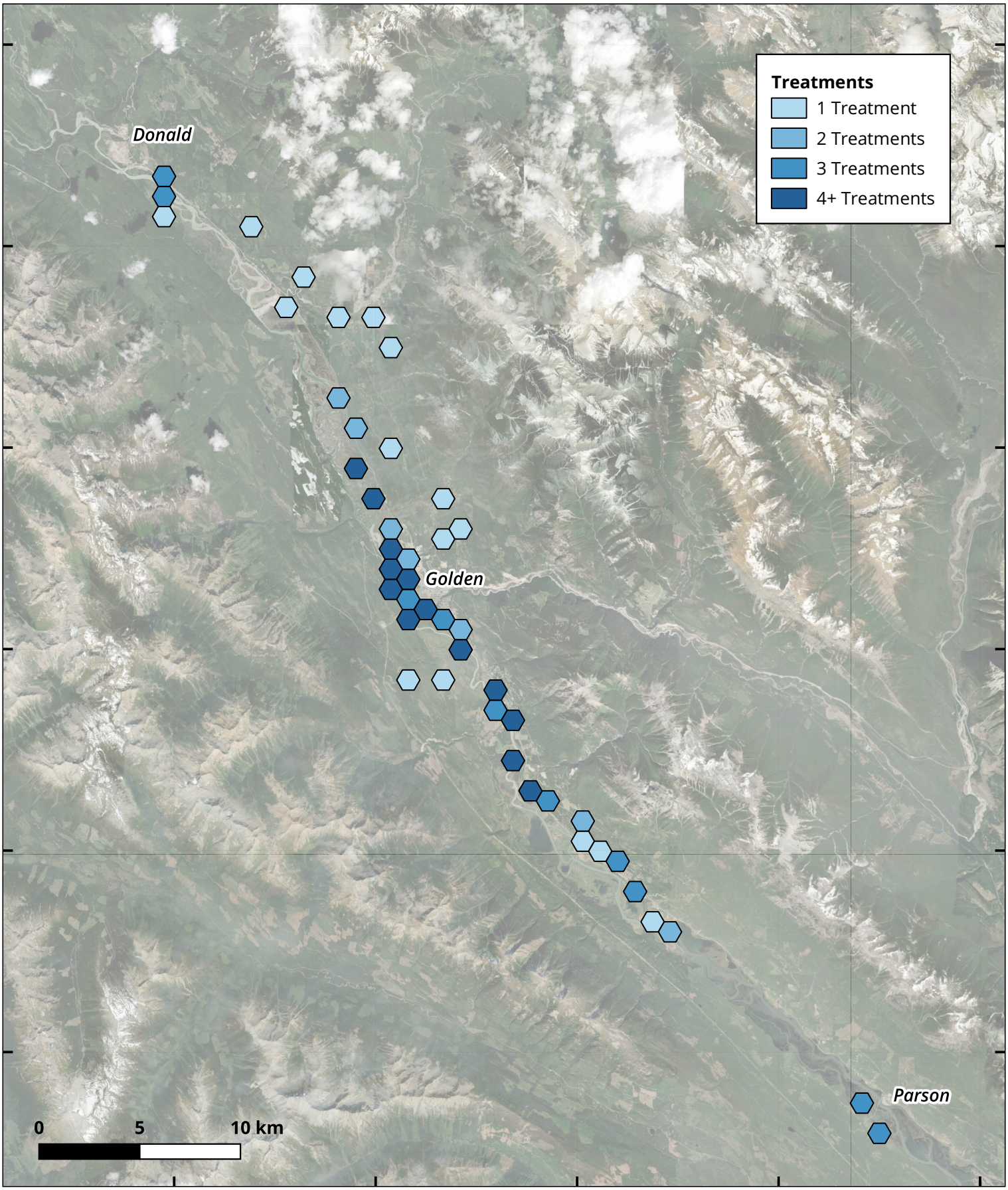
Scale = 1 : 250,000 CRS = NAD83 UTM Zone 11N



Appendix III - 2021 Area 'A'/Golden mosquito larvicide treatment data (kg, ha) by site and date for all ground (A) and aerial (B) treatments

III-A: Ground Treatments

Treatment Date	Site Code	Site Name	Treatment Amt (Kg)	Treatment Area (Ha)
2021-04-21	CSRD-096	2601 Highway 1	4.55	1.14
2021-04-21	CSRD-095	Donald Scale Ditches	6.83	1.71
2021-04-21	CSRD-024	Highway Grey Water Pond	2.28	0.57
2021-04-21	CSRD-019	Donald Slough	4.55	1.14
2021-04-22	CSRD-124	Clear Cut Stream	9.10	2.28
2021-04-22	CSRD-051	Appleton Slough Lafontain Road (#1)	4.55	1.14
2021-04-26	CSRD-089	841 Barber Road	2.28	0.57
2021-04-26	CSRD-125	1524 Campbell Road	2.28	0.57
2021-04-26	CSRD-102	Gun Range Ditches	4.55	1.14
2021-04-26	CSRD-043	Buffalo Ranch	2.28	0.57
2021-04-26	CSRD-094	1568 Campbell Road	9.10	2.28
2021-04-26	CSRD-090	1659 Oberg Johnson Road	2.28	0.57
2021-04-27	CSRD-105	WABS (owned by 2369 Upper Donald)	4.55	1.14
2021-04-27	CSRD-077	1087 Upper Donald Road	9.10	2.28
2021-04-28	CSRD-011	Sanders Lake Campground	4.55	1.14
2021-05-03	CSRD-034	Al's Slough (#3)	9.10	2.28
2021-05-03	CSRD-022	Wiseman Slough (#2)	4.55	1.14
2021-05-03	CSRD-093	1680 Moberly School Road	4.55	1.14
2021-05-03	CSRD-033	Al's Slough (#2)	4.55	1.14
2021-05-05	CSRD-060	1810 Schiesser Road	9.10	2.28
2021-05-10	CSRD-048	Cedar Lake (South End)	4.55	1.14
2021-05-10	CSRD-149	2397 Forde Station Rd.	4.55	1.14
2021-05-21	CSRD-137	Mitchell Road wetlands	9.10	2.28
2021-05-27	CSRD-107	Kicking Horse Seepage	1.14	0.28
2021-05-27	CSRD-065	Confluence Park	3.41	0.85
2021-05-27	CSRD-004	LP swamp	4.55	1.14
2021-05-27	CSRD-005	Golf Course (#1)	4.55	1.14
2021-06-01	CSRD-046	Nicholson Wetlands	9.10	2.28
2021-06-01	CSRD-031	Nicholson Boat Launch	4.55	1.14
2021-06-01	CSRD-085	Habart Wetlands	4.55	1.14
2021-06-02	CSRD-046	Nicholson Wetlands	4.55	1.14
2021-06-02	CSRD-010	Race Track	1.14	0.28
2021-06-02	CSRD-004	LP swamp	2.28	0.57
2021-06-02	CSRD-001	Reflection Lake (North)	2.28	0.57
2021-06-02	CSRD-107	Kicking Horse Seepage	1.14	0.28
2021-06-02	CSRD-003	Old Mill	2.28	0.57
2021-06-02	CSRD-065	Confluence Park	2.28	0.57
2021-06-08		Airport ditch	4.55	1.14
2021-06-08	CSRD-084	Watson Farm	9.10	2.28
2021-06-08	CSRD-067	Columbia Wetlands North (#3)	4.55	1.14
2021-06-08	CSRD-075	Rotary Trails	2.28	0.57
2021-06-08	CSRD-107	Kicking Horse Seepage	2.28	0.57
2021-06-08	CSRD-010	Race Track	13.65	3.41
2021-06-08	CSRD-004	LP swamp	4.55	1.14

Appendix III - 2021 Area 'A'/Golden mosquito larvicide treatment data (kg, ha) by site and date for all ground (A) and aerial (B) treatments

Treatment Date	Site Code	Site Name	Treatment Amt (Kg)	Treatment Area (Ha)
2021-06-08	CSRD-064	Airport Runway	4.55	1.14
2021-06-09	CSRD-074	Airport South End	4.55	1.14
2021-06-10	CSRD-110	Parson Wetlands W #2,3806 Thomas Rd	2.28	0.57
2021-06-10		Cow fields	6.83	1.71
2021-06-10	CSRD-061	Anderson Road Slough	4.55	1.14
2021-06-10	CSRD-005	Golf Course (#1)	4.55	1.14
2021-06-14	CSRD-111	Parson Wetland W #3, 3776 Sanborn Rd	4.55	1.14
2021-06-14	CSRD-028	Parson RV Park	9.10	2.28
2021-06-14	CSRD-137	Mitchell Road wetlands	4.55	1.14
2021-06-14	CSRD-003	Old Mill	4.55	1.14
2021-06-15	CSRD-045	Eco Adventure Ranch	9.10	2.28
2021-06-21	CSRD-075	Rotary Trails	2.28	0.57
2021-06-21	CSRD-107	Kicking Horse Seepage	1.14	0.28
2021-06-21		Airport ditch	1.14	0.28
2021-06-23	CSRD-110	Parson Wetlands W #2,3806 Thomas Rd	2.28	0.57
2021-06-23	CSRD-111	Parson Wetland W #3, 3776 Sanborn Rd	6.83	1.71
2021-06-23	CSRD-028	Parson RV Park	9.10	2.28
2021-06-23	CSRD-138	CP ditch	4.55	1.14
2021-06-23	CSRD-076	15th Street Swamp forest	4.55	1.14
2021-06-25	CSRD-064	Airport Runway	1.14	0.28
2021-06-25	CSRD-075	Rotary Trails	3.41	0.85
2021-06-28	CSRD-075	Rotary Trails	9.10	2.28
2021-06-28	CSRD-005	Golf Course (#1)	4.55	1.14
2021-06-30	CSRD-138	CP ditch	9.10	2.28
2021-07-01	CSRD-110	Parson Wetlands W #2,3806 Thomas Rd	2.28	0.57
2021-07-01	CSRD-111	Parson Wetland W #3, 3776 Sanborn Rd	9.10	2.28
2021-07-01	CSRD-045	Eco Adventure Ranch	4.55	1.14
2021-07-05	CSRD-045	Eco Adventure Ranch	4.55	1.14

Appendix III - 2021 Area 'A'/Golden mosquito larvicide treatment data (kg, ha) by site and date for all ground (A) and aerial (B) treatments

III-B: Aerial Treatments

Treatment Date	Sites	Amount Treated (Kg)	Area Treated (Ha)
2021-05-04	Reflection Lake (North),Reflection Lake (South),Nicholson Wetlands,Palumbo Heights Swamp,1816 Campbell Road,Mirage swamp,Hidden swamp,Columbia Wetlands S (#6)	728.00	182.00
2021-06-11	Columbia Wetlands North (#1),Watson Farm,Columbia Wetlands North (#3),LP swamp,Confluence Park,Old Mill,Columbia Wetlands Golden,Habart Wetlands,Nicholson Wetlands,Eco Adventure Ranch,Nicholson Boat Launch,Columbia Wetlands South (#6),Horse Creek North ,Horse Creek Wetlands (south end),Low Lying Forest 2,Old farm (highway 1)	3640.00	606.67
2021-06-24	Low Lying Forest 2,Golf Course (#1),Columbia Wetlands North (#1),Watson Farm,Columbia Wetlands North (#3),LP swamp,Airport Runway,Confluence Park,Old Mill,Columbia Wetlands Golden,Habart Wetlands,Nicholson Wetlands,Eco Adventure Ranch,Nicholson Boat Launch,Columbia Wetlands South (#6),Horse Creek North	2912.00	485.33
2021-06-30	Columbia Wetlands N (#1),Watson Farm,Columbia Wetlands N (#3),Confluence Park,Airport Runway,Airport S End,Old Mill,15th Street Swamp forest,Habart Wetlands,Nicholson Wetlands,Eco Adventure Ranch,Nicholson Boat Launch,Columbia Wetlands South (#6),Horse Creek North ,Horse Creek Wetlands (south end),Mitchell Road wetlands,Parson RV Park,Columbia Wetlands Golden,Rotary Trails,Airport ditch	1456.00	242.67
2021-07-07	Golf Course (#1),Columbia Wetlands N (#1),Watson Farm,Columbia Wetlands N (#3),LP swamp,Confluence Park,Airport Runway,Rotary Trails,Airport S End,Old Mill,15th Street Swamp forest,Reflection Lake (N),Reflection Lake (S),Habart Wetlands,Nicholson Wetlands,Eco Adventure Ranch,Nicholson Boat Launch,Columbia Wetlands S(#6),Horse Creek N ,Horse Creek Wetlands (S end)	1456.00	242.67

Appendix IV – 2021 Area 'A'/Golden Mosquito Hotline call and email summary

Date	Resident Comments	Designation	Action Taken
7-20-2021	Wondering when the mosquitoes will get better	Concern	Return call
5-4-2021	Has a pond and is now noticing mosquitoes in there. Can we stop by.	Inquiry	Return call, site visit
5-14-2021	Question about mosquito habitat in Blaeberry	Inquiry	Return call
7-5-2021	Mosquitoes are bad along Anderson Rd.	Concern	Return call
7-5-2021	Mosquitoes are bad along Anderson Rd.	Concern	Return call, site visit
7-15-2021	Mosquitoes are bad in north Blaeberry	Concern	Return call, return email
7-15-2021	Mosquitoes are bad in Blueberry	Concern	Return call