

**2022 EARLY SEASON REPORT**  
Mosquito Control Program  
Regional District of Central Kootenay  
Area 'D' – Meadow Creek and Pine Ridge regions

Submitted by Morrow BioScience Ltd.  
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## Executive Summary

Morrow BioScience Ltd. (MBL) is entering into the fourth 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 2022 mosquito season based on current environmental conditions and anticipated climate influences.

April snowpack within the West Kootenay and Upper Columbia basins, contributing to the regional river and lake levels, is largely predictive of the potential peak flooding level of the local Duncan River and Kootenay Lake for the season. The snowpack in these basins ranges from 118 – 123 percent of normal. The current Snow Water Equivalent data are trending near historical highs for local high-elevation snow survey stations within the West Kootenay basin. Higher-than-average regional river and lake levels are expected in 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 in mid-April, as snowmelt sites started showing signs of early melting. The BC River Forecast Centre is predicting that cooler weather anticipated for late-April through early-May may cause a delay in regional snowmelt. 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.

As previously established, some education outreach material will be available through the MBL. Outreach material will also be posted in public bulletin boards within the municipalities. MBL will participate in an in-person and virtual-option town hall meeting for program residents on 4 May. 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.

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## Introduction

This report is provided to the Regional District of Central Kootenay (RDCK) and will serve as a projection tool for the 2022 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 early May. 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 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.

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.

MBL field technicians have developed a detailed database of site profiles and consistently add 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 start rising 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 to the wall of the gut 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 and Pine Ridge 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. 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 2022. 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.

In partial fulfillment of our education outreach commitment, MBL staff are presenting at a RDKB-facilitated town hall meeting on 4 May. The presentation will include a summary of 2021 field activities and a review of recommendations for 2022. The presentation will also involve a discussion about expectations for the 2022 season regarding floodwater mosquito abundance based on snowpack and weather patterns. Habitat reduction tips for larval mosquitoes and personal protective tips will be addressed. 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 over the course of the spring and early summer. Image 2 provides a snapshot of the relative snowpack across the province within basins from 1 April Snow Survey and Water Supply Bulletin<sup>1</sup>, as released by the Province on 9 April. 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.

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<sup>1</sup> [https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2022\\_apr1.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2022_apr1.pdf)

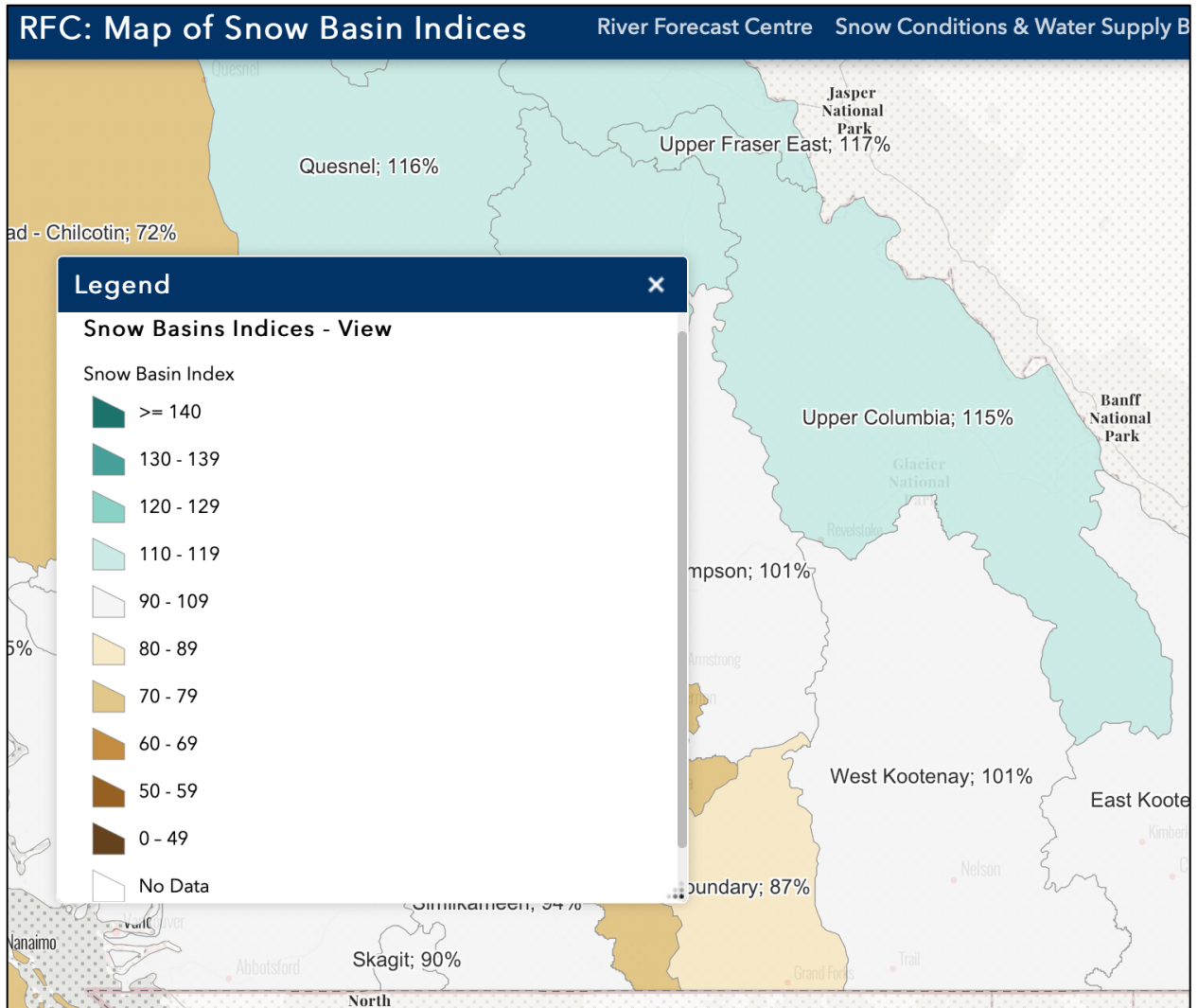


Image 2. River Forecast Centre snow basin indices for 1 April 2022.

Snowpack accumulation has occurred since 1 April. As such, the percentages reported in Table 1 reflect the most recent available snowpack estimates in basins affecting the regional Duncan River and Kootenay Lake. The snowpack is indicative of a higher-than-normal water year within the program purview. Generally cooler or average ambient temperatures across much of the province indicate that measurable snowmelt may not start until early or mid-May, as opposed to in 2021 when measurable snowmelt began in April.



Table 1. Snow basin indices for basins that directly affect the flood plain areas of the Duncan River and Kootenay Lake near Meadow Creek, determined by the 1 May automated snow weather station reading. ([https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/asp\\_summary\\_2021-22.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/asp_summary_2021-22.pdf)).

Basin	Percent of Normal Snowpack
	2022
West Kootenay	118
Upper Columbia	123

Leading up to the 2022 season, the weather in April was relatively cooler within the Southern Interior and the snowpack in many regional basins was augmented. Supporting this statement is SWE data within East Creek station, which are tracking considerably higher than the 2020-2021 SWE trend lines. Current snowpack data indicate the SWEs are higher than the station’s 75<sup>th</sup> percentile (Figure 1), indicating considerable snowpack in contributing basins. Of note, snowpack is only one predictor for flood levels. Precipitation, the timeline for snowmelt (e.g., protracted vs. concentrated), and Duncan Dam releases 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.

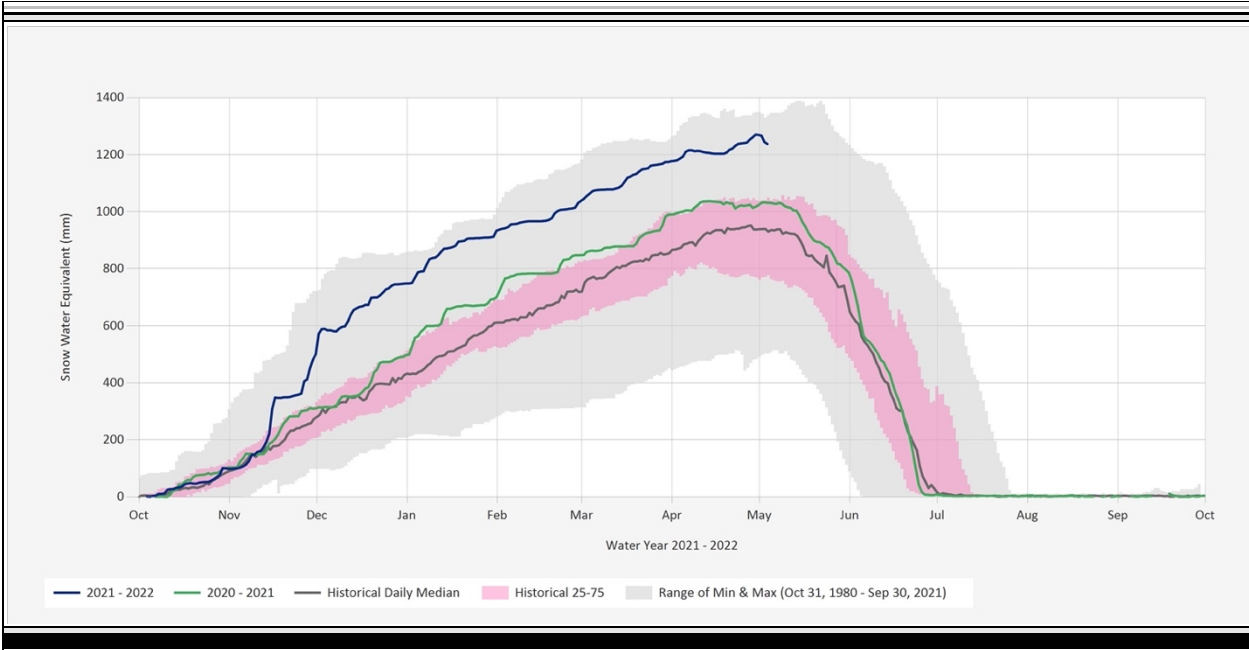


Figure 1. Snow Water Equivalent (SWE; mm) for East Creek Station (ID: 2D08P) in West Kootenay Basin. Accessed on 4 May 2022.

## Weather

River levels, and lake levels to a lesser extent, can be significantly affected by regional precipitation, as well as how quickly snowmelt occurs in contributing basins. El Niño Southern Oscillation (ENSO) conditions greatly influence weather patterns; 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>, there is an 53% likelihood of maintaining La Niña conditions through the summer. The weather pattern ramifications for BC in a La Niña climate include cooler temperatures and wet weather in southern BC. The River Forecast Centre specifically notes flooding correlations with recent La Niña years<sup>2</sup>.

Interestingly, the Temperature and Precipitation Probabilistic Forecasts for Canada<sup>3</sup> for May – July show that ambient temperatures within basins contributing to the Duncan River and Kootenay Lake will be approximately normal in areas and with a 40-50% chance of being below normal in other areas. Precipitation forecasts indicate a normal amount of precipitation through July. MBL staff are monitoring snowpack levels, weather forecasts, and regional river and lake levels daily in the event the 2022 mosquito season begins quickly. The short-range forecast includes seasonal or just below seasonal ambient temperatures. These temperatures may further slow the regional snowmelt.

The higher-than-normal snowpack in contributing basins signal high regional Duncan River and Kootenay Lake peaks in 2022. 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 2022

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 2022. Improvements include:

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<sup>2</sup> [https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2022\\_apr1.pdf](https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/river-forecast/2022_apr1.pdf)

<sup>3</sup> [https://weather.gc.ca/saisons/prob\\_e.html](https://weather.gc.ca/saisons/prob_e.html)

- Participation in an in-person optional town hall meeting for Meadow Creek and Pine Ridge area residents on May 4. In-person events may improve attendance.
- Post some education outreach material on local bulletin boards to increase visibility.

## 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 on our Facebook page (Morrow BioScience Ltd.), our Twitter feed (@MorrowMosquito), 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:

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