

**2023 EARLY SEASON REPORT**  
Mosquito Control Program  
Regional District of Central Kootenay  
Area 'D' – Meadow Creek and Pine Ridge regions

Submitted by Morrow BioScience Ltd.  
19 April 2023

---



[www.morrowbioscience.com](http://www.morrowbioscience.com)  
Toll Free: 1-877-986-3363  
[info@morrowbioscience.com](mailto:info@morrowbioscience.com)

## Executive Summary

Morrow BioScience Ltd. (MBL) is entering into the first year of a renewed 5-year contract providing mosquito control services to the Meadow Creek and Pine Ridge areas within Regional District of Central Kootenay (RDCK). The goal of the pre-season report is to present predictions for the 2023 mosquito season based on current environmental conditions and anticipated climate influences.

April snowpack within the West Kootenay and Upper Columbia basins is largely predictive of the potential peak flooding level of the local Duncan River and Kootenay Lake for the season. As of 1 April, the snowpack was 90 and 81 percent of normal for the West Kootenay and Upper Columbia basin, respectively. Fittingly, the 18 April Snow Water Equivalent data for a representative station within the West Kootenay Basin are trending near the 25<sup>th</sup> percentile for a high-elevation site. The regional river and lake levels are expected to be lower than those of 2022, as a result of the regional snowpack. However, significant local precipitation and/or releases from the Duncan Dam received together with the annual freshet may result in higher than anticipated peaks for both the Duncan River and Kootenay Lake. Given the potential for another high-water year, MBL is preparing for increased reconnaissance, monitoring, and treating in areas with high concern calls from residents in previous years.

Site monitoring began on 17 April, as snowmelt sites started showing signs of early melting. No mosquito larvae were detected and many sites associated with the Duncan River and Kootenay Lake were dry. Despite neutral El Niño Southern Oscillation weather conditions, Environment Canada is predicting cooler-than-average ambient temperatures through June and normal precipitation. This may result in a slight delay to the freshet. MBL staff will again utilize the real-time data collection portal and provide point specific data on client-enabled dashboards. The dashboard will allow the RDCK program manager to instantaneously determine the site monitoring and treatment status, including the ability to access historical point-associated data.

MBL will participate in an open house event organized by the RDCK on or around 15 May. The event will offer residents the opportunity to pick up information pamphlets and directly engage with MBL's lead biologist and regional operations manager. Outreach material will also be posted on public bulletin boards within the municipalities. Additional improvements to the program for 2023 include hiring another field technician to assist with site monitoring and ground-treating and conducting a monthly evaluation of all electronic and online data collection platform systems. MBL remains committed to providing the RDCK with consistent updates on benchmarks throughout the season. The mid-season report will be delivered to the program manager immediately following the peak in the Duncan River and Kootenay lake, with frequent updates provided throughout the season.

## TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	ii
INTRODUCTION .....	1
MONITORING METHODOLOGY .....	1
DATA MANAGEMENT .....	3
EDUCATION OUTREACH.....	3
SEASON FORECAST .....	4
SNOWPACK.....	4
WEATHER.....	6
PROGRAM IMPROVEMENTS INCORPORATED IN 2023 .....	7
REPORTING SCHEDULE .....	8
CONTACTS.....	8
REFERENCES .....	9

## LIST OF FIGURES

<b>Figure 1.</b> Snow Water Equivalent (SWE; mm) for East Creek Station (ID: 2D08P) in West Kootenay Basin. Accessed on 18 April 2023.....	6
--	---

## LIST OF TABLES

<b>Table 1.</b> Snow water equivalent indices for basins that directly affect the flood plain areas of the Meadow Creek and Pine Ridge noted in the 18 April 2023 Automated Snow Weather Station Weekly Summary. Values are expressed as percent of long-term median..	6
--	---

## Introduction

This report is provided to the Regional District of Central Kootenay (RDCK) and will serve as a projection tool for the 2023 mosquito season. The report includes a discussion regarding the magnitude of potential flooding within the Meadow Creek and Pine Ridge regions of Electoral Area 'D', as it relates to floodwater and snowmelt mosquito larval abundance. Supporting data include current snowpack information within the basins contributing to the Duncan River and Kootenay Lake. The weather forecast for the spring and summer are outlined and discussed as they pertain to the potential impact on the regional mosquito production. This report offers an approximate evaluation of how the mosquito season may develop based on current weather predictions and snow levels; it is possible that conditions could change in late April. The mid-season report will have more thorough explanations of environmental conditions affecting floodwater mosquito larval levels and an update on all deliverables.

## Monitoring Methodology

Floodwater and snowmelt mosquito larvae are the primary targets of the Meadow Creek and Pine Ridge region mosquito program. Snowmelt larvae hatch first in the season (i.e., April – early May) within the contract purview. Female snowmelt mosquitoes (e.g., *Aedes communis*) lay their eggs in puddles or low points on the landscape that are likely to receive snowmelt in the spring. Certain snowmelt mosquito species begin to hatch at approximately 4°C water temperature and can complete development to adult emergence at 10°C (Clements 1992). Thus, Morrow BioScience Ltd. (MBL) staff monitor these sites frequently beginning in March or April, depending on environmental conditions. This season, monitoring began on 17 April. No larvae were detected.

Female floodwater mosquitoes (e.g., *Aedes vexans*, *Ae. sticticus*) deposit their eggs on damp substrate primarily along the Duncan River corridor and Kootenay Lake foreshore. When the high water caused by the freshet and/or significant localized precipitation floods these areas, the result is large-scale floodwater mosquito egg hatching. If numerous seasons have passed between high-water years, then high river levels may produce a compound number of floodwater mosquito larvae. Because the eggs of certain *Aedes* species have been documented to complete embryogenesis at lower threshold aquatic temperatures between 6°C and 8°C (Trpis et al. 1973), hatching may commence in the early spring within the programs. Time-to-hatch is considerably longer at lower aquatic temperatures, but early identification of hatching events allows for more responsive site monitoring and, thus, higher treatment efficacy rates. MBL staff begin monitoring floodwater mosquito development sites as soon as the Duncan River levels show a steady increase, typically in mid-April. Various sites within Meadow Creek and Cooper Creek were monitored on 17 April. None were found to contain larvae and many were dry.

MBL field technicians have developed a detailed database of site profiles and have consistently added new sites to the monitoring regime throughout MBL's tenure as mosquito control contractors for the Meadow Creek and Pine Ridge region mosquito control program. Site monitoring is governed largely by ambient temperature data within contributing basins, local precipitation accumulation data, and changes in regional river and lake levels. All snowmelt and floodwater mosquito development sites are monitored on a weekly basis throughout the mosquito season. When both the Duncan River (Below Lardeau River gauge; 08NH118) and Kootenay Lake (Queens Bay gauge; 08NH064) levels are high, along with consistently high ambient temperatures, monitoring efforts may increase to a semi-weekly schedule. Mosquito Hotline calls/emails also inform site monitoring efforts. In this way, sites are adaptively monitored and adaptively treated. Monitoring and treatment timing adjust to reflect intra-regional habitat variations and accompanying mosquito species variations.



Image 1. Standard dip (350 ml) from a floodwater mosquito development site showing 3<sup>rd</sup> and 4<sup>th</sup> instar mosquito larvae.

MBL field technicians treat mosquito larvae in the 3<sup>rd</sup> and 4<sup>th</sup> instar stages (Image 1). This treatment method is designed to target the instar stages with the highest feeding rate, leading to higher treatment efficacy. Additionally, by waiting until mosquito larvae are in the 3<sup>rd</sup> and early 4<sup>th</sup> instar stages, early instar larvae are available as food sources in their ecosystem.

Late instar larval mosquitoes in sufficient number (i.e., >4/dip) are treated by applications of Aquabac®, a microbial larvicide product. This product has the active ingredient *Bacillus thuringiensis israelensis* (Bti) and is carried on a corncob formulation. The mode of action for Bti is relatively simple and with a 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 Bti bacterial spore. After the mosquito larvae ingest the toxin protein, disruption of the larval mid-gut cells occurs. This event leads to considerable damage of the gut wall and quickly results in larval death (Boisvert and Boisvert 2000).

As the season progresses and more mosquito development sites become flooded, it is increasingly difficult to treat sites by ground due to site access challenges and simultaneous larval development at multiple sites. At this point, a helicopter is utilized to conduct aerial campaigns (i.e., program-wide treatments). Aerial applications use the same larvicide as ground applications, although commonly with a higher application rate to permeate canopy cover. Aerial campaigns within the Meadow Creek region programs typically require one day, depending on the river and lake peaks, Duncan Dam releases, and environmental conditions. All sites are checked within one or two days of the initial treatment to ensure treatment efficacy. If necessary, touch-up treatments are conducted. Pine Ridge sites are relatively smaller and accessible throughout the season and, thus, don't require aerial treatments. MBL will continue to maintain close and clear communication with the RDCK program manager to ensure all sites are effectively managed and to assess whether program managers have been alerted of possible new mosquito development sites.

## Data Management

MBL's real-time data collection portal will be utilized again in 2023. This portal enables MBL staff to electronically update site information regarding the number of mosquito larvae and pupae per dip, adult presence, treatment amounts, take photos, and maintain site profile details. All data are related to GPS points and made instantaneously available to the RDCK mosquito program manager in a user-friendly format.

The tool has helped MBL staff increase operational efficiencies. The portal also provides an easily accessible reference platform for discussions between MBL staff and the RDCK program managers via a client-authorized dashboard. The dashboard displays sites and all associated data.

## Education Outreach

Providing residents with mosquito-related information is a cornerstone of MBL's mosquito control programs. The goals for education outreach are to raise awareness about mosquito habitat reduction around residences (i.e., remove standing water, refresh outside standing water sources frequently, cover water sources, etc.), provide personal protective tips for avoiding

nuisance mosquitoes (i.e., long-sleeved and loose clothing, repair screens on homes, recommendations for personal mosquito deterrents, etc.), and also to provide residents with assurance that the RDCK contractors for the Meadow Creek and Pine Ridge regions are committed to mosquito control in their area.

As part of MBL's education outreach commitment, MBL staff are presenting at a RDCK-facilitated open house on or around 15 May. The open house will allow residents the opportunity to collect information pamphlets and directly speak with MBL staff about the up-coming season, mosquito control methods, and habitat reductive tips. Additionally, MBL staff have prepared multiple FAQ documents addressing each of the topics typically presented at education outreach events. These documents are available on the MBL website ([www.morrowbioscience.com](http://www.morrowbioscience.com)) under the 'Resources' tab.

Link promotion to all education outreach materials will be conducted through the MBL social media platforms and, with permission, through participating municipalities' social media platforms and websites. To increase visibility, some outreach pamphlets will also be posted on local bulletin boards. MBL remains committed to providing education outreach within the Meadow Creek and Pine Ridge region mosquito control program.

## Season Forecast

### Snowpack

Floodwater mosquito habitat within the Meadow Creek region is primarily affected by water fluctuations in the Duncan River and Kootenay Lake. Additionally, water attenuation and releases from the Duncan Dam affect the flooding at the head of Kootenay Lake within the Meadow Creek area. Pine Ridge mosquito development sites are less impacted by regional water levels and more influenced by local snowmelt.

The snowpack in the West Kootenay basin and, to a lesser degree, the Upper Columbia basin can be good indicators of how much water will come through the Duncan River/Lardeau River system and Kootenay Lake over the course of the spring and early summer. Image 2 provides a snapshot of the relative snowpack across the province organized by basin from 1 April Snow Survey and Water Supply Bulletin<sup>1</sup>, as released by the Province on 12 April. Immediately preceding the 2023 floodwater mosquito monitoring season, the snowpack within the West Kootenay and Upper Columbia basins were 90 and 81 percent of normal, respectively<sup>1</sup>. The 1 April 2022 snowpack percentage range was considerably higher. In addition, there was significant late-season snowpack augmentation in basins across the province in late spring 2022. Thus, the overall contribution of snowpack to Kootenay Lake and Duncan River/Lardeau River will likely be less in 2023 than it was in 2022, reducing the likelihood of a relatively lower-water year.

---

<sup>1</sup> [https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2023\\_apr1.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2023_apr1.pdf)



Duncan River, Kootenay Lake, and Duncan Dam water level/release variations are important to track because they inform the timing and extent of annual floodwater mosquito hatching events and subsequent required control efforts. As of 19 April, it appears that the Duncan River (below the Duncan Dam) levels are receding and that the Duncan Dam has attenuated some of the mid-April spikes that were experience upriver from the Dam. Outside of a small spike in levels in mid-April, Kootenay Lake (Queens Bay) is at approximately 530.1 m; Kootenay Lake levels haven't been this low since early May of 2022.

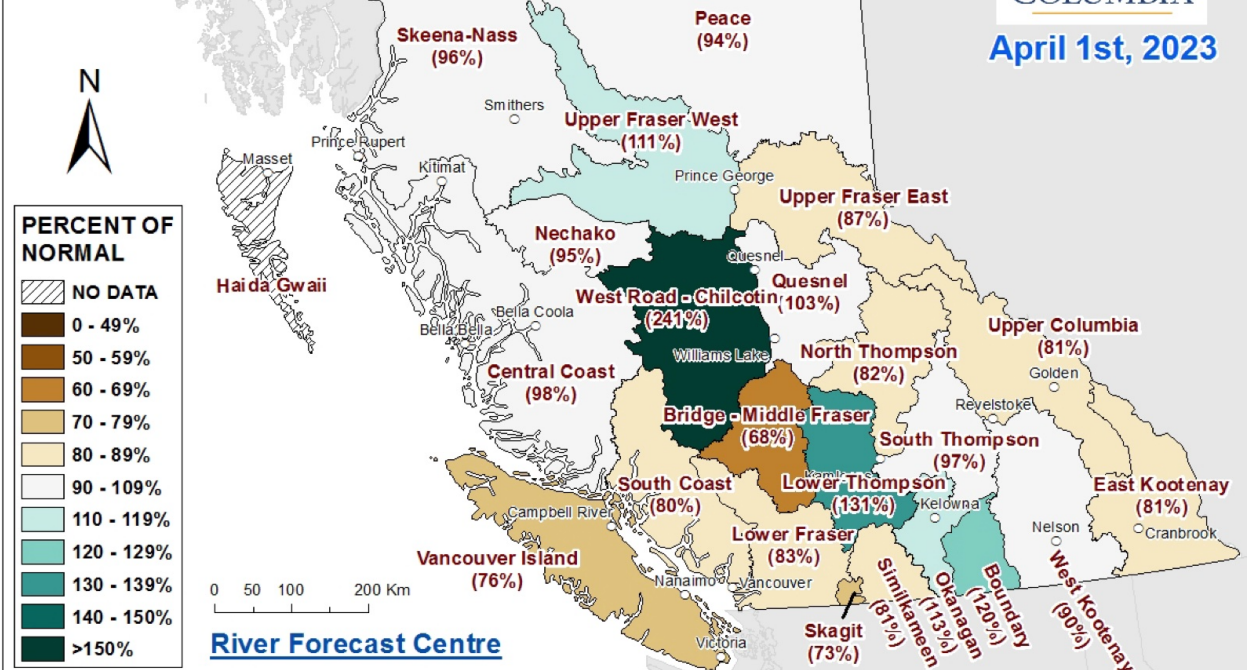


Image 2. River Forecast Centre snow basin indices for 1 April 2023.

Slight snowpack accumulation and depletion has occurred since 1 April. As such, the percentages reported in Table 1 reflect the most recent available relative Snow Water Equivalent (SWE; percent of long-term median) estimates in basins affecting the regional Duncan River and Kootenay Lake. Currently, the SWE in the West Kootenay and Upper Columbia basins is indicative of a below-normal water year within the program purview. Predicted warming average ambient temperatures in the coming weeks indicate that measurable snowmelt may start to occur in late-April or early May, as opposed to in 2022 when the most significant snowmelt began in late May-early June. Of note, snowpack is only one predictor for flood levels. Precipitation and the timeline for snowmelt (e.g., protracted vs. concentrated) also contribute to the extent of flooding experienced in an area. Late-season snowpack augmentation has occurred in multiple previous seasons. Thus, the prediction for flooding extent can change quickly.



Table 1. Snow water equivalent indices for basins that directly affect the flood plain areas of the Meadow Creek and Pine Ridge noted in the 18 April 2023 Automated Snow Weather Station Weekly Summary. Values are expressed as percent of long-term median. (<https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/river-forecast-centre/snow-survey-water-supply-bulletin/snow-conditions-commentary>).

	<b>SWE – Percent of Long-Term Median</b>
<b>Basin</b>	<b>18 April 2023</b>
West Kootenay	91
Upper Columbia	74

The East Creek snow survey station also reflects regional snowpack trends and serves as a representative site for the regional snowmelt trajectory. The current SWE is within the 25<sup>th</sup> percentile of the station’s historical data (Figure 1). By comparison, the 2022 SWE at the same date was higher than the station’s 75<sup>th</sup> percentile. The relatively SWE in 2023 indicates the likelihood for a lower-water year than that of 2022. Of note, SWE values are still increasing meaning that seasonal melting had not begun as of 18 April.

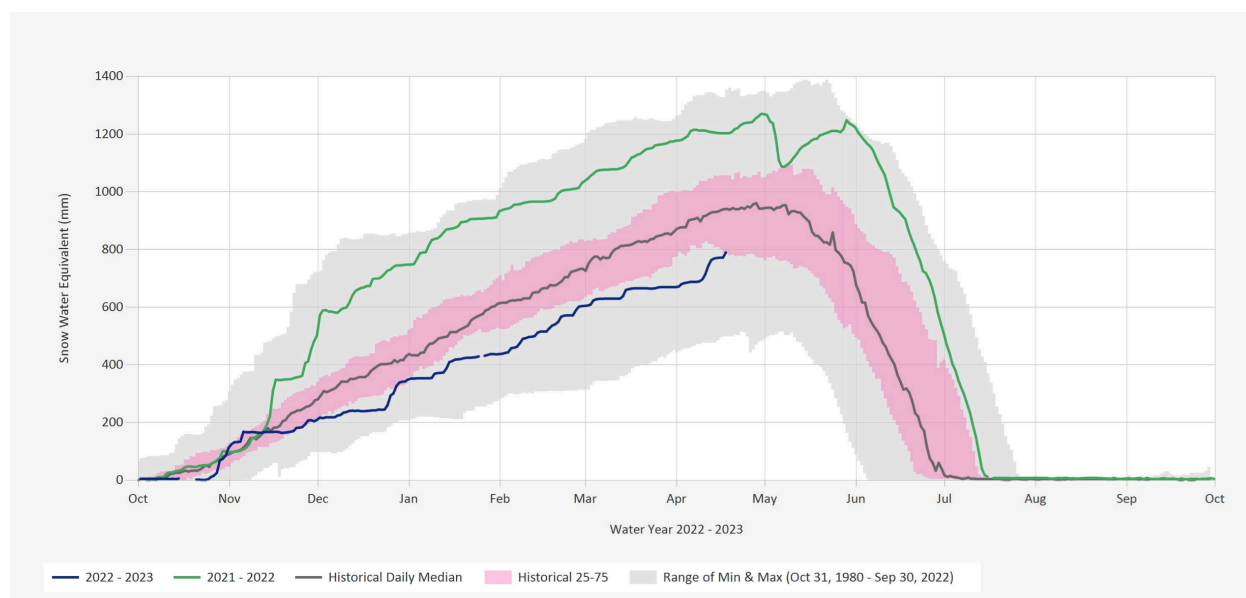


Figure 1. Snow Water Equivalent (SWE; mm) for East Creek Station (ID: 2D08P) in West Kootenay Basin. Accessed on 18 April 2023.

## Weather

Regional river and lake levels can be significantly affected by local precipitation, as well as how quickly snowmelt occurs in contributing basins. El Niño Southern Oscillation (ENSO) conditions greatly influence weather patterns and anticipating its phase (i.e., neutral, El Niño, La Niña) can

help predict the amount of precipitation a region may accumulate and general ambient temperature trends. According to the 1 April Snow Survey and Water Supply Bulletin<sup>2</sup>, La Niña conditions have ended and the now neutral phase of ENSO may be in place through the early summer. The weather pattern ramifications for BC in an ENSO-neutral year do not include the wet springtime weather of the last two seasons which led to late-season snowpack augmentation.

The National Oceanic and Atmospheric Administration predicts that there is a 62 percent chance that El Niño conditions will develop between May and July<sup>3</sup>. The impacts of El Niño climate conditions on southern BC include warmer temperatures and drier conditions in regional snow basins. If warmer ambient temperatures are concentrated in May or June, like the conditions that contributed to the 2021 heat dome, then a concurrent melting event could cause considerably high Duncan River and Kootenay Lake levels. Encouragingly, the Temperature Probabilistic Forecasts for Canada<sup>4</sup> for April – June show that ambient temperatures within basins contributing to the regional Duncan River and Kootenay Lake will be lower than normal. Probabilistic Forecasts predict an average amount of precipitation from April – June. Despite these forecasts, MBL staff are monitoring snowpack levels, weather forecasts, and Duncan River and Kootenay Lake levels daily in the event the 2023 mosquito season begins quickly and for the potential of a high-water year.

The lower-than-normal snowpack in contributing basins signals more moderate regional Duncan River and Kootenay Lake peaks in 2023. Of importance, significant precipitation events that occur simultaneously with the freshet can considerably augment localized flooding. Typically, April and May are wet months for the Meadow Creek and Pine Ridge region. Spring precipitation could amplify the peaks in the Duncan River (Below Lardeau River gauge) and the Kootenay Lake (Queens Bay gauge) beyond those expected given the current snowpack, alone. As the Duncan Dam generally attenuates the freshet, subsequent releases can also augment localized flooding. MBL staff and the RDCK program manager are frequently updated on planned releases by BCHydro.

## Program Improvements Incorporated in 2023

Providing floodwater mosquito management services for the RDCK throughout high and low-water years, brief and sustained flood levels, and early and late regional river and lake peaks has led to opportunities to fine-tune the program. Internal reviews and partner feedback has been integral in developing the list of improvements to the mosquito management program for 2023. Improvements include:

---

<sup>2</sup> [https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2023\\_apr1.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2023_apr1.pdf)

<sup>3</sup> <https://www.noaa.gov/news/what-to-watch-for-el-nino-likely-to-develop-summer>

<sup>4</sup> [https://weather.gc.ca/saisons/prob\\_e.html](https://weather.gc.ca/saisons/prob_e.html)

- Participation in an in-person open house for Meadow Creek and Pine Ridge area residents on or around May 15. Residents can drop in to receive information and speak directly to MBL's lead biologist and regional operations manager. The event will be held in Meadow Creek. RDCK will organize event advertisement.
- Post education outreach material on local bulletin boards to increase visibility of mosquito control program information.
- An additional staff member has been hired to assist with monitoring and conducting ground-based treatments.
- The electronic data entry program has been tested (passed) and will be tested again in late-April to ensure all platforms are in working order.

## Reporting Schedule

As in previous years, the technical reports will be provided to the RDCK program manager at three points in the season: early, mid, and season-end. The mid-season report will summarize field activities, relevant weather data, and expectations for the remainder of the season; it will be provided to the RDCK immediately following the peak in the local Duncan River and Kootenay Lake levels. The final report will summarize data collected throughout the season and address all program deliverables. In the interim, activity updates will be supplied to the RDCK program manager via phone or email. Supplementary reports can be provided, upon request, and instantaneous data is made available via MBL's real-time client-enabled dashboard.

## Contacts

MBL recognizes the importance of being available to residents within each of our program areas, as well as keeping them informed of relevant mosquito abatement activities and information. In an effort to continue to provide these connection opportunities, MBL regional managers check their email and phone messages on a daily basis. Managers directly reply to email and phone inquiries within 24 hours. All emails and calls forwarded by RDCK staff will also be responded to within 24 hours of receipt. Additionally, residents may find helpful information at our Facebook page ([facebook.com/morrowbioscience](https://facebook.com/morrowbioscience)), Twitter (@MoBioScience), and Instagram ([morrowbioscience](https://instagram.com/morrowbioscience)) feeds, as well as blogs and resources on our MBL website ([www.morrowbioscience.com](http://www.morrowbioscience.com)).

As a reminder, the following staff may be contacted directly with any questions that may arise:

Dirk Lewis, Owner and Lead Biologist  
Phone: (604) 317-1413  
Email: [dirk@morrowbioscience.com](mailto:dirk@morrowbioscience.com)

Barry McLane, GIS Manager  
Phone: (250) 231-6934  
Email: barry@morrowbioscience.com

Phillip Lemire, Regional Operations Manager  
Phone: (250) 801-0961  
Email: phillip@morrowbioscience.com

General Email: info@morrowbioscience.com  
MBL Mosquito Hotline: 1-877-986-3363

## References

- Boisvert, M. & Boisvert, J. (2000). Effects of *Bacillus thuringiensis* var. *israelensis* on Target and Non-Target Organisms: A Review of Laboratory and Field Experiments. *Biocontrol Sci Tech* 10, 517-561.
- Clements, A. (1992). *Biology of Mosquitoes*. CAB International.  
[https://beckassets.blob.core.windows.net/product/readingsample/457488/9783540928737\\_excerpt\\_001.pdf](https://beckassets.blob.core.windows.net/product/readingsample/457488/9783540928737_excerpt_001.pdf)
- Trpis, M., Hauf, W., & Shemanchuk, J. (1973). Embryonic Development of *Aedes (O.) sticticus* (Diptera: Culicidae) in Relation to Different Constant Temperatures. *The Canadian Entomologist*, 105(1), 43-50. Doi:10.4039/Ent10543-1