Mosquito Control Program Year End Report 2019

Regional District of Okanagan-Similkameen

Prepared by: Cindy Boehm, Shad Collins & Zoë Kirk, RDOS Public Works Projects Coordinator

Executive Summary

The Regional District of Okanagan-Similkameen (RDOS) commenced its Mosquito Control Program (MCP) in 1974. The program objectives have been to monitor and control nuisance mosquito populations throughout the Similkameen and South Okanagan. All site services are provided only upon request of individual property owners. They are eligible to receive treatment in bodies of standing water too large for them to drain. Over the years, the RDOS program has continued to adapt, evolve and incorporate new tools in order to stay relevant and effective.

Due to severe flooding in the 2017 and 2018 seasons resulting in ground water levels remaining higher than normal throughout the fall and winter and compounded by an early snowmelt in 2019, several persistent boggy areas were observed during this season. Conditions and climate change affects prompted the earliest ever start to the mosquito control season in 2019. Operations commenced mid-March with the monitoring of lowland flooded areas. A week of record breaking temperatures (122 new records were set by March 21, 2019) noted temperatures rise to over 20C. This heat wave trigged the simultaneous hatching of millions of floodwater mosquito larvae. With crews already on the ground, they were able to respond rapidly. These very high larvae levels reacted well to the early treatment and their populations were radically reduced thus avoiding a large biomass hatch. Subsequent treatments kept larvae numbers low even as snowmelt water levels continued to rise. The drastic reduction of larvae from the initial hatches resulted in low adult numbers for the remainder of the season.

By April 29, 2019 larvae samples were showing the first non-Aedes (non-floodwater) mosquito species. After the driest March recorded with the mosquito control program, the April rains resulted in early hatches of many of the summer mosquito species that continued into May and June. With the cooler temperatures and rains in July, the mosquito breeding sites were topped up with water prolonging the hatching of larvae. In late July, when the temperatures began to rise and stay elevated overnight, many of the persistent boggy areas started to dry out and by August, roughly 75% of mosquito sites had dried up. The remaining areas were those sites having persistent irrigation seepage or natural bogs needing treatment.

As part of the evolution of the Mosquito Control Program, larvae identification was added in 2019. Mosquito larvae was collected and transferred into an isopropyl alcohol/pond water mix, labelled and shipped to a biologist in Victoria. A total of 17 different mosquito species were collected as larvae throughout the RDOS. The BC Centres for Disease Control have identified 11 of these species as potential vectors of West Nile, and 5 of these; Aedes vexans, Aedes dorsalis, Culex tarsalis, Culiseta incidens, and Culiseta tarsalis are listed as highly competent vectors. Disease carried by mosquitoes in the RDOS is not limited to West Nile so precautions must be taken to limit breeding sites that harbour these vectors.

VectoBac 200G granules were applied to a total area of 327.95 hectares of mosquito breeding habitat in the 2019 season. All applications were completed under the BC Ministry of Environment Pest Management Plan for the RDOS.

Table of Contents

1. Introduction

1.1 Program Purpose and Scope

The objectives of the RDOS Mosquito Control Program (MCP) are to limit the potential of widespread mosquito annoyance, and reduce the possibility of mosquito-borne diseases for the benefit of residents, visitors, workers, and livestock in the RDOS catchment area. From March to September the RDOS Mosquito Control Program (MCP) treats over 400 sites throughout electoral areas: A, B, C, D, F, G, H and I as well as Summerland, Osoyoos, Penticton, and Oliver.

The Regional District's MCP methodologies can be put into three main categories: prevention, treatment, and monitoring.

- Prevention focuses on minimizing larval habitats;
- Treatment requires pesticide in order to control mosquito populations;
- Monitoring is constant and requires vigilance from the crews.

Mosquitos being controlled throughout the RDOS can be placed into two categories: nuisance and vector. In the South Okanagan and Similkameen, the vast majority of mosquitos are considered to be nuisance mosquitoes. Nuisance mosquitoes are extremely aggressive towards humans and livestock but are not known to carry life threatening pathogens at this time. Vector mosquitoes, on the other hand, are known to transmit a variety of diseases which can infect humans and animals causing illness, or in more serious situations, death. The RDOS MCP mainly involves targeting nuisance mosquitos; however, outbreaks have occurred, such as the 2009-2010 West Nile outbreak. These occurrences reiterate the importance of having a robust control program and procedures in place to handle situations as they arise with continued focus on assuring the health and safety of the local residents.

1.2 Program History

Nuisance mosquitos have been a problem in the South Okanagan and Similkameen Valley for as long as humans have inhabited them. The main reason for this is the quantity and quality of mosquito larval habitats; oxbows to wetlands and annual flood zones. In 1974, the RDOS initiated a program to monitor and mitigate local mosquito populations in the more densely populated areas. Over the past forty years the program has been adapting and integrating tools and technology to remain as effective as possible.

1.3 Program Start-End dates

Mosquito population control is most effective when the first hatches are greatly reduced. It cannot be understated that the reduction in these numbers sets the stage for summertime enjoyment. The annual weather conditions and resultant snowpack, lake, river and stream levels all play an integral role in the MCP variable start dates.

This year, with the low snow-pack and early high temperatures, the stage was set for early flooding. Larval population densities in the early weeks often exceeded 250 per dip; the treatment threshold is 3 per dip. Figure 1 illustrates the high number of larvae seen in some of the dips during this 2019 mosquito control season.

Figure 1.1: Larvae dips (2019)

A new technique was implemented in 2019 for treating water bodies that still froze overnight. After breaking the ice that formed overnight and finding high larval levels, crews sprinkled the BTI granules on top of the ice and as it melted in daytime temperatures, it entered the water, resulting in high mortality rates for the larvae. This method allowed crews to treat these areas and efficiently continue to the next site resulting in a savings in time, fuel, and the treatment was applied at the critical stages.

Spring weather and precipitation amounts play a role in the extension or reduction of the various mosquito. Summer temperatures and localized rain events can make some sites persistent in their larval breeding capacity. The survival of adult mosquitos is temperature

and humidity dependent as forests, long grass, hedges and sheltered areas give good resting places for adult mosquitos and help to extend their lives.

2. Treatment Information & Resource Allocation

2.1 Application Methods

The RDOS uses a granular form of *bacillus thuringiensis var israelensis*, more commonly referred to as Bti, to control mosquito larvae. Bti is a naturally occurring, non-toxic bacteria which specifically targets mosquito and black fly larvae. For further information about Bti and how it works refer to the Health Canada-Bti fact sheet:

Link to Health Canada BTI https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/fact-sheets-other-resources/bacillus-thuringiensis-subspecies-israelensis.html

Figure 2.1: VectoBac 200G

Bti has undergone nearly 40 years of lab/field research and over 30 years of large-scale operational use in a variety of public health programs around the globe. Bti is very target specific with activity largely restricted to mosquitoes and related flies (in the sub-order Nematocera of the order Diptera). The specific prodce used by the RDOS is VectoBac 200G, see Figure 2.1.

In addition to Bti's non toxicity to beneficial insects, numerous toxicology studies have shown Bti to be non-pathogenic and non-toxic to other forms of wildlife (birds, fish, mammals, etc.) and humans. The World Health Organization has approved the use of Bti for drinking water. This is particularly important in many regions around the globe that depend on potable water or rain water stored in vessels in and around their home.

2.2 Treatment data (2019)

On average, the mosquito control program includes three to four helicopter flights per season or up to six in flood years. In 2019, due to the lower than average snowpack and dry spring, only two flights were needed.

Crews managed the early spring melt and large flooded areas by foot. As the heat melted the snowpack , the crew employed the helicopter to manage the flooded sites that were no longer safe to access or inaccessible by foot.

The following tables and figures provide a complete record of the 2019 Mosquito Control Programs treatment application records.

Figure 2.2: Treated Area per Electoral Area or Municipality

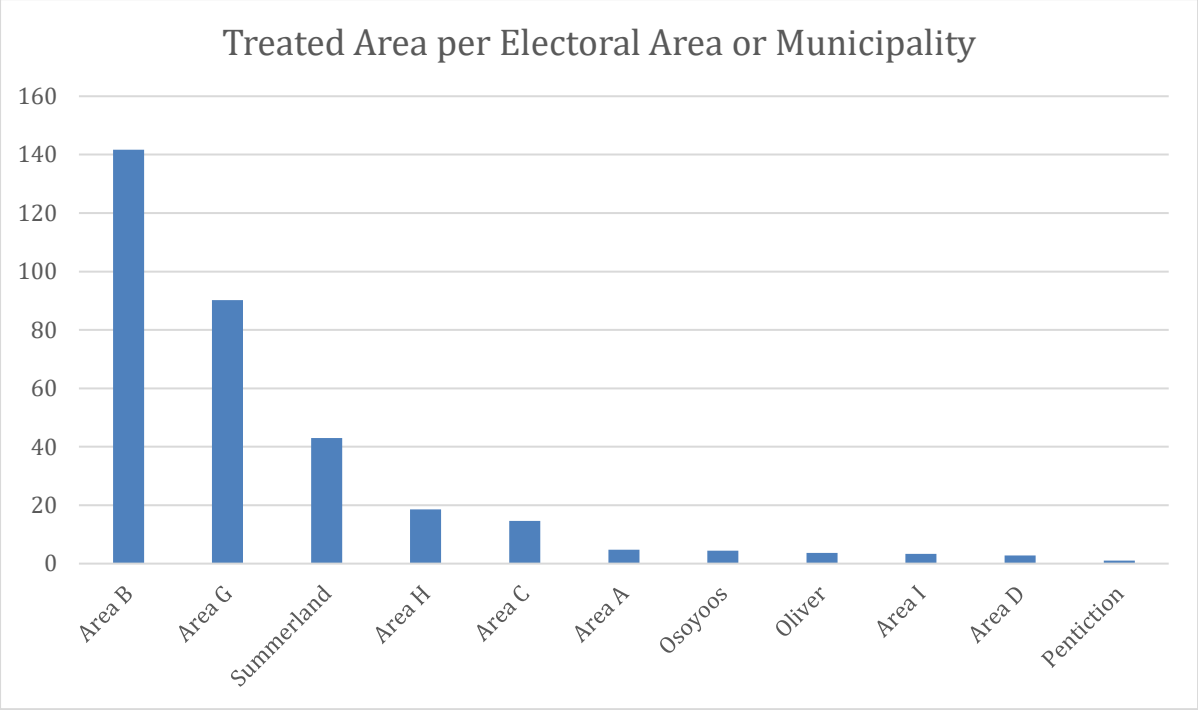


Figure 2.3 Pesticide Use per Electoral Area or Municipality

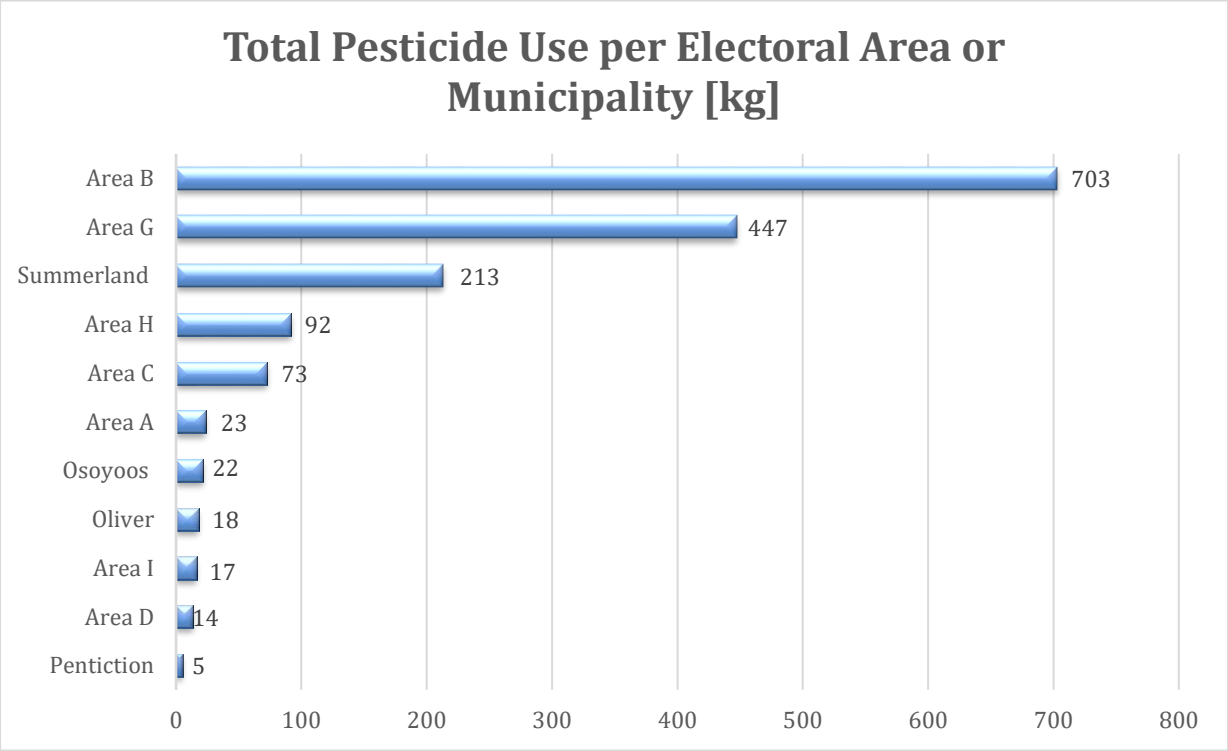


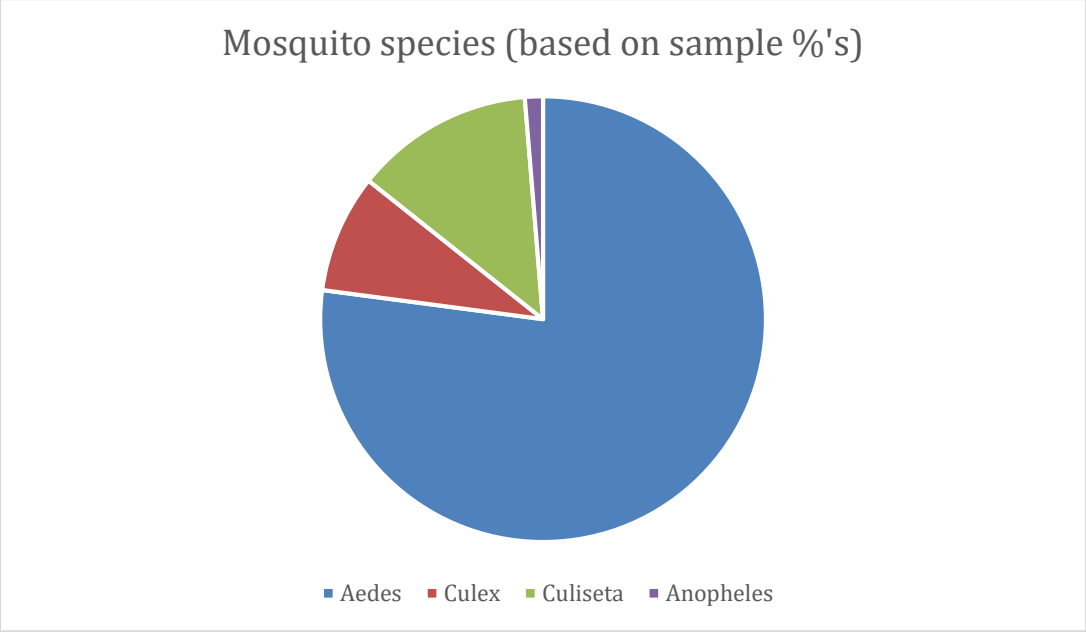
Table 2.1 Helicopter Treatment Pesticide Use and Area Data

May 16 & May 24 (rate= 4.6 kg/ha)

Area / Municipality	Larvicide Amount [kg]	Treated Area [ha]
Area 'I'	12.5	2.71
Area 'B'	237.4	51.61
Area 'D'	19.7	4.28
Area 'G'	345.0	75.01
Area 'C'	30.3	6.58
TOTALS:	**644.9**	**140.19**

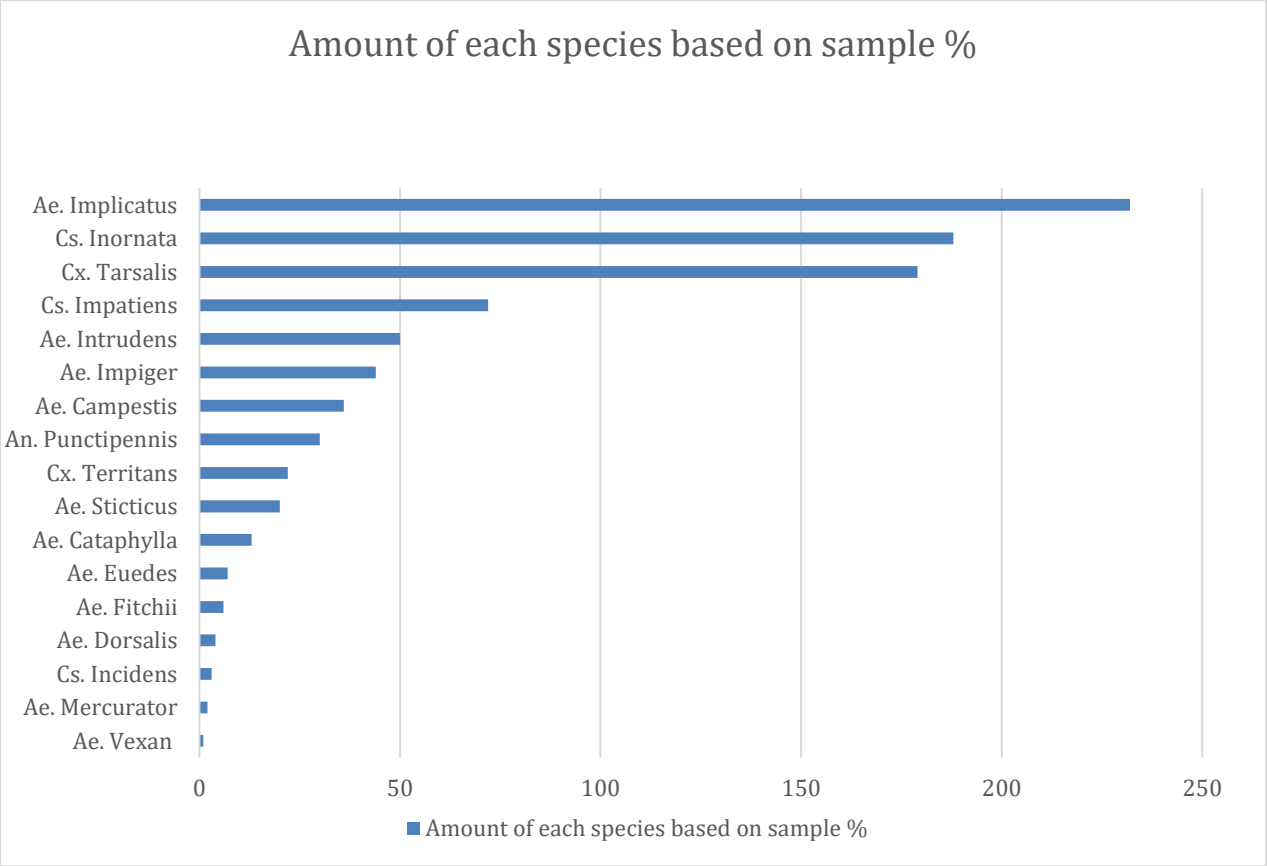
2.3 Mosquito Species Identification

Figure 2.4: Mosquito Species Identified for 2019 Mosquito Season



As illustrated above, *Aedes* mosquitos make up the large majority of the mosquito population in the Okanagan and Similkameen valleys, and is typical for the rest of British Columbia. *Aedes* mosquitos, also known as flood water mosquitos, lay their eggs in the mud. Once the water levels rise with the following spring snowmelt, the eggs become saturated and the larvae hatch within a couple of days. Adult *Aedes* mosquitos hatch around the beginning of May and fly until the end of July. The females are capable of laying multiple batches of eggs (depending on the abundance of blood meals) per season. This process allows multiple females to lay numerous egg batches within a close proximity; resulting in a significant accumulation of eggs within one flood water pool. Again, this adds to the argument that controlling larvae populations before the first hatch of adults is the most effective way to control mosquito levels in the RDOS for the duration of the summer.

Figure 2.5: Mosquito Subspecies Based on Sample Percent Total 2019



Note: The first larvae sample shipment (March 19-April 19) levels were too concentrated (with larvae) to count so the only information the biologist was able to supply was that the entire batch were *Aedes*. This shipment was treated as an outlier, and was not include in the above graph.

2.4 Mosquito Biology

In order to become adults, all mosquitoes need non-agitated water in their larval stage. Larvae must proceed through four stages called instars. Each stage requires a molt allowing the larvae to mature and increase in size. The final water stage is called a pupae during which a complete metamorphosis takes place and the winged form emerges. This entire process begins in early spring in snow-meltwater pools and usually takes a few weeks. With increased temperatures, this process accelerates and can complete in as little as 5-7 days. With normal temperatures, (daytime temperatures reaching 15 degrees) most mosquitoes require 7-14 days. Adult mosquitoes feed on plant nectar. However, the female mosquito requires a blood meal in order to complete the development of her eggs. Females will take blood as soon as the opportunity presents itself; if no blood is available, she will go looking for it. Although most mosquitoes do not have to fly far to find a blood source (1-2km), some species can fly great distances and up to great heights (30km from their origin and at heights up to 10,000 meters).

With the mountain and valley topography, mosquitos are easily dispersed from the frequent winds thus placing an increased importance on finding and treating new larval sites.

Figure 2.6: Adult mosquito resting on the vehicle dashboard

Floodwater mosquitoes (*Aedes*) lay their eggs in the soil of receding flood water where they overwinter in egg form waiting for the spring floods. These eggs can remain viable for upwards of 20 years and can endure deep cold. When the flood waters come, the eggs hatch synchronously, causing an intense biomass of flying insects that not even the most industrious of predators can hope to control. Large areas of flooded land increases the number of eggs ready to hatch in subsequent flooding events.

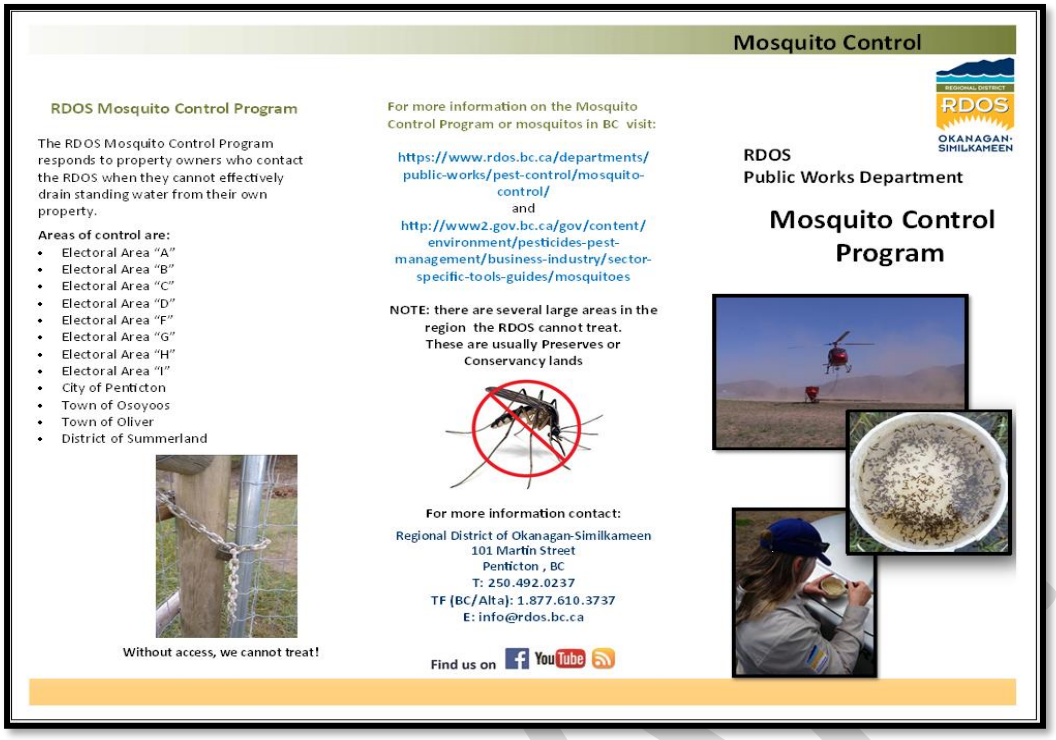
Summer Mosquitoes (*Culex*, *Culiseta*, and *Anopheles*) lay their eggs on the water surface. The hotter the temperatures, the quicker the eggs hatch. These mosquitoes continue to lay eggs as long as there is water available and the temperatures remain above freezing. Once temperatures drop below freezing, the remaining hatched females breed and hide away until warmer temperatures return. As soon as temperatures allow, they are ready to take a blood meal first thing in the spring .

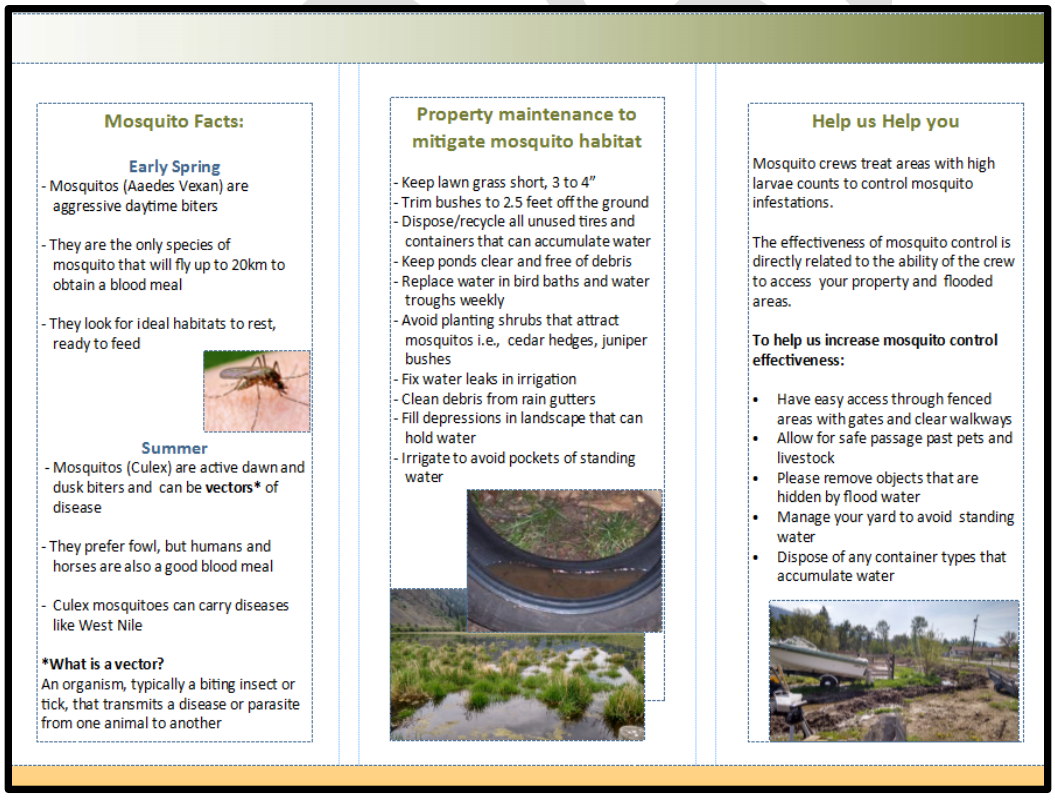
3. Public Information

3. 1 Preventative Measures

Mosquito development occurs in a wide variety of habitats; removal of standing water and control of mosquito breeding sites should be a priority for homeowners. In a 250 ml dip, one larva can translate into an excess of 10,000 mosquitoes emerging from a small backyard pond or swimming pool. Left untreated, or undrained, the resultant adult mosquito population will cause noticeable annoyance for local residents. Tires, lawn depressions, gutters, animal feeders, birdbaths, all assortment of man-made containers, leaking irrigation and rain events can all be harbingers of larvae. Decorative ponds should be aerated with a fountain or aeration device.

Figure 3.1 Mosquito Program Brochure





3.2 Climate Change and Mosquitos

Climate change is effecting mosquito distribution. Over the last 20 years, 6 species of mosquito have been reported as newly established in Canada; in addition, 10 others have expanded their geographic range. Of these, 4 are well established throughout the RDOS: *sticticus, cataphylla, campesris, and tarsalis*.

The last two years have brought unprecedented water levels to the Okanagan and Similkameen adding mosquito habitats and greatly increasing the area of ground where eggs are now deposited. The diverse species collected in our region reflects the variety of localized habitats and the impact that local weather conditions, snowpack, lake and river/creek levels have on their distribution.

The two key factors of climate change that effect endemic mosquito populations in our region are an increase in median temperature, and changes in rainfall patterns. The increase in precipitation and the variability in timing have given the mosquito(s) more opportunity to flourish and expand its breeding ground. It is anticipated that both the mosquito lifecycle and virus transmission patterns will be affected by climate change, resulting in an increase in both the range and local abundance of several key mosquito species.

"Climate change is increasingly being recognized for its potential to adversely affect public health. One such consequence of climate change that has been described in the literature is a change in the distribution and habitat of mosquito vectors that are known to transmit disease." National Collaborating Centre for Infectious Disease, 2016

3.3 MBD–Mosquito-Borne Diseases

The mosquito as a vector for disease is the undisputed champion. Mosquito-borne diseases are increasing in Canada. According to the Canada Communicable Disease Department the changes in our climate is influencing the extent to which our mosquito vectors spread viruses. Mosquito-borne diseases in our endemic populations have been increasing and new species (and associated pathogens) moving into other territories will only add to the risk of infections.

West Nile virus (WNv) is familiar to us here in western Canada, but other endemic mosquito borne diseases in the area include Western Equine Encephalitis and two California serogroup viruses : Jamestown Canyon virus and the Snowshoe Hare virus. The serogroup viruses can be transmitted by a number of mosquito species, and the virus has been found in all provinces and the North West Territories. These viruses can cause febrile illness and neurological disease in humans. Our canine companions also need to be protected from Canine Heartworm.

Unfortunately, diagnosing many of these infections is difficult because of their non-specific symptoms and the low level of awareness among health care practitioners. Climate change will continue to expand mosquito habitats, their associated diseases and the extension of our mosquito season; our response must be to meet these challenges with continued and expanded surveillance, backed by science and appropriate treatment.

3.4 Mosquito Sampling

A new component added to the RDOS Mosquito Control Program was larval collection and identification. The protocols employed were provided from a biologist in Victoria. Samples were obtained using consistent methods from larval sites scattered throughout the RDOS then shipped to the biologist Victoria for identification All sent samples were counted, identified and the larval stage, or instar, was noted. When larva are 3 instar and older, specific identification is relatively simple. However, due to their small size and immaturity, most 1&2 instar larval specimens could not be identified to species; in these situations, the larvae were identified to genus.

Our mandate is first and foremost to control mosquito larvae in their breeding sites. The high larval levels contained in the vast areas of flooded land made it necessary to begin treatment earlier than in past years. The Mosquito control program has a large area to monitor and treatment of these sites was critical in preventing the release of their adult mosquito population. The entire first sample sent for identification of larva only had the Aedes classification for floodwater mosquitos.

In the industry, some vector control companies wait for the majority of the larvae at the site to be 3 instar and older for more accurate classification. However as all sites have larvae at different stages and if treatment is held off to allow more larvae to mature for classification, a large percentage of the larvae will be left untreated and enter the adult airborne stage.

The larvae in all subsequent sample shipments contained larvae at every instar stage . This is indicative of the quick addition of other species into the standing water environments. Samples showed non-floodwater larva present by the end of April.

Samples were taken from the Nature Conservancies as a record for comparison. Details of all larval sampling are included at the end of this report.

Figure 3.2: Collecting larvae sample

3.5 Mosquito Identification results

Mosquito larvae samples were sent to Victoria for identification in April, May and July. . Seventeen species of larval mosquitos were collected during the 2019 season: 11 *Aedes*, 3 *Culiseta*, two *Culex*, and one *Anopheles*. All of these mosquitos are able to produce multiple generations during the season if the right conditions persist.

Aedes remains the dominant mosquito species in the first part of the season. This species is noted for its aggressive biting behaviour, its strong flying ability, adaption to very cold water, ability to use a variety of water conditions, and in the case of the species *Aedes cataphylla*, the ability to mature 5 batches of eggs in one season. This species lays its eggs in the mud and wet earth as water retreats; conversely, when it floods in the spring all the eggs hatch simultaneously. Note: They do carry canine heartworm.

Figure 3.3 *Aedes Vexans*

Culiseta appeared in the samples by April 29th. It is known as a serious pest to cattle but they bite people too. These mosquitos will fly in weather too cold for other insects and can be seen flying around on a winter day when the sun comes out. Larva can be found in ice covered pools and they often emerge when snow is still on the ground. It is the most widespread mosquito in BC and some *Culiseta* species keep pools of water teeming with larva all summer. They are a primary vector for Western Equine Encephalitis.

Figure 3.4
Culiseta Inornata

Culex were indicated in our samples by May 6th. Traditionally, these mosquitoes are not present until late May to early June. This species will tolerate any water source, even highly polluted ones. They bite readily, will come into your house, and typically reproduce all summer long. As a primary vector of Western Equine Encephalitis and West Nile Virus, this species needs surveillance and a treatment regime.

Figure 3.5 *Culex Tarsalis*

Figure 3.6
Anopheles Punctipennis

The ***Anopheles*** mosquito is persistent in their desire to enter houses. They bite freely after dark or in shaded areas. These mosquitos will use any type of water sourcefor reproducing. This species was identified in the sampling by May 2.

3.6 Sampling at a Glance

Species	Charateristics	Location (2019)
Aedes Sticticus	◦**Viscous biters day or night** ◦Several mile flight range ◦**Hatch immediately after eggs are flooded in the spring**	Eastgate, Chopaka
Aedes Cataphylla	◦**Aggressive biter, bites in broad daylight** ◦ Strong flyer predominant species of the dry interior grasslands/pastures, snowmelt pools, forests one ◦**Female can mature 5 batches of eggs in 1 season**	Princeton, Summerland
Aedes Implicatus	◦**Vigorously bites in shaded areas snowmelt pools or rain pool woodland mosquito** ◦Emerges early	Oliver, Princeton, Caweston, Summerland, Osoyoos
Aedes Fitchii	**Strong flyer – is a nuisance up to 1500m snow pool breeder** ◦ Likes open grassland and wooded environment	Chopaka, Osoyoos
Aedes Intrudens	◦**Vicious biter day or night** ◦ A big nuisance as they enter buildings readily through the smallest of openings ◦ **Prefer woodland areas, bogs and snow pools**	Chopaka
Aedes Dorsalis	◦Live and breed in fresh and salt water – major beach pest ◦ **Continuous summer breeder**	Eastgate
Aedes Campestris	◦**Attack even in the extreme heat of the day – attack in swarms bite all day** ◦ Wide flight range ◦ Like alkaline pools and water rich in organic matter	Osoyoos

Species	Charateristics	Location (2019)
Aedes Vexan	◦**Major cause of daytime annoyance** ◦ Wide distribution in Canada ◦ **Strong flyer 20-50 km; 100's of km when they get into the jet streamrequire** ◦ Flooding may immerse eggs several times in any one season each initiating a further hatch	All Areas
Aedes Impiger	◦**Prefer high evelations**	Princeton, Osoyoos, Summerland
Culiseta Inornata	◦Serious biter of cattle ◦ **wide distribution across BC** ◦ Fly when it is too cold for other insects ◦ **Larvae found in ice covered pools** ◦ Main transmitter of WEE	Osoyoos, Oliver
Culiseta Impatiens	◦ **Emerge when snow is still on the ground** ◦ Mainly bite cattle and humans	Osoyoos, Oliver
Culiseta Incidens	◦ **Loves to bite on warm evenings** ◦ Very large in size ◦ **Most common widespread mosquito in BC**	Summerland
Culex Tarsalis	◦ Bite readily and enter houses ◦ **Any water source will do even with high degree of pollution** ◦ Several generations per summer ◦ **Vaccinate horses for WEE and West Nile**	Osoyoos, Oliver,
Culex Territans	◦Breed in permanent pools and swamps ◦ **Do not like polluted water** ◦ Mainly amphibian biter	Oliver, Osoyoos
Anopheles Punctipennis	◦**Bite freely after dark** ◦ Breed any type of water ◦ **Persistent in entering houses**	Caweston, Oliver, Osoyoos

4. Common Questions and Answers

Q: How does the RDOS control mosquitos?
A: With the use of environmentally friendly pesticide. The RDOS uses a granular product called Vectobac®. Small pieces of crushed corn are saturated with an active ingredient called *Bacillus thuringiensis var israelensis* (Bti). The Bti is 'stuck' to granules using paraffin wax. The product is placed on the water surface where the active ingredient is released. Mosquito larvae are filter feeders and when they ingest the bacteria it creates a toxin in their gut which terminates them.

Q: Can Bti have negative effects on humans and other animals?
A: Bti is a non-toxic naturally occurring bacteria which has been successfully used as a biological pest control agent to combat mosquitoes and black flies since 1982. There has been significant research on the product during its long period of worldwide use. As a listed pesticide, research continues to show its effectiveness on these 2 targeted organisms (mosquito and black fly larva). There have been no registered poisonings of humans due to an intake of Bti.

Q: **Do I have to pay for mosquito control?**
A: Mosquito control is paid for by the entire Electoral Area or Municipality in which you reside. Therefore, all residents in the area are part of the program even if control is not on their property.

Q: **Does the RDOS treat everywhere there is mosquito populations?**
A: No. Private property owners must ask for mosquito control to be conducted on their property. Crews only treat where permission has been granted. Also, most conservancies do not allow any form of mosquito control. Additionally, if an Electoral Area or Municipality has chosen not to contribute to the program funding, that area will not be treated.

Q: **Can I get sick from a mosquito bite?**
A: Mosquitoes are vectors for disease. The biggest killers in tropical countries are Malaria and Yellow Fever. Here in BC, mosquito bites can result in extreme allergic reactions and/or secondary infections. Diseases like Canine Heart-Worm, Western Equine Encephalitis and West Nile Virus are transmitted between birds and mosquitoes to family pets, livestock and humans. Recently, the mosquito-vectored virus that causes Zika has become a major health concern in many areas of the world including the southern USA. The primary vector for Zika, *Ae. aegypti*, does not find our current climate hospitable, but with a changing climate and the possibility of competent secondary mosquito vectors, Canada has employed two specialty labs to study and monitor the situation.

5. RDOS Integrated Pest Management Plan and Bylaws

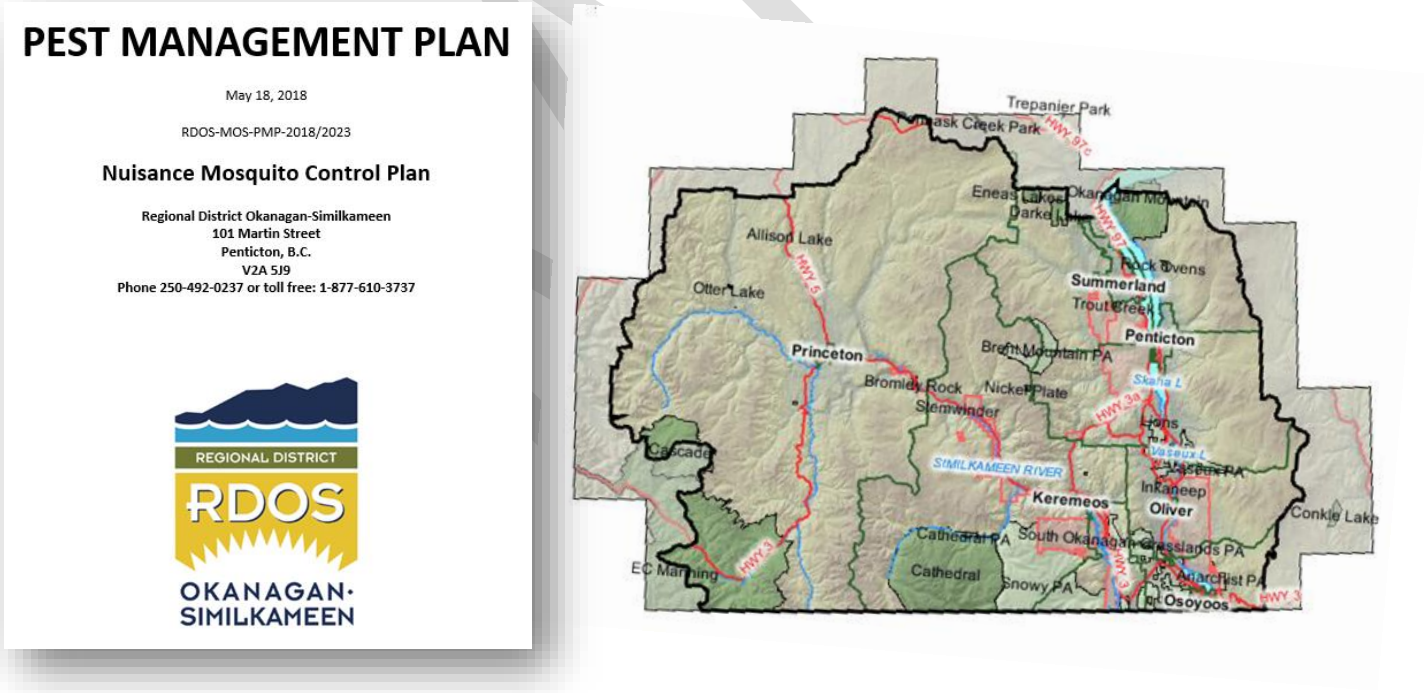
5.1 Integrated Pest Management Plan (IPMP)

The RDOS is required to have an active, approved Integrated Pest Management Plan in place at all times. The plan expires every five years, and reapplication is required. Costs are adjusted in correlation to amount of hectares to be treated as determined fromannual data supplied to the Province after the treatment season ends.

Significant consultation is required when a new IPMP is developed, including all Indigenous peoples who have rights or claims on the area to be treated.

Link to IPMP: http://www.rdos.bc.ca/departments/public-works/pest-control/

Figure 5.1 – Integrated Pest Management Plan



5.2 Service Establishment Bylaw and Update

The current bylaw in place for the Mosquito Control Program is located at the following link.

Link to Bylaw 2602-2014:
http://www.rdosmaps.bc.ca/min_bylaws/bylaws/engineering/2014/BL2602.pdf

6. Larvae Sample Data

Text??

Table 6.1: First Shipment

Date	Location	Site	Instar Stage	Sample Size	Species
3-Apr-19	Baldy	C - on the way to Baldy	1'	~450	Aedes spp
1-Apr-19	Cawston	B - VLA Rd	1'	~220	Aedes spp
3-Apr-19	East Gate	H - Airstrip Rd	1'	28	Aedes spp
5-Apr-19	Keremos	B - River Rd	1'	~320	Aedes spp
28-Mar-19	Oliver	C - Tuc Drive - Vet	1'	33	Aedes spp
2-Apr-19	Osoyoos	A - Old Richter Passage	1-2'	184	Aedes spp
3-Apr-19	Princeton	G - Princeton Golf course	1-2'	58	Aedes spp
29-Mar-19	Summerland	Sum - Dale Meadows	1-3'	106	6Ae sticticus, 5Ae cataphylla 95Aedes spp
4-Apr-19	Summerland	Sum - Dale Meadows	1-2'	88	Aedes spp
1-Apr-19	White Lake	I - Saddlehorn Rd	1'	102	Aedes spp

Table 6.2: Second Shipment

Date	Location	Site	Instar Stage	Sample Size	Species
04-Apr-19	OK Falls	D - Rail Rd-Treatment Plant ditch	2-3'	64	51Ae implicatus, 13Aedes spp
09-Apr-19	Alkali Rd, Osoyoos	A - Old Richter Passage	1-2'	40	Aedes spp
11-Apr-19	Oliver (Area C)	C - Island Rd	1-3'	83	14Ae implicatus, 69Aedes spp
12-Apr-19	Princton	H - Alleby Rd	3-4'	~90	71Ae implicatus, 9Ae impiger, 8Ae cataphylla
15-Apr-19	Cawston	B - VLA Rd	1-3'	279	24Ae implicatus, 255Aedes sp
16-Apr-19	Osoyoos	A - Rd 22 Conservancy	3-4'	39	30Ae implicatus, 5Ae fitchii, 4Ae impiger,
17-Apr-19	White Lake	I - Saddlehorn	P	19	19Chaoborid pupae (phantom midge, not mosquito)
18-Apr-19	Summerland	Sum-Monro-Train marsh	2-4'	152	39Ae implicatus, 31Ae impiger, 82Aedes spp
18-Apr-19	Chopaka	B - HWY 3A	1-4'	38	15Ae intrudens, 2Ae sticticus, 1Ae euedes, 1Ae finchii, 19Aedes spp

Table 6.3: Third Shipment

Date	Location	Site	Instar Stage	Sample Size	Species
26-Apr-19	East Gate	H - Airstrip Rd	1-3'	12	4Ae dorsalis,3Ae implicatus, 2Ae sticticus, 3Aedes spp
26-Apr-19	Summerland - Princeton	H - Summerland Princeton Rd	1	13	young Chaoborid larvae, not mosquitoes
26-Apr-19	Osoyoos	A - Old Golf Course	1-3'	56	1Ae campesris, 37Cs inornata, 6Cs impatiens, 12Culiseta spp
29-Apr-19	Osoyoos	A - Rd 22 Conservancy	3-4P	37	35Ae campestris, 2Ae mercurator,
29-Apr-19	Oliver	C - on the way to Baldy	P, adult	6	5Chaoborid pupae, 1Chaoborid adult midge, not mosquito
30-Apr-19	Cawston	B - VLA Rd	2-3'	13	12An punctipennis, 1Ae vexans,
2-May-19	Oliver	C - Nature Trust	1-4P	54	7An punctipennis, 29Cx tarsalis, 15Cx territans, 2Culex sp, 1Cs inornata
6-May-19	Oliver	C - Rd 18	3	8	5An punctipennis, 3Cx tarsalis
10-May-19	Oliver	C - on the way to Baldy	1-3'	94	54Cs inornata 15Cs impatiens 25Culiseta spp

Table 6.4: Fourth Shipment

Date	Summerland	Sum - Simpson Rd	2-4'	24	3Cx tarsalis, 9Cs inornata, 7Cs impatiens, 2Cs incidens, 3Culiseta spp
23-May-19	Keremeos	B - River Rd	3-4'	16	10Ae sticticus, 6Ae euedes
30-May-19	Summerland	Sum - Dale Meadows	1-4'	50	29Cs inornata, 14Cs impatiens, 1Cs incidens, 6Culiseta spp
31-May-19	Summerland	Sum - Williams Ave.	1-4'	146	17Cs impatiens, 54Cs inornata
6-Jun-19	East Gate	H - Airstrip Rd	1-4'	27	21Cs inornata, 5Cs impatiens, 1Culiseta spp
21-Jun-19	Osoyoos	A - Haynes Point	3	35	35Ae intrudens
9-Jul-19	Osoyoos	C - Rd 18	1-4P	23	3An punctipennis, 19Cx tarsalis, 1Culex spp,
10-Jul-19	Cawston	B - Wooden Rd	2-4P	18	18Cx tarsalis
10-Jul-19	Osoyoos	C - McKenney Rd	2-4'	31	3An punctipennis, 5Anopheles spp, 16Cx tarsalis, 7Cx territans
11-Jul-19	Summerland	Sum - Dale Meadows	1-4P	119	91Cx tarsalis, 8Cs impatiens, 20Cs inornata

7. References

1. Public Health Agency of Canada, "Government of Canada," *Endemic mosquito-borne diseases due to climate changes - Canada.ca*, 04-Apr-2019. [Online]. Available: https://www.canada.ca/en/public-health/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2019-45/issue-4-april-4-2019/article-3-endemic-mosquito-borne-diseases-climate-change.html. [Accessed: 02-Aug-2019].

2. P. Belton, *The Mosquitoes of British Columbia*. Victoria: British Columbia Provincial Museum, 1983.

Acknowledgements: The program would like to acknowledge the contributions from RDOS administration staff, front counter staff and the dedicated flight staff at Eclipse Helicopters for assisting in the successful execution of the program every year. *Zoe Kirk,* **Supervisor MCP**

Screenshots of ArcGis Collector - on cell phone

Pre-flight safety check – prior to each flight: shown here with Global TV for their annual segment on the RDOS Mosquito Control Program