# *Regional District of East Kootenay, Mosquito Control Program for Wasa/Ta Ta Creek/Skookumchuck*
# 2018 Final Report

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## Executive Summary

The 2018 season is the 21st season that Morrow BioScience Ltd. (MBL) has conducted floodwater mosquito control operations for Wasa/Ta Ta Creek/Skookumchuck within the Regional District of East Kootenay (RDEK); 2018 also marks the 2nd year of a 5-year contract to conduct mosquito control for the area. Continuing efforts include the identification of new mosquito development sites at varying regional water levels and increasing public engagement opportunities.

In 2018, heat maps were again created based on mosquito larval Aquabac® treatment data gathered using MBL's new real-time data collection system. Additionally, a client-accessible dashboard was supplied to the RDEK program manager to quickly summarize up-to-date monitoring and treatment data in a convenient screen shot. The maps provide another tool for field managers and technicians to use when determining areas within which to increase larval mosquito operations in the future. As well, it enables managers from both entities (RDEK, MBL) to provide quick answers to residential questions regarding treatment efforts.

The 2018 season began with a higher-than-average snowpack in all three of the snow survey stations associated with East Kootenay basin. Snow accumulated in basins affecting the Kootenay River near Wasa/Ta Ta Creek/Skookumchuck through April. The freshet began in late-May with a regional spike in ambient temperatures, which brought out a considerable amount of low and mid-elevation snow. The ambient temperature spike in early May brought out the rest of the mid-elevation snow along with some high-elevation snow. The early May spike in temperature lead to the peak in the Kootenay River in Fort Steele on 18 May (4.195 m). Moderate precipitation (rain) in June may have augmented regional River levels and slightly prolonged seepage sites presence beyond normal.

Ground treatments started on 18 May. All ground treatments took place in May and June; the final ground treatment took place on 12 June. Two aerial treatments were required to treat sites that became active concurrently and were challenging/unsafe to access by ground. Aerial treatments took place on 21 May and 1 June. The extent of each mosquito development site was considerably larger than normal, thus requiring more-than-average treatments and amounts.

The total ground treatments amounted to about 239 ha (i.e. 956 kg) and the total aerial treatments amounted to approximately 1,605 ha (i.e. 9,628 kg). All new and existing sites were successfully treated in 2018 and post-treatment efficacy assessments revealed high control rates.

MBL regularly updates our Facebook and Twitter accounts to reflect up-to-date mosquito and treatment related information for MBL's contract areas. To provide residents with a

further avenue of contact, MBL has a toll-free Mosquito Hotline (888-733-2333) that is checked daily during the mosquito season. No calls or emails were received by the Mosquito Hotline or through the contact option on the MBL website for the Wasa/Ta Ta Creek/Skookumchuck area. MBL participated in a town hall meeting with the RDEK at the Wasa Community Hall on 18 June. MBL staff shared information pertaining specifically to the mosquito abatement program and addressed any questions. The meeting was well-attended.

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***Cover photo credits***
*Main photo: Mosquito development site near Wasa during the freshet (2018, Logan Harris)*

## Introduction

Morrow BioScience Ltd. (MBL) became the mosquito control contractor for the Wasa/Ta Ta Creek/Skookumchuck area within the Regional District of East Kootenay (RDEK) in 1997. Since 1997, MBL field technicians have gained a strong knowledge of mosquito development site locations and hatch timing within low and high-water years. Throughout the last two decades, the trending reduction in floodwater mosquito annoyance is due, in large part, to the thorough monitoring and timely treatments conducted by MBL field technicians. The contract was renewed for another five (5) years in 2017.

MBL's primary objective is to reduce floodwater mosquito nuisance within the contract areas. Integrated Pest Management (IPM) principles are a pillar of MBL's corporate philosophy and mosquito management strategy. Ultimately, the success of this program incorporates effective floodwater mosquito control program coupled with maintaining a low environmental impact for all field activities. MBL employs a regular site-monitoring regime, allowing for accurate and effective ground treatments, with a reduced dependence on aerial treatments, thus reducing the environmental impact of treatment activities. The success of this program is further supported by the fact that site visits can occur with little notice, since MBL's long-time field manager resides in Cranbrook.

MBL acknowledges that input from Wasa/Ta Ta Creek/Skookumchuck community members improves the possibility of locating standing water in hard-to-access locations or on private property. Local residents also update MBL technicians of any considerable land management alterations which may impact mosquito development sites well before the season begins. In this way, MBL technicians have developed and maintained close community ties throughout the contract tenure(s). Community involvement and a dedication to strict IPM techniques are essential to achieving the goal of reduced floodwater mosquito annoyance while remaining environmentally conscious.

## Program Development

Despite more than two decades that MBL has conducted mosquito abatement activities in Wasa/Ta Ta Creek/Skookumchuck, new sites are continuously verified and digitally mapped. New discoveries are due to flooding and increased local precipitation considerably augmenting known mosquito development sites and creating additional habitat. Electronic data files based on the GPS waypoints have been supplied to the RDEK.

In 2018, MBL further improved the mosquito control program by refining the real-time online data collection and management portal tested in 2017. This tool allowed field technicians to update mosquito development site profiles, add larval/adult abundance data, update treatment information, take relevant photos, and create a daily site monitoring strategy in real-time. Program managers within MBL and the RDEK were also

able to view detailed maps of the area and all associated data in real-time. The online portal provided assurance to RDEK management that sites were treated appropriately. Additionally, the portal allowed for timely responses to residential questions regarding treatments in their area.

## Significant Regional Environmental Conditions

### Snowpack

Snowpack in basins influential to the Kootenay River near Wasa/Ta Ta Creek/Skookumchuck is an important environmental variable to track, as it can reveal how severe the freshet may be at varying points in the season. Following the real-time snowpack levels will also indicate when the freshet has ended. As the freshet is the primary factor affecting floodwater mosquito development, it is a benefit to the overall success of the program to understand the snowpack and freshet variations throughout the season.

Snow survey stations take continuous snowpack measurements and the results are reported in real-time[1]. Snow basin indices are then calculated from those measurements. In addition to these indices, 'percent of normal' calculations are also made. Specifically, when snow pack depths are measured, their heights are then compared to 'normal' heights (from comparable dates in previous seasons), revealing what 'percent of normal' the current levels are. These indices can aid field technicians in preparing for the freshet.

The main basin that influences the Kootenay River freshets in the Wasa/Ta Ta Creek/Skookumchuck area is the East Kootenay basin (Figure 1). The snowpack in the East Kootenay Basin was reported to be at 150% [2] immediately preceding the start of the 2018 mosquito monitoring season. In comparison to 2017, he snowpack in 2018 was 13% higher than at the same time in 2017, another considerably high-water year. In April, unstable weather systems contributed large amounts of snow to high-elevation snow gauge stations.

[1] http://bcrfc.env.gov.bc.ca/data/asp/realtime/index.htm

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

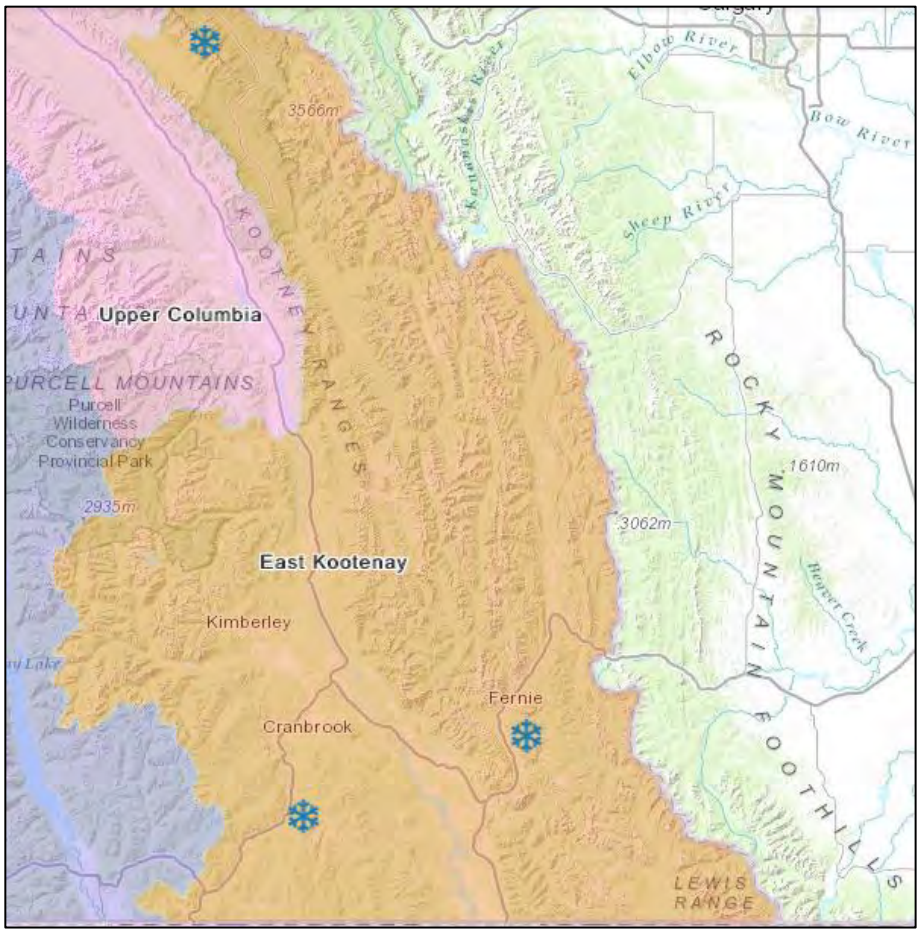


**Figure 1. East Kootenay snow basin (orange). Snow survey stations are denoted by a snowflake symbol.**

More specifically, the Snow Water Equivalent (SWE) from the three snow survey stations within the East Kootenay basin can provide a closer look at when, exactly, the snow was depleted from those stations[3]. The northern-most snow survey station within the Basin (i.e. Floe Lake) was completely depleted of snow by late June (Figure 1). The two southern-most snow survey stations (i.e. Moyie Mountain and Morrissey Ridge) are at lower elevations and, as such, were depleted of snow by late May[4]. Given the depletion of SWE in the region's high-elevation snow stations between May and June, it is reasonable to assume that the contribution of the freshet to the regional Kootenay River levels was insignificant by the early July. Also of interest is that the peak snowpack at all three snow stations exceeded the 75$^{th}$ percentile of historical data.

## Ambient Temperature Records

Regional Kootenay River levels can be indirectly affected by ambient temperature spikes occurring in snow basins associated with these river systems in the early part of the mosquito season (i.e., April – June). When ambient temperatures spike, snowmelt comes

[3] http://bcrfc.env.gov.bc.ca/data/asp/realtime/index.htm

down through the regional Kootenay River, increasing levels, and creating floodwater mosquito development sites. These events cause the ground along the Kootenay River edges to be wetted. The ground immediately adjacent to these Rivers contains floodwater mosquito eggs. These eggs remain dormant until ideal hatching conditions are present, which include water, low dissolved oxygen levels, and sufficiently high ambient temperatures. Typically, hatching conditions present themselves within the month of May.

**Image 1. Seepage site near Skookumchuck, BC (2018).**

Ambient temperatures more strongly influence sites that are shallow, relatively stagnant, and land-locked. Most the mosquito development sites within Wasa/ Ta Ta Creek /Skookumchuck monitored by MBL technicians are shallow and relatively stagnant (Image 1). Thus, as the ambient temperatures begin to rise, water temperature more quickly reflects ambient temperatures, creating an ideal environment for mosquito development. Larvae develop slower in cool water and much faster in warm water. In fact, in a laboratory study performed by Mohammad and Chadee (2011), *Aedes* mosquito eggs (i.e., floodwater mosquito eggs) were subjected to 35 °C conditions. Under this temperature, optimal feeding, and optimal spatial distribution conditions it took as little as six (6) days for first instar larvae to emerge as adults.

When comparing the previous three mosquito seasons (i.e. 2015-2017), the maximum

ambient temperature data in 2018 are generally similar (Figure 1). However, in April of 2018 ambient temperatures appeared to be lower. This trend is consistent with the BC River Forecast Centre's 1 May report[4] stating that temperatures were 1°C – 2°C below normal for most of southern BC in April. Ambient temperatures in much of southern BC began to increase consistently in late April (Figure 2). Accordingly, notable snowmelt began to occur at the same time, creating high regional River levels (see 'Regional Kootenay River Levels' section). The temperature spikes from late April through early May, which were experienced throughout the southern portion of the province, led to the peak in regional Kootenay River levels in mid-May. In comparison to other, recent high-water years, the ambient temperature trend for 2018 appears to be well within the normal bounds, despite the slow start (Figure 2).

Higher ambient temperatures in July and August can also create localized annoyance due to container mosquito emergence and dispersal. Container mosquito habitats near residential homes can be continually created throughout the summer due to local watering practices or not removing standing water. MBL field technicians regularly inform residents that adult container-bred mosquitoes can be greatly reduced around their homes by ensuring potential container mosquito environments are either free of water or refreshed frequently.

[4] http://bcrfc.env.gov.bc.ca/bulletins/watersupply/archive/2017/2017_May1.pdf

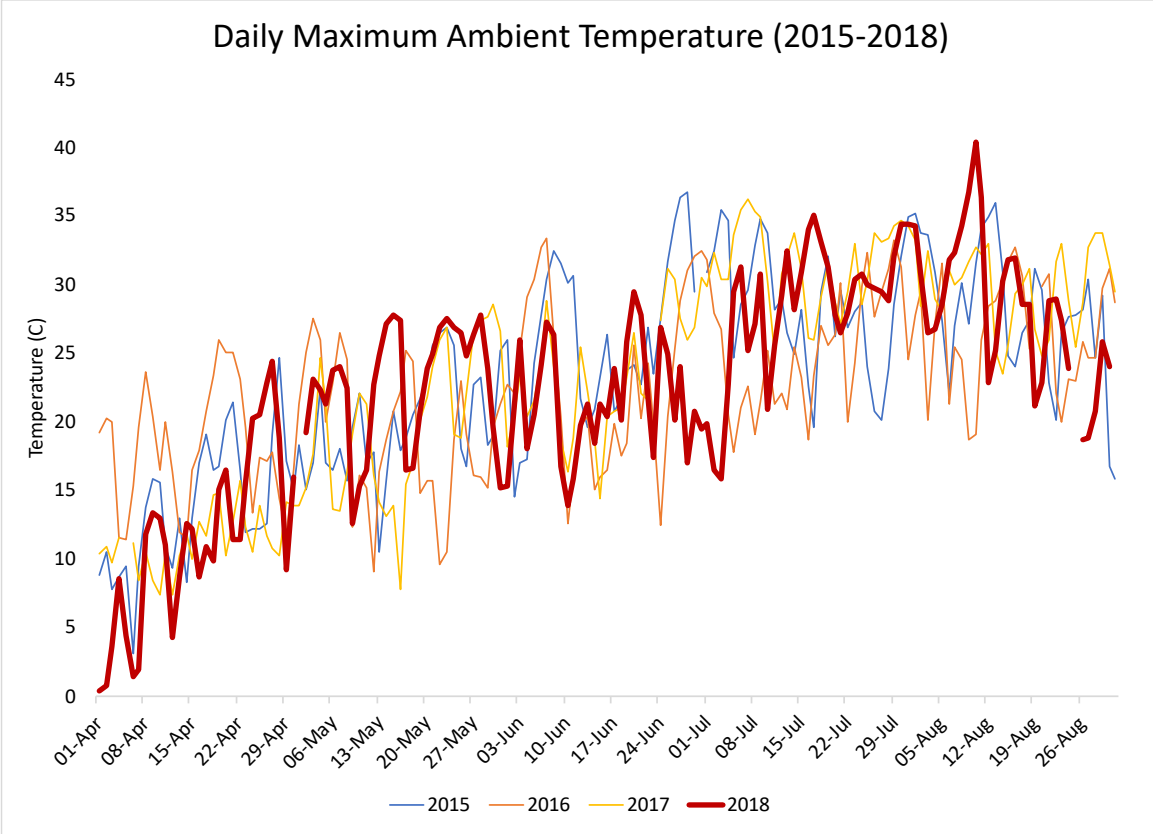


**Figure 2. Maximum daily temperature (°C) as recorded at the Cranbrook Airport, BC (Climate ID: 1152105) between 1 April – 31 August, 2015-2018. Gaps in the data represent days wherein the monitoring station was not functioning properly.**

## Precipitation

While not the major contributor to overall river levels in the local Kootenay River, precipitation can impact levels when the ground is saturated in influential basins or when considerable precipitation is received during the peak of the freshet. It can also affect certain sites that are not necessarily associated with the River, but that are fed by snowmelt. If a large amount of rain occurs on top of snowmelt, the rain rolls off the snowmelt and can pool in areas where mosquito development takes place.

There was a moderate amount precipitation accumulation throughout the 2018 mosquito season (i.e. April – August; Figure 3). Of the months monitored, the greatest amount of precipitation accumulation was received in June (Figure 3; 58.6 mm). The maximum precipitation for the season was received during a timeframe wherein the local Kootenay River levels were still elevated. Thus, it is unlikely that precipitation in June amplified mosquito development habitat associated with the regional Kootenay River and maintained seepage sites beyond the normal timeframe.

It is also possible that container mosquito sites may have been created due to the rain. Container mosquito species (e.g. *Culex* spp.) require sites that have stagnant, warm water

for breeding and maturation. Specific sites include flat roofs, rain gutters, old tires, tree holes, birdbaths, and rain barrels, to name a few. It is possible that container mosquitoes emerged from localized sites and were a nuisance to residents into August. While MBL's mandate does not include controlling container mosquitoes, field staff help concerned residents reduce potential container mosquito breeding sites on their property by advising them to remove or replace standing water regularly.

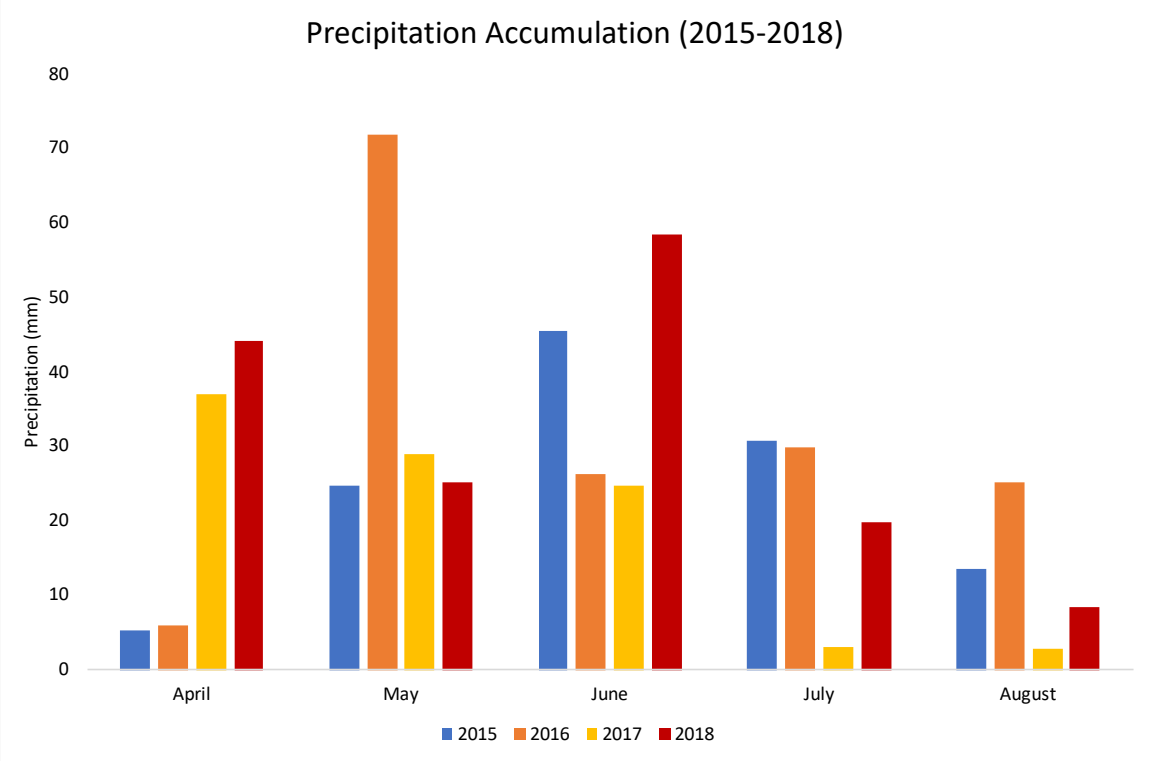


**Figure 3. Monthly total precipitation accumulation (mm) as recorded at the Cranbrook Airport, BC (Climate ID: 1152105) between 1 April – 31 August, 2015-2018.**

## Regional Kootenay River Levels

The Kootenay River at Fort Steele primarily affects the floodwater mosquito abundance in the area around Wasa/Ta Ta Creek/Skookumchuck. The water levels of that river system are governed by two main influences: 1) local snowmelt and 2) the freshet from the East Kootenay snow basin. Frequent and large amounts of precipitation can also affect River levels, though typically to a lesser degree than the primary factors listed above.

A spike in regional ambient temperatures in late April melted snow at low and mid-elevations, resulting in a rise in regional Kootenay River levels (Figure 4). A second spike in ambient temperatures in early May led to the melting of residual mid-elevation snow and some high-elevation snow. This second large regional snowmelt gave resulted in peak local Kootenay River levels in mid-June (Figure 4). Specifically, the Kootenay River at Fort Steel peaked on 18 May at 4.195 m (Figure 4). Because the peak in the regional river occurred at a relatively warm time of the mosquito season, environmental cues were

present for successful mosquito larval development, requiring treatments that started in May (see 'Larval Treatment' section).

The peak regional River level in 2018 was essentially the same as that recorded in 2017 – another considerably high-water year (Figure 4). The peak in the Kootenay River in recent seasons is important to note because larval mosquito abundance can be, in part, predicted by the regional rivers' peaks relative to recent seasons. Since the 2018 Kootenay River peak was essentially the same as that recorded in 2017, it is unlikely that any dormant mosquito eggs were triggered to hatch because 2017 flooding had presumably triggered those to hatch. This is in stark comparison to last year, 2017, when the Kootenay River peak far exceeded those of 2015 and 2016. In that case, mosquito eggs that were laid above those peak levels in 2015 and 2016 likely remained dormant until 2017 floods triggered their hatching, resulting in a compound mosquito hatch. Thus, given similar peak River levels between 2018 and the preceding season, the mosquito hatch was markedly less than in 2017.

After the Kootenay River at Fort Steele peaked in mid-May, regional river levels rose to another sub-peak, creating a bi-modal appearance to seasonal River levels (Figure 4). Following the second peak, Kootenay River levels slowly receded. By mid-June, regional River levels had decreased enough to reduce the need for mosquito larval treatment. By that time, many of the known seepage and foreshores sites related to the regional Kootenay River were dry or had been successfully treated.

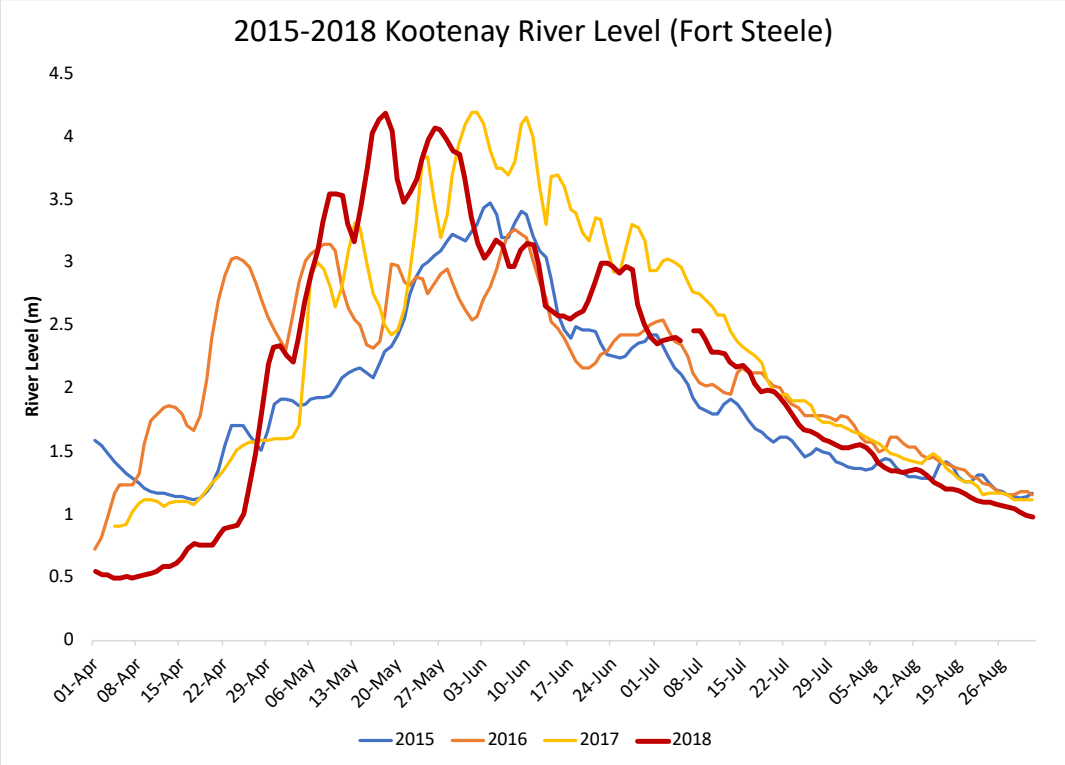


**Figure 4. 2015-2018 Kootenay River levels (m), 1 April – 31 August. Kootenay River measurements were taken from the 'Kootenay River at Fort Steele' station.**

## Monitoring Methodology

*Aedes. vexans* and *A. sticticus* mosquitoes are the most common floodwater nuisance mosquitoes within Wasa/Ta Ta Creek/Skookumchuck. As opposed to other mosquitoes (i.e., some *Culex*, *Culisetta, Anopholes spp.*), floodwater mosquitoes lay their eggs on damp substrate in areas with a high flooding potential; they are often called 'floodwater' mosquitoes for this very reason. If the water flooding the eggs is sufficiently warm, contains a low enough dissolved oxygen (DO) content, and is organically rich (which contributes to a decreased DO content), hatching will commence (Gjullin et al. 1950).

In order to address early-season mosquito larval hatching, weekly monitoring began in early April. Monitoring increases to twice a week when regional ambient temperatures and Kootenay River levels increase consistently. Frequent monitoring takes place until local Kootenay River levels decrease and seepage sites become dry or yield no more larval mosquitoes. Certain sites are monitored more frequently than others due to their propensity to produce mosquitoes quickly (e.g. sites that are shallow will typically produce mosquito larvae earlier. In normal seasons, monitoring typically ceases in July.

Image 2. MBL field technician checking dipper for mosquito larvae

Larval mosquitoes in sufficient number (i.e. >4/dip) are treated by ground applications of a microbial larvicide product (i.e. Aquabac®). This product has the active ingredient *Bacillus thuringiensis israelensis* (Bti) and is carried in a corncob formulation. The mode of action for Bti is relatively simple and with a rather high degree of species specificity. 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, disruption of the larval mid-gut cells occurs because of cleavage of the protoxins by mid-gut proteases. This event causes considerable damage to the wall of the gut and quickly leads to larval death (Boisvert and Boisvert, 2000).

As the season progresses and more mosquito development sites become flooded or all become active simultaneously, it becomes increasingly difficult to treat sites by ground. At this point, aerial treatments become necessary. The aerial campaign uses the same pesticide as ground applications, although with a higher application rate to permeate canopy cover.

It is important to time treatments according to the correct stage of larval development (3$^{rd}$ and 4$^{th}$ instar). If treatments are applied too early, the larvae will not have started

feeding yet and if applied too late, the larvae molt into pupae (i.e. non-feeding stage). Both circumstances will 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 in their ecosystem.

## Larval Treatment

### Ground (Hand/Blower) Treatment Summary

Whenever possible, MBL field technicians conduct ground treatments. Early in the mosquito season, field staff access sites by foot. In addition to reducing the environmental impact of field activities, ground treatments allow for the identification of new sites and access points to sites that are commonly shrouded by canopy-cover when conducting all activities by air.

Monitoring mosquito development sites began in early May. Appendix I depicts larval abundance within the program area. In 2018, MBL field technicians applied approximately 956 kg of Aquabac® by ground (i.e. hand/blower), at a rate of 4 kg/ha in the Wasa/Ta Ta Creek/Skookumchuck area. Thus, approximately 239 ha, in total, were treated by ground, with all the ground treatments occurring in May and June (Figures 5, 6). Appendix II shows the area and frequency of ground and aerial treatments for Wasa/Ta Ta Creek/Skookumchuck in 2018.

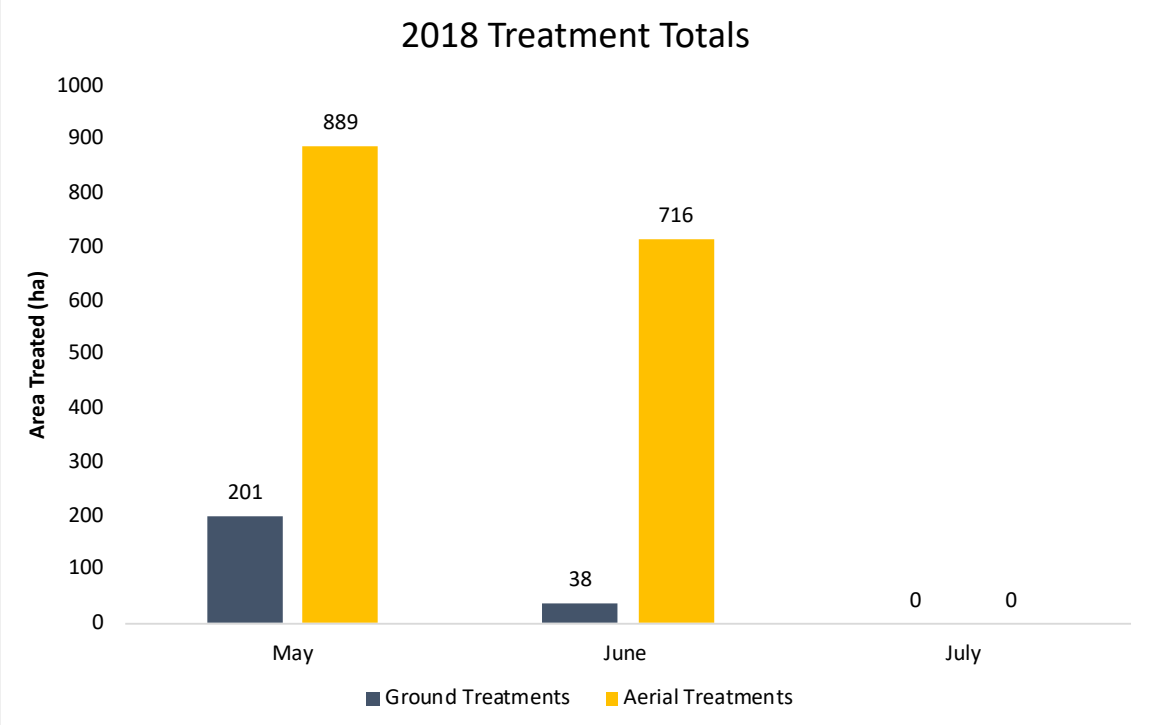


**Figure 5. 2018 Wasa/Ta Ta Creek/Skookumchuck ground and aerial treatments (ha) from May – July.**

Ground treatments at mosquito development sites started on 18 May (Figure 6). Ground treatments focused on the Kootenay River foreshore mosquito development sites and started, in earnest, immediately following the first spikes in River levels (Figure 6). Despite the high water, certain foreshore sites were accessible throughout the mosquito season. After early-June, ground treatments began to taper off after local Kootenay River levels were consistently receding; the final ground treatment took place on 12 June (Figure 6). Appendix III provides more specific information about site, treatment timing, and the extent of treatment.

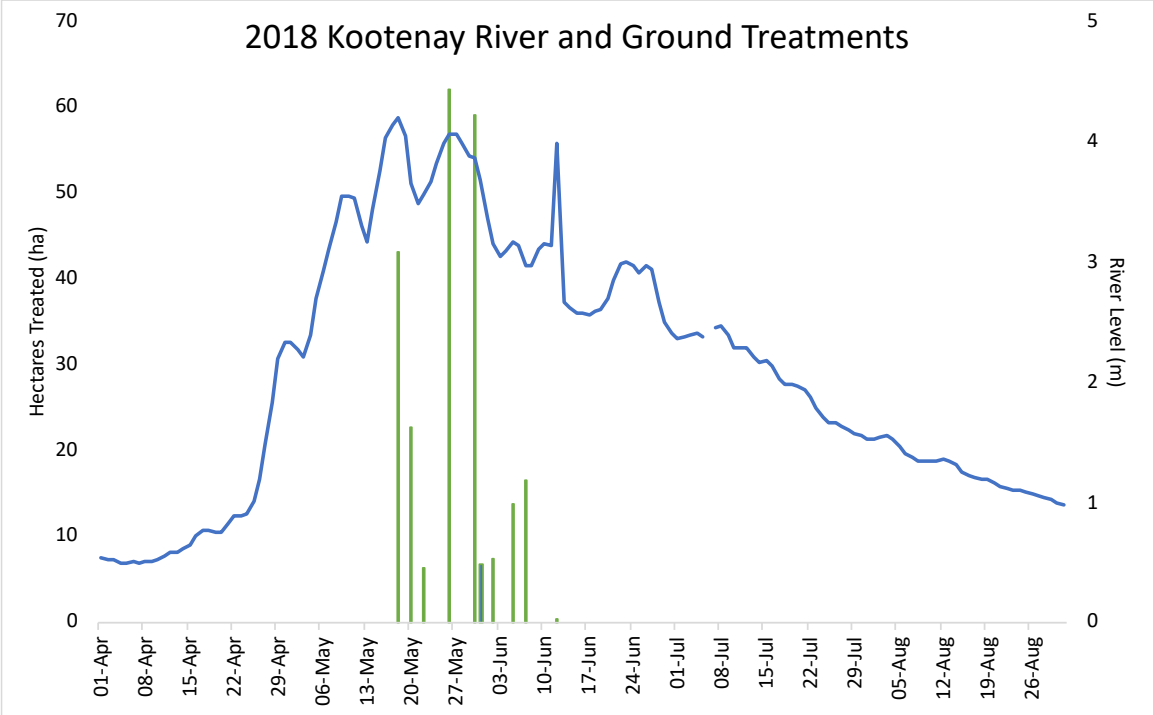


**Figure 6. Ground (hand/blower) treatments (ha) with respect to the daily peak of the Kootenay River at Fort Steele (08NG065) for the 2018 mosquito season.**

## Aerial Treatments

Aerial treatments are necessary whenever access to mosquito development sites is not possible by foot, when there is a significant amount of mosquito larval activity, and when larval development is occurring too quickly to treat all sites by ground. Thus, the total number of aerial treatments conducted within a given year is dependent upon the amount of water moving through or adding to the system and the larval mosquito development rate.

In 2018, two aerial campaigns were necessary. Aerial treatments took place on 21 May and 1 June (Figure 7). MBL field technicians applied a total of approximately 9,628 kg. Aerial treatments were applied at a rate of about 6 kg/ha, thus, the total area treated by

helicopter was approximately 1,605 ha (Figures 5, 7; Appendix II, Appendix III). Post-treatment monitoring revealed high control rates.

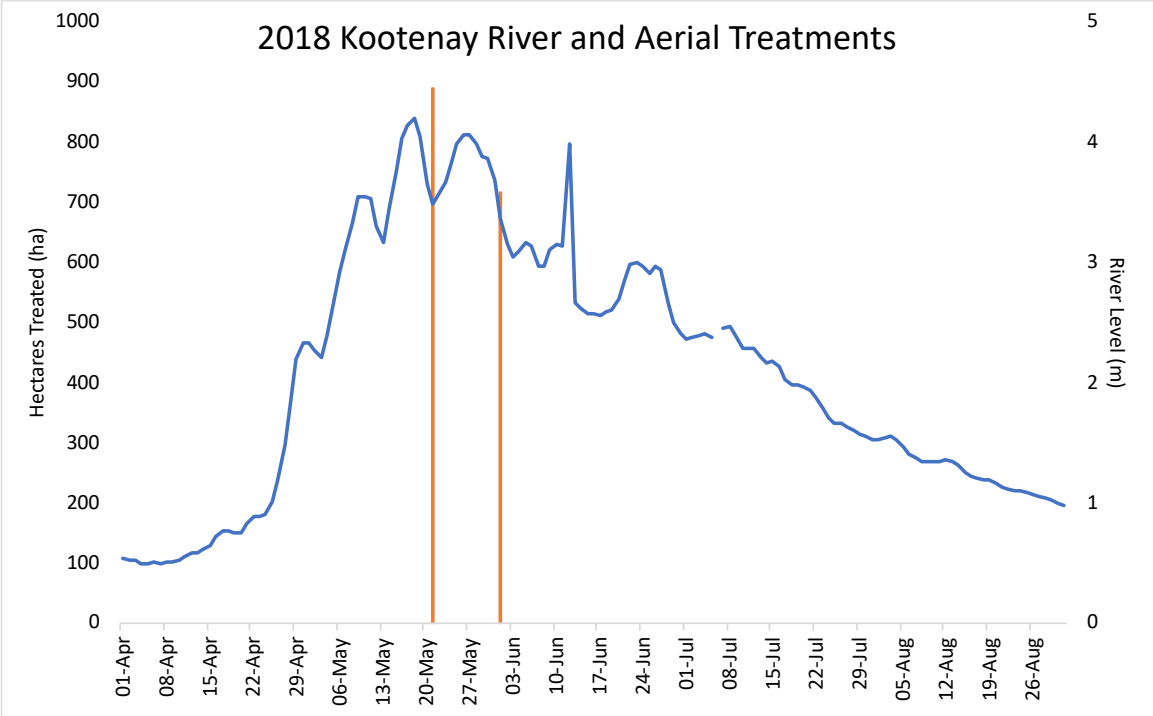


**Figure 7. Aerial treatments (ha) with respect to the daily peak of the Kootenay River at Fort Steele (08NG065) for the 2018 mosquito season.**

## Public Engagement

Direct communication between MBL staff and the public can occur in many circumstances. The most common direct interfacing with the public occurs when technicians are in the field. MBL technicians, while conducting site visits, are often asked questions by landowners or nearby residents. These encounters provide an excellent opportunity for public relations. The fact that technicians are visibly monitoring and treating lets residents know that attention is being given to mosquito abatement efforts. An important outcome of these interactions can be the identification of new sites and larval mosquito activity by involved residents.

MBL contact information is disseminated when field technicians have direct communication with the public. Contact information for MBL includes an email, phone number, and social media sites (Twitter, Facebook). Another resource for public queries is the new MBL website (morrowbioscience.com). By providing the public with these resources and avenues of communication, it enables community members to follow-up with questions.

MBL staff was invited to present to a town hall meeting at the Wasa Community Hall on 18 June. Staff shared information pertaining specifically to the mosquito abatement

program and addressed community questions. The mid-season summary presentation was well-attended. MBL remains committed to look for new areas to expand this aspect of our program and to improve our communication techniques.

## Hotline Calls and Emails

No calls or emails were received either via the MBL website, Mosquito Hotline, or via social-media platforms. The reduction in calls and emails from 2017 is likely due to the combination of a comparatively lower-water year and increased application rate at highly productive mosquito development sites. It is also possible that residents are unaware of communication platforms for this program. As such, in 2019 MBL will distribute posters within the contract area outlining contact options for mosquito-related concerns. An advertisement will also be placed in a local paper.

## Social Media

This year, 2018, is the 7th consecutive year in which MBL had a social media presence online. There are five main 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 social sustainability, 4) provide the community with opportunities to get involved with related public events, and 5) offer a platform for mosquito-related discussion amongst involved citizens and the MBL team.

Facebook (facebook.com/morrowmosquito) remains the primary avenue for MBL to disseminate mosquito-related information. Regular updates on mosquito abundance began in March noting the kick-off of the freshet around British Columbia. In addition to field updates, post topics also included volunteer, outreach efforts conducted by MBL staff members.

The total number of followers on the MBL Facebook page is currently 282. This number has increased by 100 since October 2017. Another way to gauge how many people are looking at or responding to MBL's posts is by considering MBL's post "reach". Specifically, each time a follower interacts with the MBL page a subset of their "friends" is exposed to the information that the original follower commented on or "liked". In this way, the maximum reach relevant to the Wasa/Ta Ta Creek/Skookumchuck area was 7,497 on 22 August and was in response to a posting outlining two positive cases of West Nile virus detected in birds near Kimberly, BC. The post helped inform residents of suggestions from the BC Centre for Disease Control for reducing the risk of contracting the virus.

Another aspect to MBL's social media outreach strategy is the use of Twitter (@morrowmosquito). Utilizing Twitter allows the opportunity for community members

to follow, in real-time, our activities and updates relating to mosquito control issues. An average of one "tweet" a week is sent out throughout the mosquito season. Some of these "tweets" were forwarded from other sources if those messages were mosquito-related.

To date, the maximum number of followers on Twitter is 140, which is an increase from September 2017. Part of the reason for the increase in followers through this method is the link between the Twitter account and the Facebook account. Each time a "tweet" was sent out via Twitter, it was also posted to the Facebook page. This way the Twitter feeds reached as many people per day as did the Facebook posts. Twitter and Facebook accounts are also linked to the Morrow BioScience website, enabling visitors to easily connect with each account. Notable Twitter followers include local municipalities and media.

### MBL Website

The MBL website (**www.morrowbioscience.com**) was launched on March 26, 2015. This site was developed to allow clients and the public to have access to information about MBL's background, activities, outreach, and staff members. The website is continually being refined as MBL further develops our programs.

Currently, the site contains information about MBL's philosophy, staff background, and current projects. The site outlines MBL's services and relevant news, including a blog updated throughout the mosquito season. Of importance is the 'Contact' tab which allows a person to directly send a message to MBL. Additionally, there are links to MBL's Facebook account and Twitter feed, so interested individuals may have real-time updates on MBL's activities.

## West Nile virus Summary

Along with its partners, the Government of Canada conducts on-going surveillance of West Nile virus (WNv) cases in humans between mid-April and the end of October. As of 8 October there were no confirmed human cases of WNv reported in BC. It should be noted that Health Canada includes any WNv human cases that are deemed probable or confirmed. Cases may include WNv neurological syndrome, WNv non-neurological syndrome, and WNv unclassified/unspecified.

Mosquito pools, horses, and birds within BC have also been tested. To date, no mosquito pools have tested positive for WNv in BC, nor have any horses. On 22 August two wild birds in Kimberly, BC tested positive for the virus. Given the proximity of these positive cases to the Wasa/Ta Ta Creek/Skookumchuck area, future education outreach events will also include information about how to report cases of dead, wild birds for WNv

testing. MBL field technicians are aware of the potential for WNv-infected animals and mosquito pools. Staff utilize personal protective measures and are on alert for the occurrence of dead, wild birds in the area.

## Recommendations and Reminders

Future work within the Wasa/Ta Ta Creek/Skookumchuck areas will continue to include reconnaissance efforts for new sites. MBL will continue to refine the real-time online data collection and management portal. Capabilities to be added may include georeferenced flight paths for aerial treatments and aerial footage of treatments.

MBL provides each of our programs with the best floodwater mosquito control possible. Within that commitment is the focus on consistent communication and to continually pursuing areas in which to improve. Improving MBL's visibility and direct accountability to program residents is a goal for 2018.

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

- Notify the Ministry of Environment of the RDEK intent to treat mosquitoes in 2019 under the RDEK 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.
- Ensure that the toll-free line is up and operational (1-888-733-2333). This toll-free line is forwarded each year to the hotline supplied by the current contractor.

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# 2018 Mosquito Larval Densities at Sample Locations

Appendix I

**Morrow BioScience Ltd**
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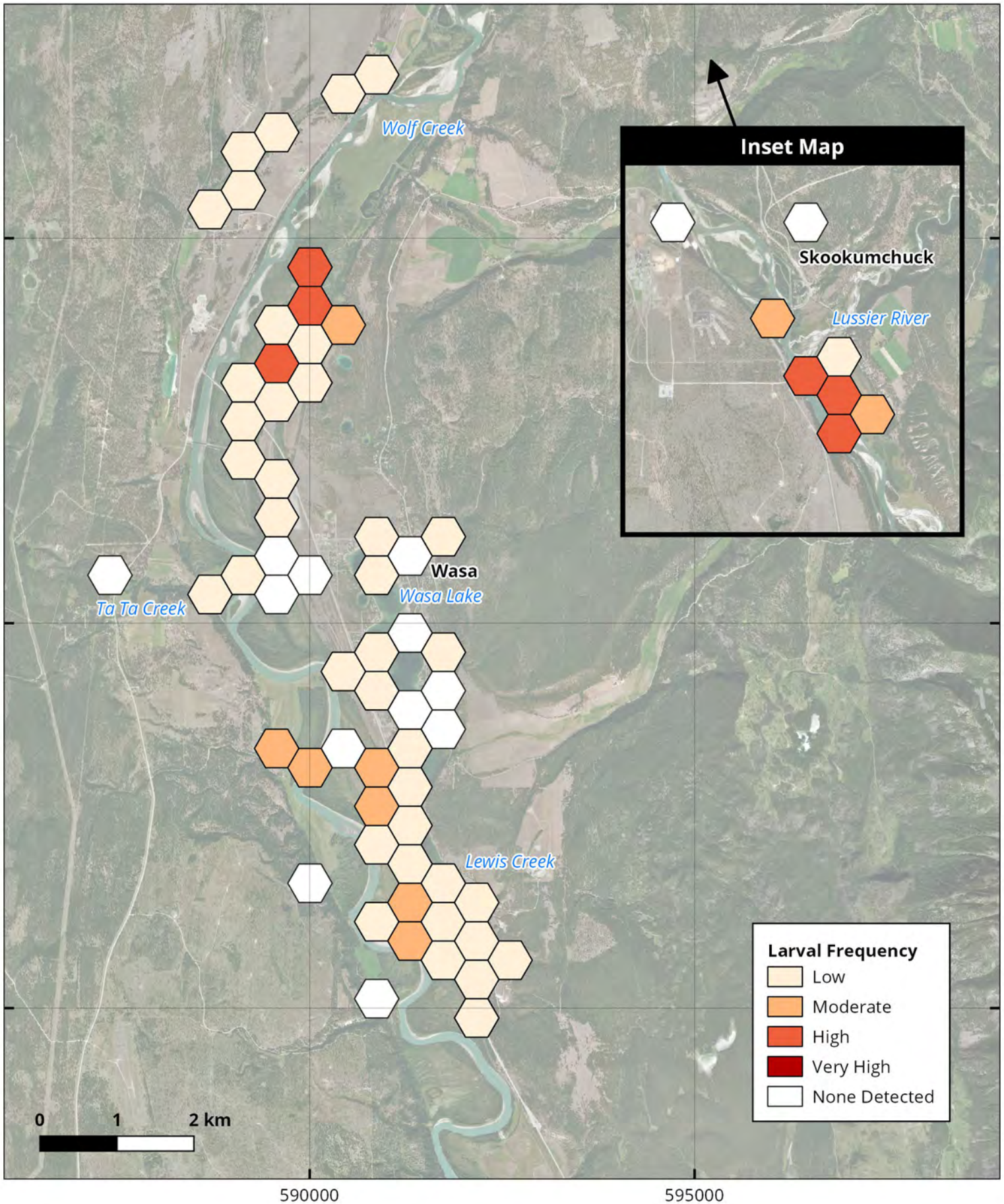
gis@morrowbioscience.com 1(877)986-3363

Scale = 1 : 65,000 CRS = NAD83 UTM Zone 11N





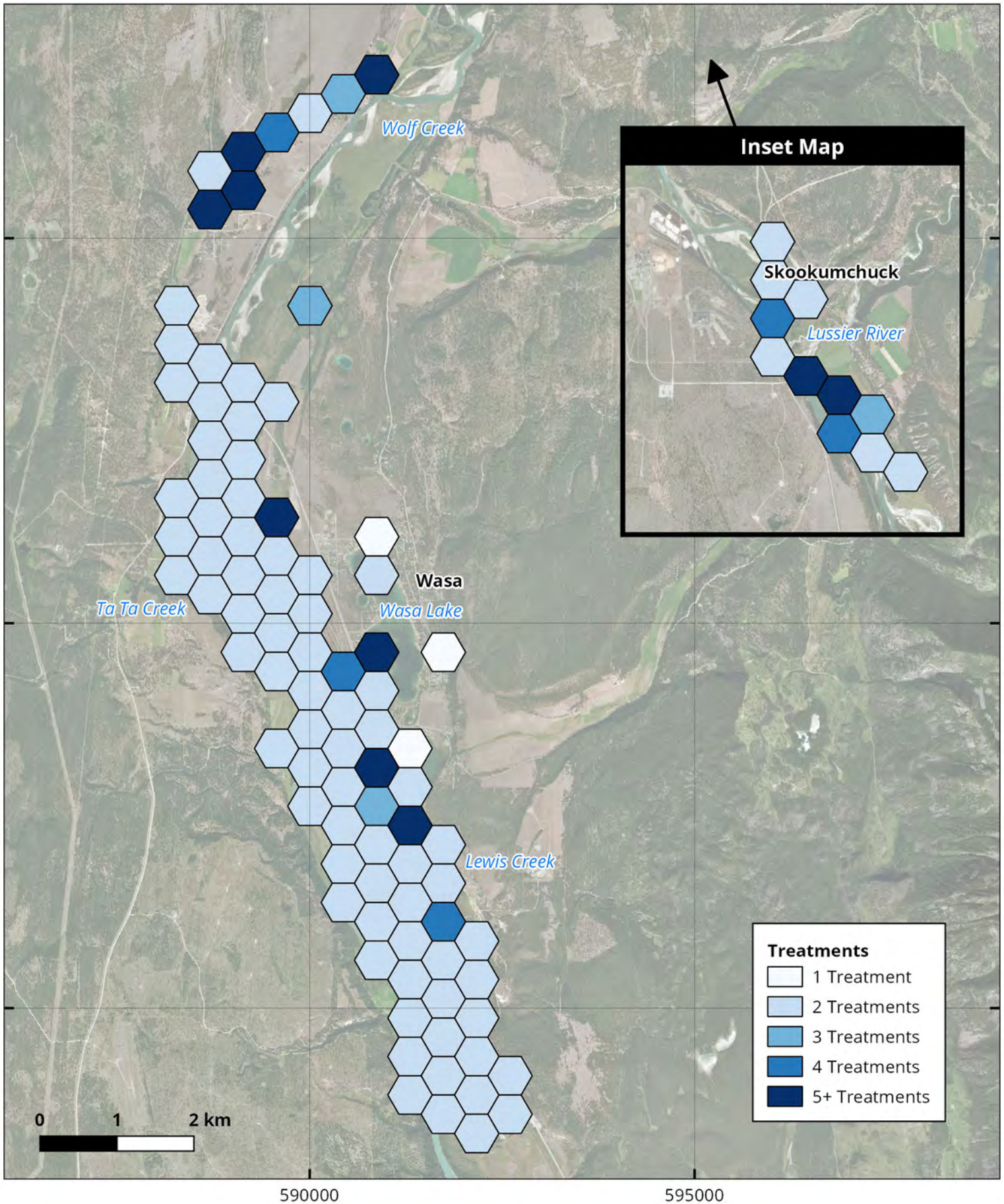
# 2018 Mosquito Larvicide Treatment Locations

Appendix II

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

Scale = 1 : 65,000 CRS = NAD83 UTM Zone 11N





# Appendix III. 2018 treatment data (kg, ha) by site and date for all ground (A) and aerial (B) treatments within Wasa/Ta Ta Creek/Skookumchuck.

**III-A: Ground Treatments**

| Date | Site | Treatment Amount (kg) | Treatment Area (ha) |
|---|---|---|---|
| 18-May-18 | RDEK-050 | 18.20 | 4.55 |
| 18-May-18 | RDEK-050 | 18.20 | 4.55 |
| 18-May-18 | RDEK-050 | 18.20 | 4.55 |
| 18-May-18 | RDEK-050 | 18.20 | 4.55 |
| 18-May-18 | RDEK-050 | 18.20 | 4.55 |
| 18-May-18 | RDEK-050 | 18.20 | 4.55 |
| 18-May-18 | RDEK-050 | 9.00 | 2.25 |
| 18-May-18 | RDEK-050 | 9.00 | 2.25 |
| 18-May-18 | RDEK-050 | 4.60 | 1.15 |
| 18-May-18 | RDEK-050 | 9.20 | 2.30 |
| 18-May-18 | RDEK-050 | 4.60 | 1.15 |
| 18-May-18 | RDEK | 27.20 | 6.80 |
| 20-May-18 | RDEK | 54.60 | 13.65 |
| 20-May-18 | RDEK-048 | 18.20 | 4.55 |
| 20-May-18 | RDEK-048 | 18.20 | 4.55 |
| 22-May-18 | RDEK-010 | 4.00 | 1.00 |
| 22-May-18 | RDEK-010 | 4.00 | 1.00 |
| 22-May-18 | RDEK-027 | 8.00 | 2.00 |
| 22-May-18 | RDEK-023 | 2.00 | 0.50 |
| 22-May-18 | RDEK-045 | 8.00 | 2.00 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 9.10 | 2.28 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 9.10 | 2.28 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |
| 26-May-18 | RDEK-042 | 18.20 | 4.55 |

| | | | |
|---|---|---|---|
| 26-May-18 | RDEK-045 | 6.00 | 1.50 |
| 26-May-18 | RDEK-045 | 6.00 | 1.50 |
| 30-May-18 | RDEK-064 | 18.20 | 4.55 |
| 30-May-18 | RDEK-005 | 18.20 | 4.55 |
| 30-May-18 | RDEK-062 | 18.20 | 4.55 |
| 30-May-18 | RDEK-062 | 9.10 | 2.28 |
| 30-May-18 | RDEK-062 | 18.20 | 4.55 |
| 30-May-18 | RDEK-061 | 9.10 | 2.28 |
| 30-May-18 | RDEK-061 | 9.10 | 2.28 |
| 30-May-18 | RDEK-061 | 9.10 | 2.28 |
| 30-May-18 | RDEK-061 | 18.20 | 4.55 |
| 30-May-18 | RDEK-018 | 6.00 | 1.50 |
| 30-May-18 | RDEK-027 | 3.00 | 0.75 |
| 30-May-18 | RDEK-024 | 9.00 | 2.25 |
| 30-May-18 | RDEK-027 | 18.20 | 4.55 |
| 30-May-18 | RDEK-027 | 18.20 | 4.55 |
| 30-May-18 | RDEK | 36.40 | 9.10 |
| 30-May-18 | RDEK-027 | 18.20 | 4.55 |
| 31-May-18 | RDEK-037 | 9.10 | 2.28 |
| 31-May-18 | RDEK-037 | 9.10 | 2.28 |
| 31-May-18 | RDEK-043 | 9.10 | 2.28 |
| 02-Jun-18 | RDEK-026 | 6.00 | 1.50 |
| 02-Jun-18 | RDEK-021 | 9.10 | 2.28 |
| 02-Jun-18 | RDEK | 12.00 | 3.00 |
| 02-Jun-18 | RDEK-025 | 3.00 | 0.75 |
| 05-Jun-18 | RDEK-027 | 6.00 | 1.50 |
| 05-Jun-18 | RDEK-027 | 9.10 | 2.28 |
| 05-Jun-18 | RDEK-042 | 2.00 | 0.50 |
| 05-Jun-18 | RDEK-042 | 2.00 | 0.50 |
| 05-Jun-18 | RDEK-042 | 2.00 | 0.50 |
| 05-Jun-18 | RDEK-042 | 6.00 | 1.50 |
| 05-Jun-18 | RDEK-042 | 8.00 | 2.00 |
| 05-Jun-18 | RDEK-042 | 6.00 | 1.50 |
| 05-Jun-18 | RDEK | 14.00 | 3.50 |
| 07-Jun-18 | RDEK | 22.10 | 5.53 |
| 07-Jun-18 | RDEK-028 | 18.20 | 4.55 |
| 07-Jun-18 | RDEK-029 | 18.20 | 4.55 |
| 07-Jun-18 | RDEK-029 | 8.10 | 2.03 |
| 12-Jun-18 | RDEK-070 | 2.00 | 0.50 |

## III-B: Aerial Treatments

| Date | Site | Treatment Amount (kg) | Treatment Area (ha) |
|---|---|---|---|
| 21-May-18 | Program-wide | 5332.60 | 888.77 |
| 01-Jun-18 | Program-wide | 4295.20 | 715.87 |