Sterile Insect Release Program Evaluation & Funding Model

Final Report

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I. Disclaimer

The analysis and conclusions in this report are those of Cascadia Partners, and are not necessarily shared by the British Columbia Ministry of Agriculture and Food.

II. Executive Summary

The Okanagan-Kootenay Sterile Insect Release Program has been operating since 1992 with an area-wide mandate to control codling moths in the region. They currently serve the Regional District of the Okanagan Similkameen, the Regional District of the Central Okanagan, the Regional District of the North Okanagan and the Columbia Shuswap Regional District. The program provides a variety of services to manage the codling moth population – a major pest for local apple and pear growers that caused significant fruit damage prior to the program.

Recent industry trends have put some pressure on the sustainability of this program. Since the project was launched, the number of apple orchards has shrunk by two-thirds, due in part to industry fragmentation, the lure of higher-value crops, and increasing real estate values in the area.

From 2010 to 2021, local growers were paying $140 per acre per year for the service provided by the program; this number was increased to $150 in 2022. With fewer acres of apples, this smaller funding envelope from industry has in turn resulted in financial pressure on the program, with the option to increase tax rates or fees to alleviate this pressure having been declined previously. This is, of course, not sustainable over the long term.

The program was initially funded with a significant portion coming from senior government and the other portion split between industry and the four regional districts. Over the past decade, however, senior government funding has dropped significantly.

Approach to Evaluating the SIR Program

As an external and independent consulting firm, Cascadia Strategy Consulting Partners has been engaged by both the OKSIR program and the BC Ministry of Agriculture, Food, and Fisheries to conduct an economic evaluation of the SIR program and provide guidance on the following questions:

- Is the program critical to the economic viability of apple growers in British Columbia?
- What is the value of the SIR program to apple growers and the local economy?
- *[Optional Future Phase]* If the program is to continue, what options are there for a resilient and predictable long-term funding model that would ensure the program is sustainable well into the future?

We approached these questions in two phases. In Phase 1, the project focused on gathering the Okanagan and Similkameen (local) perspective, while Phase 2 looked at comparable jurisdictions such as Creston and Washington State as proxies. During the project, 26 interviews (16 local, 5 Creston, 5 Washington) were conducted with individuals who represent one or more of the following roles:

- Growers – organic and conventional; mostly apple, with some pear, cherry, and mixed tree fruits
- Packers
- Consultants / horticulturalists
- Entomologists
- SIR leadership, including program management and Board members

Throughout the project, data was gathered from these interviews, as well as from documentation available about the SIR Program, academic and industry publications, and available statistics. The data collected from these various sources has helped support an economic model that quantifies some of the impacts of the program. Non-quantitative impacts have also been captured and shared, of which there are many.

Key Benefits Identified

There are a series of benefits that BC apple growers receive through the SIR Program, as shown in the image below. These benefits range from low codling moth presence and low fruit loss to reduced spraying and health and environment benefits.

These benefits were first identified during local research, and were further confirmed during our jurisdiction scan with Creston and Washington. Many of these benefits – such as fruit loss, and costs to spray – can be quantified, and this project has sought to do so through an economic valuation. Other benefits – such as the value and importance of an area-wide mandate, and the multiple benefits of less spraying (health, environmental, reduced pest resistance, maintenance of good bugs) – are harder to quantify in dollars but are nonetheless key to the success of BC's apple industry and to the well-being of its local citizens.

Financial Valuation of the SIR Program

A note about units of measure: While SIR and Cascadia Partners reside in Canada where hectares are the official unit of measure in the metric system, the analysis has been done with acres as it is the commonly-used unit in the apple industry in Canada.

Cascadia's analysis estimated that if the SIR Program were to stop, a grower with a 10-acre farm would incur direct annual costs between ~$11,500 and ~$16,000 (conventional) and ~$25,000 to ~$76,000 (organic) to manage codling moth. This would include the cost to conduct mating

disruption, trap and monitor for codling moth, access the Decision Aid System (DAS) independently, still lose more fruit to codling moth damage, and spray more. These additional costs would not be manageable for many growers. It is expected that many growers would not take these full measures, and their codling moth pressure would be heightened, further impacting the proactive growers trying to manage the pest with these various tools.

In addition to these direct costs to growers, the BC apple industry is unlikely to survive without the SIR program. In 2021, British Columbia's apple exports totaled $16.5M[1]. In 2019, the BC apple industry is estimated to have contributed approximately $61.5M[2] to GDP and 578 jobs (this includes full-time, part-time, seasonal, and self-employed jobs). Without the program, this economic impact would be severely affected, particularly in the short term before agricultural land can be redeployed.

In Summary

Following the local research, jurisdiction scan, and financial analysis, Cascadia Partners concludes that the BC apple industry will likely not survive without the services offered by the SIR Program. Organic growers will struggle the most, as they have fewer, less effective, and more costly tools against codling moth at their disposal.

Growers who take a comprehensive approach to managing codling moth will incur prohibitive costs and still have significant fruit loss if their neighbours have an outbreak. Without an area-wide mandate, proactive growers would have no recourse against a neighbouring hotspot and may still end up with high codling moth pressure and fruit loss. Mating disruption does not work effectively with farms smaller than 10 acres, which means many orchards in BC would not even have mating disruption at their disposal. This is a key tool required in effective codling moth management. Growers would need to spray more, which would lead to increased spray costs, accelerated pest resistance, fewer beneficial pests, and health and environmental impacts.

Cascadia Partners concludes that the SIR Program offers significant value to the BC apple industry, its growers, Okanagan and Similkameen residents, and the local economy. Much of this value has been quantified in the sections below and other qualitative benefits have been described in this report.

Given the existential nature of the SIR program to the BC apple industry, if maintaining a domestic apple industry is a public policy objective, then a long term, resilient, predictable funding model for SIR is necessary.

III. Current SIR Services

There are approximately 7,500 acres of BC apples, concentrated in the Okanagan, Similkameen and Creston areas. While the exact number of apple orchards is not known, most of these orchards are relatively small by commercial standards. Of

[1] Statistics Canada Global Trade Tracker
[2] Cascadia analysis based on Deloitte Economic Contribution Study of British Columbia's Tree Fruit Sector

these commercial apple orchards, the average size is thought to be less than 10 acres and an estimated 10-20% of growers are using organic farming methods.

The SIR is currently funded by a $150.40/acre parcel tax that is paid by all apple and pear growers in the coverage area and municipal property taxes that together, contribute $1.7M annually. Commercial apple and pear growers in the Okanagan and Similkameen area currently receive services from the SIR program on a weekly basis during the growing season. The scope of the services currently offered by SIR are quite comprehensive, and includes:

- Sterile moth release. During the weekly farm visit, the field manager will release a minimum of one dish of sterile moths per acre throughout the farm; when a farm is having a codling moth issue, up to 4 dishes of sterile moths per acre are provided at no extra charge to the grower.
- Trap placement and monitoring. The field staff assigned to each farm provide and place traps around the orchard. During the 22-week growing season, field managers return to the farm weekly and check the traps to count the number of sterile and wild moths that have been caught. This data is collected by the field manager and entered into the SIR system.
- Tailored recommendations. The trap count data is shared with the farmer and their consultant (if applicable) and if the trap count has indicated a significant population increase, the program will send a horticulturalist to visit the farm and discuss pest management strategies.
- Additional support. When required to minimize an area-wide outbreak, the program can offer growers additional, tailored support in order to manage codling moth pressure.
- BC-DAS. The BC Decision Aid System tool leverages a variety of data models and local weather station data to provide insights on degree days and the lifecycle of a variety of pests in the area. This tool is available to all growers in the program area for no extra charge. DAS has been augmented to include recommendations tailored to BC growers on which products to spray based on the pest and where it is in its lifecycle. Licensed from Washington State University, the SIR program has brought DAS to BC and adapted it to link with 20 local BC weather stations, providing more accurate insights to BC growers.
- Authority to deal with hot spots. As part of its area-wide mandate, the SIR program investigates codling moth hot spots in wild trees, backyard trees, and orchards and provides advice on how to manage the outbreaks. Should the owners of the trees fail to sufficiently handle the outbreak, the program has the legal authority to remove the problem trees.

IV. Benefits Offered by SIR Program – Local Perspective

After completing Phase 1 local interviews, there were some very consistent views that emerged and were voiced by nearly all. These views include:

- With the SIR program in place, most farmers do not have to spray for codling moth and have little to no fruit damage.
- While the apple industry in BC has been struggling in recent years, it will not have a chance of surviving if the SIR program were stopped. This would be especially true for organic farmers.
- The information provided by SIR helps many farmers and consultants make decisions about pest management and when to do targeted sprays. Without this information, it is anticipated that many growers would not manage codling moth, or would do calendar spraying.
- The SIR program has numerous benefits to growers and the local economy. Most notably, those interviewed shared that paying the parcel tax of $150/acre is much cheaper than each farm needing to manage codling moth independently, and it is significantly better for the environment as it reduces spraying.

Each of these points come with a host of implications for the local economy and growers and a series of benefits. The SIR Program, as outlined below, impacts growers' bottom line in a variety of ways, provides health and environmental benefits, is effective because of the area-wide approach, enables data-driven decision making, and supports food security for Canadians. Each of these benefits are explored in more detail in the sections below.

Figure 1 – Key benefits offered by SIR program, local perspective

A. BENEFIT: MINIMAL CODLING MOTH PRESENCE AND FRUIT LOSS

The most significant benefit offered by the SIR program is that in the Okanagan and Similkameen area there is very little codling moth and thus little to no fruit damage for most growers. Most growers had between 0%-1% damage in the past 5-10 years.

The fact that codling moth is so effectively managed, however, adds complexity. Some growers may think there is not a codling moth issue and thus underestimate the efforts required to manage codling moth on their own should the program no longer exist. In some ways, the program has become a victim of its own success.

In the past couple of years, codling moth has been on the rise in the area, though the cause seems unclear. Some interviewees speculated that it may be due to bins arriving from Creston, where there is a high concentration of codling moths in orchards. Others wondered if it may be due to newer, short-term use pesticides. However, the degree of increase to-date appears to be low and

was only seen by some growers – one grower cited that last year they had 2% fruit damage, whereas previous years the damage was 0.2%.

If the SIR Program stopped – local perspective

When speaking with interviewees, many consultants and experts suggested that we may not see much change in the codling moth population for the first 1 to 3 years; the length of this grace period would depend greatly on weather. Following this period, all experts we spoke with expected a large uptick in the population. Growers would likely have a learning curve as they move to independent management of codling moth, and the moth population would grow during this time. Some predicted that if a grower did nothing for 3 years after the program was stopped, 90% of their apples would be infested. Most interviewees we spoke with were also concerned that many farmers would take no or minimal measures to manage codling moth on their orchards, which would have significant impacts on all growers.

Many growers and experts referenced Creston, as this area left the SIR Program ~15 years ago and has had a codling moth problem for some time.

B. BENEFIT: REDUCED SPRAYING

In addition to the low presence of codling moth, nearly all growers cited that reduced spraying was the biggest benefit offered by the SIR Program. Many growers interviewed had not sprayed for codling moth in the past 10 years.

There were exceptions to this, with one grower spraying 3 times a year for codling moth and some growers needing to apply 1 spray to an area of their orchard every few years. It was also mentioned that there are growers who are spraying when they don't need to – up to 8 or 9 times per year.

While one organic grower sprayed heavily for a couple of years during an outbreak 5 years ago, less than 10% of organic growers had to spray at all in the past 10 years. A couple of growers wondered if their early spray for obliquebanded leafroller had the side benefit of helping to control codling moth, but growers and experts had mixed opinions on this.

Prior to SIR, many growers were using harsher, broad spectrum products (which have since been banned) to manage codling moth and were spraying 4 to 5 times a year. With this approach and these product options, they were still having notable damage (5%) to fruit and observing pest resistance.

Spraying less has a series of downstream benefits for growers and the local community, most notably:

1. Financial savings to growers from reduced spraying
2. Slowed pest resistance
3. Maintaining the good bugs
4. Environmental, health, and community relations benefits
5. Support for agrotourism industry

1. Financial savings to growers from reduced spraying

Most growers interviewed currently spend very little or nothing each year to spray for codling moth. Not only do they save money not having to buy the chemicals, but they save on operational costs associated with additional spraying (labour, machinery, maintenance of machinery, fuel, etc.)

If the SIR Program stopped – local perspective

Nearly all interviewees estimated that without the SIR Program, they would need to spend a minimum of $160 / acre / year on chemical products to manage codling moth. This estimate was significantly higher for organic growers.

Note: *The consultation and research conducted during the jurisdiction scan suggested that spray costs would be significantly higher than SIR members expect, with an estimated $300 / acre / year in products for conventional growers and $776 / acre / year for organic growers.*

On top of these hard costs, they would have an increase in operational costs for tractor and sprayer use, machine maintenance, labour, and fuel. While some of the operational costs would be distributed by tank-mixing codling moth sprays with nutrients or other pesticides, there would still be an increase in these costs. This is due in part to codling moth generation lifecycles not lining up with many other pests as well as the sensitive pH of some codling moth products – the latter limits what products they can be mixed with in the sprayer tank.

Even if the SIR program provided no other benefits than reduced spraying, an apple farmer would be better off financially with the program than without the program

2. Slowed pest resistance

Growers identified that by reducing how much they have to spray for pests, they are slowing the evolution of pest resistance. Best practice is to alternate between categories of sprays to minimize pest resistance. This extends the lifetime of chemical sprays, making them effective for longer. Organic growers are more notably impacted by the need to spray, as they only have 1 to 2 chemicals in alternating categories to choose from; when they have to spray more often, pests develop resistance more quickly.

Pear growers are particularly affected by the amount of spraying, as their main pest – psylla – quickly develops resistance to chemicals. If pear growers needed to start spraying for codling moth they would quickly end up with resistant psylla.

3. Keeping the good bugs

Keeping predator bugs alive, such as ladybird beetles and predatory midges, through reduced spraying also benefits tree fruit farmers who are using integrated pest management techniques on their farms. Many interviewees explained how “spraying leads to more spraying” – increased

spraying leads to increased pest resistance and fewer predator bugs, which leads to an uptick in pest populations, the need to spray more, and fewer effective product options to manage pests.

If the SIR Program stopped – local perspective

With increased spraying, growers anticipate they would experience accelerated pest resistance with limited options to manage pests. This would be most challenging for organic growers.

Additionally, there would likely be a reduction in the predatory bugs that help support integrated pest management, requiring increased spraying to manage a variety of pests that were previously controlled by the "good bugs". Pear growers would also be impacted as most rely on predators to control pear psylla, which is quick to develop resistance to insecticides.

4. Environmental, health, and community relations benefits

The SIR Program is seen by many as an environmentally-friendly option for managing codling moth. Reduced spraying offers benefits for the area's ecosystem – there are certain to be ripple effects into other tree fruits and Okanagan and Similkameen plant life in general. Community members and growers all experience health benefits from less exposure to chemical sprays. Growers also mentioned how spraying less helps them with community relations. As one grower put it: "when you're wearing your spray suit on your tractor/sprayer, no one waves back". Not only does spraying have more negative consequences for the environment, but the perception around spraying runs deep.

A grower's perspective on spraying

"If pesticides were our #1 defence against codling moth we would need to have many effective products registered for this use. The products would need to be from different chemical groups to reduce the risk of resistance.
I see two challenges, other than the ethical issue of using pesticides when there is an effective and cost efficient alternative.
1. Canada is a small market and not all chemical companies will bother registering their product with the Pesticide Management Regulator Agency (PMRA).
2. PMRA has a mandate to reduce pesticide use in Canada either by reducing the number of registered products or by approving products at the lowest possible rate.
The result of the above is that Canadian apple producers often have fewer effective tools in the toolbox than our foreign competitors."
– Local grower

5. Support for agrotourism industry

Finally, agrotourism was cited as another area that benefits from reduced spraying. The Okanagan and Similkameen area benefits from agrotourism; u-pick orchards, picnic orchards, and farm stays

are offerings that attract tourists to the area. Reduced spraying supports the maintenance and growth of this industry.

C. BENEFIT: AN AREA-WIDE APPROACH

Most interviewees felt strongly that codling moth cannot be managed without an area-wide approach. A single problem tree in a neighbour's yard can create significant issues for a grower, let alone an adjacent orchard that is not effectively managing the pest. The SIR Program's mandate to support all growers through a multi-pronged pest management approach, as well as their authority to investigate and deal with codling moth hot spots, is key to keeping the population down. Even a grower who took issue with some of SIR's powers, still understood that this area-wide mandate was necessary as a means to the end; knowing that SIR has the authority to manage codling moth on the neighboring farms makes all the difference to the success of their business.

Additionally, since SIR is a mandated area-wide approach, farmers are currently benefiting from the local property tax contributions that help fund SIR's services to growers and the local communities.

The SIR Program has been in place for approximately 30 years, and many interviewed mentioned how at the beginning, it took some time for farmers to have confidence in the program. Many growers continued spraying more than they needed to for the first few years before trusting that it was no longer required. Overall, trust in the program seems quite high now.

If the SIR Program stopped – local perspective

Interviewees, while not all clear on how they would independently manage codling moth, recognized that without SIR they would need to buy, distribute, and monitor traps, manage the pest through mating disruption, spray more, and expect to lose more fruit due to neighbouring orchards or backyard trees with codling moth surges. Several mentioned that neighbours with codling moth issues were the greatest risk for their orchards.

It was expected that many farmers would likely not take broad measures against coddling moth in the first few years, and perhaps not even once the codling moth population was strong in the area. This would pose challenges for regaining control over the codling moth population, as early detection and intervention is important.

Additionally, losing SIR would also mean losing the policy and reinforcement work that SIR has developed. The program did the complex work of bringing provincial and municipal government, taxpayers, growers, and industry associations together for an area-wide program. This level of cooperation would be difficult to regain if the program stopped.

D. BENEFIT: ACCESS TO DAS (DECISION AID SYSTEM)

Many growers and consultants / horticulturalists we spoke with mentioned how the DAS tool has become essential for them when making pest management decisions. Specifically, many use the data to plan when to spray (at the ideal time during a pest's lifecycle) and what to spray (a

suggested list of products for both conventional and organic growers is provided through DAS). Targeted sprays help reduce the frequency of spraying and increase the effectiveness of spraying products. DAS also provides guidance on how other pests, including predatory bugs, may be affected by a certain pesticide spray. DAS offers the benefit of being connected to the latest research and recommendations coming out of Washington State University, which is a global leader in pest management research. This data is then vetted and adapted to local BC situations by local agrologists and researchers. Daily data is important for making targeted spray decisions; this is especially true for organic, as no products target the adult or the egg, making precise timing key. For data-driven decision-making, the tool is a significant asset made available to farmers through the program.

If the SIR Program stopped – local perspective

Should DAS no longer be offered through SIR, growers and consultants would not have an equivalent option. Some consultants suggested they might return to using excel spreadsheets to try and predict pest lifecycle and spray strategies based on degree day information. Others could choose to subscribe to DAS independently, but would need to pay a $230 USD fee per weather station and would not have access to the automated spray recommendations that have been tailored to a BC grower's situation.

E. BENEFIT: EXPORTING TO OTHER MARKETS

The SIR Program and its monitoring and management of codling moth supports the export of BC apples and cherries to certain markets. Some markets, such as Japan and Korea, require BC growers to provide documentation demonstrating that monitoring is in place and low instances of codling moths are present; cherry exporters have a zero tolerance policy for codling moth presence and growers must demonstrate that this is the case. Not only does SIR keep the instances of codling moth down, but growers can leverage the monitoring services and the trap capture data provided by the program to support their documentation required for export.

If the SIR Program stopped – local perspective

Growers seeking to export fruit to these Asian markets would need to fund and establish a codling moth monitoring program with documentation of weekly trap counts. Additionally, they would need to maintain codling moth counts below a certain threshold in order to be able to export. The grower may choose to do a mix of mating disruption, trap monitoring, and targeted spraying to manage their orchard. If, however, they are adjacent to a problem orchard or backyard tree, their efforts to control codling moth may still result in higher-than-acceptable instances and prevent them from exporting to these markets.

F. BENEFIT: GLOBAL LEADER IN CLEAN FOODS

Many who were interviewed felt strongly that the minimal spraying for codling moth, enabled by the SIR Program and its DAS tool, were a strong marketing lever to help promote BC

and Canada as a leader in clean foods and environmental farming techniques. Both conventional and organic growers are able to use integrated pest management techniques to help control a variety of pests and diseases; if marketed appropriately, this could help position Canada and BC as a leader in environmental and innovative growing techniques.

G. BENEFIT: NATIONAL FOOD SECURITY

Lastly, a few interviewees mentioned that growing food that can serve the local community is important to them. Given recent supply chain disruptions due to Covid (delays in shipping goods to and from Asia), weather events (rail disruptions in BC due to wildfires and floods), and other geopolitical events, the need for food security has become more evident. The SIR Program, as mentioned, is essential for the long term survival of the BC apple industry.

V. Jurisdiction Scan

After speaking with Okanagan and Similkameen growers and experts, the project moved forward with interviews and additional research in comparable jurisdictions. The Creston Valley in British Columbia and the State of Washington were the focus of this research and analysis.

The goal of this work was to better understand the codling moth presence in these jurisdictions, the interventions that growers are taking to manage codling moth, and the outcomes. The data and analysis gathered from the jurisdiction scan provided insights into what the Okanagan and Similkameen growers could experience if they did not have the SIR program in place.

A. CRESTON VALLEY

The Creston Valley served as an important proxy for this project as apple growers took part in the SIR Program until about 15 years ago. Since leaving the program, the codling moth population has increased and growers are now experiencing significant pressure from the pest. As an example, Okanagan packing houses have refused to accept apples from most Creston apple growers due to the risk of bringing more codling moth to the area in the bins.

Similar to the Okanagan, the acres dedicated to apples have declined, often shifting to cherries, and there are few apple orchards remaining. This decline has been even more pronounced for organic growers, with very few acres now dedicated to organic apples. Without access to Okanagan packing houses, apple growers have sought out smaller, niche markets to sell their apples. Some sell directly to communities in Alberta, while others sell through their farm stands to valley residents. For the volumes of apples being produced in Creston, these channels seem to be adequate, and growers are also able to command a higher price than those offered by packing houses.

1. High codling moth pressure with variable fruit loss

Those that have continued with apples are experiencing a range of fruit loss impacts from codling moth. Interviewees are losing anywhere from 0-1% up to 50% of their fruit due to codling moth damage. For organic growers, this number was closer to 60% fruit loss.

2. Variable amounts of spraying

From interviews, it appears that many conventional Creston growers are calendar spraying (i.e. are spraying every week) if they have the available funds. Some growers are only spraying 4 times a year with positive outcomes, while others are spending $1,500 per acre a year on codling moth sprays. The situation for organic growers was the most challenging, with an annual cost of $1,800 per acre on chemical sprays alone.

3. No area-wide approach or recourse can be challenging

All interviewees mentioned that codling moth pressure often comes from wild trees, abandoned orchards, or neighbours having an apple tree in their yard. Without an area-wide mandate and the authority to deal with codling moth hotspots, there is essentially no recourse for these growers. It can lead to difficult conversations with neighbours, and a constant codling moth presence from wild apple trees in the forests.

4. General interest in DAS

There was strong interest from Creston growers to have access to DAS, and specifically for BC-DAS to connect to local weather stations that accurately reflect Creston growing conditions. One grower explained that the Farm West data model they consult can be 2 weeks off in its predictions based on historical models, and that during hot weather the codling moth lifecycle transitions can happen overnight. In order for targeted spraying to be effective, precise timing aligned to the pest lifecycle is key.

5. Cherry exporting is the most impacted

Significant codling moth pressure in Creston is of serious concern to cherry growers looking to export to certain markets. Cherry growing has become quite widespread in the valley, and while codling moth is not a pest to cherries, certain export markets are very careful about controlling for codling moth. In order to access the more profitable export markets (e.g. UK, Japan, China, Taiwan, and Vietnam), growers must join the Canadian Food Inspection Agency export program. Participation requires growers to place a certain number of codling moth traps per acre, monitor trap counts weekly, and provide regular reports on those trap counts. If the number of codling moth caught in the traps exceeds the threshold, growers are removed from the program and can no longer sell to those export markets. In fact, some Creston growers have been removed as their trap counts exceeded the limit on a number of occasions. Selling to these international markets can pay growers twice the price they receive from local markets, and thus has a huge financial impact. As explained during interviews, one abandoned apple orchard can threaten the livelihood of a cherry grower.

6. Conclusions from Creston Valley jurisdiction scan

Interviews with Creston growers and experts revealed that there is significant pressure from codling moth in the valley, though some growers are impacted more than others. Despite the range of data reported on spray counts and fruit loss, Creston is still a meaningful jurisdiction to consider when

trying to estimate SIR's impact on the Okanagan and Similkameen area. The main takeaway from these interviews was that without SIR there would certainly be high codling moth pressure in the Okanagan and Similkameen area after a few years, and the magnitude of the financial impact to apple or cherry growers may be out of their control, instead reflecting the actions of neighbouring orchards. Without the legislative power of an area-wide mandate such as SIR, there will be no recourse for growers. Organic apple growers will be the most severely impacted.

B. WASHINGTON STATE

The State of Washington was another valuable proxy for how Okanagan and Similkameen growers would be impacted without SIR. They have a similar climate and geography to BC's growing region, and also experience three generations of codling moth per season. A key difference between Washington and the SIR region is the size of the growing region and its farms; Washington has 170,000 acres of apples to BC's ~7,500. Over the past decade the State has also seen a move to consolidation, going from 3,052 apple farms in 2007 to 1,260 farms in 2021. This has resulted in larger farms, with an average orchard size of 100 acres and some individual farms larger than 20,000 acres (three times the size of BC's total apple growing acres). The biggest implication of farm size is that Washington growers can more effectively use mating disruption to manage codling moth, and a single farm can take its own area-wide approach to managing the pest.

Washington State University and Washington's industry experts have been collaborating with the SIR program for many years. In fact, in recent years a distributor has been experimenting with drones to release SIR's moths in certain Washington orchards. Currently, SIR sells approximately 4,000 trays of SIR's sterile moths to their Washington distributor who sells the moths and the drone distribution each week to growers at a price of $500 USD / acre per year. It was shared by industry experts in Washington that this price is quite high for growers and will often only appeal to an organic grower who is on their third year of struggling to manage codling moth pressure by other means.

1. Increase in codling moth presence is worrying for industry

Codling moth presence has become a concern for apple growers recently, and in 2021 a Washington task force with top researchers and experts was assembled to address these concerns. The task force's work is still underway, but early takeaways have been that there is no single cause of the increase in codling moth in the area. It is possible that low codling moth presence for some time gave growers the impression that it was not a main area of concern. Other possible contributing factors: tractors may be driving faster to save on labour costs (leading to lower concentrations of spray per tree); newer sprayers use less water and distribute less spray; and some growers are using 200 or 300 pheromone dispensers per acre for mating disruption instead of the recommended 400 per acre. All of these factors combined may be the cause of an increase in codling moth in the area. Experts are particularly concerned, though, because unlike in the 1990s when there were broad spectrum products that would handle a codling moth surge, it was explained that there is "no big hammer to save us this time" should things get out of control.

2. Variable fruit loss due to codling moth damage

Washington growers and their customers have zero tolerance for codling moth in fruit – as shared by one interviewee: "no one wants to find a worm in their apple at the grocery store". Any detectable measure of codling moth will be responded to on some level by a Washington grower. In the interviews, it was shared that most conventional growers do not currently have a codling moth issue (0-1% fruit damage). The remainder experience 2% fruit loss, with 3% loss in extreme cases.

Organic growers, on the other hand, are more often struggling to manage codling moth, with some growers losing between 50% to 100% of their fruit.

3. Variable spraying for codling moth

In comparison to BC orchards, spraying frequently was less of a concern for Washington growers, as their large acreage means they rarely border a residential area and receive little pushback from the local community if they are out spraying each week.

When it comes to how often growers are spraying for codling moth, like Creston, there seems to be a wide range. For conventional growers, it was shared that some farms only spray 1-3 times a year if they do not have a codling moth problem. A 'typical' conventional grower would spray between 4-7 times a year, and those with a codling moth issue would spray 10-11 times.

A sidenote on spraying in large orchards

For the larger orchards, a downside to their size can be that it takes a week to spray the whole farm; when making targeted sprays based on degree day models their timing can be 'off' by the time they get to the last blocks of their orchard.

In the past 10 years, more growers have been transitioning to organic farming practices for some or part of their crops. At present, approximately 30% of the apple acres in Washington are organic. Some growers end up transitioning back to conventional as they find it so difficult to grow productively using organic methods. Organic growers, as discussed, often struggle more with codling moth management leading to higher spray costs to less effect. Many are applying products 7-11 times a season, with some spraying up to 24 times. With the limited products available to organic growers, they have fewer options that each have unique downsides – some of the products that are more effective also kill beneficial pests, and virus products can be applied more liberally but need to be applied more often and can become costly. Overall, there are fewer organic products in each chemical category making it difficult to rotate spray types and help slow pest resistance.

4. A history of area-wide mating disruption

From 1995-1999, Washington, Oregon, and California took part in an area-wide mating disruption program. While the program is no longer in place, nearly all Washington growers (~90%) use a regimented mating disruption approach on their orchards. Mating disruption has been shown to be most effective with farms larger than 10 acres, which aligns well with the large commercial scale

orchards in Washington. With recent cost pressures, however, not all growers are using the recommended quantities of pheromone dispensers (400 per acre) and traps (1 trap per 2.5 acres). This may be one of the factors contributing to the increase in codling moth in the state.

5. Conclusions from Washington State jurisdiction scan

In Washington, codling moth is becoming a concern to the extent that a task force of top experts has been assembled to identify the source(s) of the problem. Its apple industry has large farms which are conducive to mating disruption, most growers have established mating disruption programs in place, and it is coordinated in its research and marketing.

If Washington is struggling to understand and manage codling moth with such a consolidated industry, it is likely that this would be a much greater challenge for growers in British Columbia with so many smaller farms that cannot use mating disruption and with no past area-wide experience of using this approach. While BC can certainly benefit from the codling moth research coming out of Washington, it suggests that the province would have great cause for concern without SIR.

VI. Financial Impact of SIR Program

The data captured during local interviews, interviews with other comparable jurisdictions, and additional desktop research has formed the basis for this financial analysis of the SIR Program. There are several financial impacts that would directly affect a grower (A. through C. in the list below), and these have been laid out individually and then as a total annual cost for a 10-acre conventional grower and a 10-acre organic grower. Beyond the direct cost to a grower, a more general assessment was done on the impact of exporting BC apples and on the economic impact of the BC apple industry on provincial GDP and jobs (D. and E. below). All prices are in Canadian dollars.

Financial Impact Components

A. Direct value of SIR services to a grower
    a. Mating disruption as an alternative for growers
    b. Trapping / monitoring for codling moth
    c. Decision Aid System
B. Lost fruit revenues due to codling moth damage
C. Cost to spray more
D. Financial impact of exporting BC apples
E. BC apple industry's impact on GDP and jobs

The assumptions for each of the items in the financial valuation above are outlined in more detail in the following sections.

A. DIRECT VALUE OF SIR SERVICES TO A GROWER

In order to estimate much of the direct value of the SIR program to a grower, this report took the approach of considering what a proactive grower may do if they found themselves without the SIR

program. This clearly does not represent all growers in the Okanagan and Similkameen, as it was shared by local interviewees that they assumed many growers would do nothing – at least in the first few years without SIR – and would take action with codling moth management techniques only once the codling moth pressure had increased to a worrying level. For a grower who would take a multi-pronged approach to codling moth management, as most Washington growers are doing, the following components were estimated: cost for mating disruption, cost for trapping and monitoring for codling moth, and accessing DAS directly.

1. Mating disruption as an alternative for growers

Mating disruption requires a minimum of 10 acres and thus would not be effective for many Okanagan and Similkameen growers. For the purposes of this financial evaluation it was assumed that a proactive grower who no longer has access to SIR services would do mating disruption if their farm was 10 acres or larger.

Other key assumptions made:

- Placement of 200-400 pheromone dispensers per acre
- Labour[3] would be hired at $20 per hour to place the pheromone dispensers
- It would take 1.5 hours of labour per acre to place the pheromone dispensers
- A consultant would be hired[4] to support the mating disruption program

Based on these assumptions, the cost of mating disruption was estimated to be $107 - $184 per acre for a grower.

2. Trapping / monitoring for codling moth

Regardless of farm size, it was assumed that a proactive farmer would also conduct trapping and monitoring of codling moth. For this analysis it was assumed that:

- Labour would be hired at $20 per hour to place and monitor the traps
- It would take 30 minutes per acre each week to monitor the traps
- A consultant would be hired to advise on mating disruption, trapping, and monitoring at $75 per acre per year
- Placing traps, monitoring, and consulting would occur weekly for the 22 weeks of the growing season

[3] While growers could choose to spend their own time and not hire labour, a grower's time does have value. As such, this financial valuation assumed a labour cost of $20 per hour for these activities.
[4] Consultant services would support mating disruption and trapping / monitoring activities; full consultant fees have been included in the cost estimate for "Trapping / monitoring for codling moth".

Based on these assumptions, the cost of trapping and monitoring was estimated to be $341 per acre for a grower.

3. Decision Aid System

Without access to BC-DAS through SIR, it was assumed that a proactive grower would subscribe to DAS from Washington State University. Currently, an annual subscription to DAS costs $230 USD, or $292 CAD per year.

The cost of DAS access for a grower is $292 CAD per year.

Some growers would likely purchase their own weather station in order to have more accurate weather data to feed into DAS. This would represent a one-time cost of approximately $3,200. This station purchase fee was not included in overall calculations as it is assumed that not all growers would need to make this purchase.

B. LOST FRUIT REVENUES DUE TO CODLING MOTH DAMAGE

Without the SIR Program in place it is anticipated that growers would experience more fruit damage due to codling moth. However, the anticipated cost due to codling moth damage is more difficult to calculate since the amount of fruit lost by growers in other jurisdictions varied so greatly. In Washington one interviewee shared that most conventional growers did not have a codling moth problem (0-1% loss) while another shared that most had 5-10% loss due to injury. In Creston, some conventional growers surrounded by codling moth hot spots are experiencing 60% fruit loss and other farms had low rates. Considering the smaller size of BC apple orchards, it is most likely that growers would struggle to manage codling moth, as compared to Washington growers.

With that context, the following estimates were made for conventional growers:

- Low fruit damage of 5% due to codling moth
- High fruit damage of 10% due to codling moth

For organic growers, the loss is anticipated to be much more significant, with some growers reporting 100% loss. The following assumptions were made about fruit loss for organic growers in the Okanagan and Similkameen area:

- Low fruit damage of 10% due to codling moth
- High fruit damage of 50% due to codling moth

Based on interviews, the following assumptions were also used in calculating fruit loss:

- A grower will produce an average of 35 bins per acre per year
- A bin is approximately 800 pounds of apples

- A conventional BC grower receives $0.25 per pound for their apples
- An organic BC grower receives $0.45 per pound for their apples

Based on these estimates:
A conventional grower's lost revenue due to codling moth fruit damage: $350 to $700 per acre
An organic grower's lost revenue due to codling moth fruit damage: $1,260 to $6,300 per acre

C. COST TO SPRAY MORE

Without SIR, growers would certainly need to spray more for codling moth. As mentioned, this comes with a variety of downstream impacts – especially pest resistance, good bugs, and health and environmental impacts. These downstream effects would have a significant impact on BC growers and citizens and should be studied in more depth to better understand their long term effects.

For the purposes of this financial model, the most direct impact to quantify is the cost to a grower that would need to spray more in the absence of the SIR program. Conservative estimates were used – there were conventional growers who reported spending $1,500 per acre on sprays and organic growers who spent $2,200 per acre.

In calculating the cost for additional spraying, the following assumptions were made:

- Minimal operational costs were attributed to additional codling moth spraying, as some growers are already spraying every 7 to 10 days for something else and most growers mix nutrients and various insecticides in their tanks before spraying
    - The attributed operational costs – tractor and sprayer amortization and maintenance, tractor driver time, and fuel – total $29 per acre per year
- Conventional growers may only need to spray 4 times a year for codling moth, so this spray count was used
- On average, it would cost conventional growers $75 per acre for their spray products
- Organic growers would spray one time with oil, 8 times with Virosoft, and 3 times with Entrust
- Prices for organic spray products range from $40 to $87 per acre

Based on these estimates:
The cost to conventional growers to spray would be $329 per acre
The cost to organic growers to spray would be $805 per acre

D. SCENARIO ANALYSIS SUMMARIZING DIRECT ANNUAL COSTS TO GROWER

A number of scenarios were developed to better understand the implications of these additional costs to a grower. A 10-acre farm using either conventional or organic growing methods would be able to leverage mating disruption as a tool; this farm size also seemed reasonable as local

interviewees shared that the average farm size in the Okanagan and Similkameen area was between 4 and 10 acres.

A summary of the above-described cost elements are included in the table below:

Table 1. Scenarios – 10-acre apple orchards, conventional and organic		
	Conventional farm	Organic farm
A. Direct value of SIR services to a grower		
Mating disruption as an alternative for growers	$107 to $184 per acre	Same as conventional
Trapping / monitoring for codling moth	$341 per acre	Same as conventional
Decision Aid System	$292 per station per year	Same as conventional
B. Lost fruit revenues due to codling moth damage	$350 to $700 per acre	$1,260 to $6,300 per acre
C. Cost to spray more	$329 per acre	$805 per acre
Costs for SIR alternatives and other grower costs on 10-acre apple orchard	**$11,560 to $15,830 per year**	**$25,424 to $76,594 per year**

As can be seen in the summary table, the financial impact to an Okanagan or Similkameen conventional grower with an average-sized farm would be substantial, with a per year cost estimated to be between $11,500 and $16,000. The organic growers would feel the effects even more, with a low estimate of $25,000 and a high estimate of three times that amount. These costs to growers would likely cause many to leave the apple industry, as they would not be viable given current apple wholesale prices.

E. FINANCIAL IMPACT OF EXPORTING BC APPLES

The SIR program manages codling moth presence to very low amounts and also does trapping and monitoring of codling moth, both of which are necessary to export apples and other fruit to international markets. In addition to the direct costs growers would incur to manage codling moth without SIR, the BC apple industry and its exports would be negatively impacted. In 2021, BC's apple export industry represented $16.5M in value. These exports would be at significant risk in the absence of the SIR program.

F. BC APPLE INDUSTRY'S IMPACT ON GDP AND JOBS

It is the opinion of authors of this report that the BC apple industry will not survive if SIR were stopped at this point. As such, SIR is a critical service provided to BC apple growers and is closely connected to BC's apple economy. Building on a recent economic impact assessment commissioned by the BC Ministry of Agriculture, the impact in 2019 of BC's apple industry on provincial GDP is estimated to represent $61.6M and it is estimated that the industry sustains 578 jobs (full-time, part-time, seasonal, and self-employed).

This analysis assumed a proportional apple contribution to tree fruit GDP and jobs as was reported between apple and tree fruit farmgate values; knowing that apples represent 38% of BC tree fruit farmgate values, this analysis assumed apples also represented 38% of BC's tree fruit contribution to GDP and 38% of BC tree fruit jobs.

Based on these estimates:
BC apple industry contribution to GDP: $61.6 M
BC apple industry contribution to jobs: 578 (full-time, part-time, seasonal, and self-employed)

This is the estimated impact of the BC apple industry on the provincial economy and the economic impact that the SIR program sustains given its criticality to the continuity of the BC apple industry.

This impact requires additional context. If apple acreage was to decline, there would be a redeployment of land, capital, and labour to other industries. Some of these jobs and resources would likely be redeployed to other agricultural products, given that many apple orchards are situated on BC's Agricultural Land Reserve. This report does not speculate further on the details of economic redeployment.

VII. Conclusion

With the collection of interviews, additional research, and analysis conducted as part of this program evaluation, this report concludes that BC's apple industry is unlikely to survive without the SIR program. Organic growers, in particular, would struggle or fail to survive. There are many factors that would compound without the SIR program in place. Within 1-3 years of stopping SIR, it is expected that there would be high codling moth pressure, with few tools at growers' disposal given the size of apple orchards in BC.

If a grower is to try and manage codling moth on their own, they would carry a substantial cost, making it difficult for them to survive financially. Mating disruption is a comparable tool to SIR, but is not very effective with farms less than 10 acres, such as is common in BC. Without tools like mating disruption or SIR, codling moth pressure would increase significantly.

To try and manage the pressure, growers would need to spray more, which comes with a host of ramifications. It was previously mentioned that "spraying leads to more spraying" – spraying more would kill beneficial insects that help control codling moth and other pests. Without these beneficials, pest populations would grow larger and more spraying would be required. With increased spraying would also come accelerated pest resistance. This is of enormous concern to entomologists. Currently, there are no new insecticides for codling moth in the research pipeline and it takes 10 years to develop a new insecticide. If the current products become less effective due to pest resistance, there are no other options at the moment and a grower's toolkit would be further limited.

One of the key success factors of the SIR program is its area-wide mandate. Without the legislative backing that gives SIR the authority to manage codling moth hotspots, growers (both apple and

cherry) have no recourse against abandoned orchards or backyard trees with codling moth infestations. This would impact growers in general, but especially for cherry and apple growers who are exporting to codling moth-sensitive markets. In Creston, growers whose orchards are next to codling moth hotspots are at a loss as to what else they can try. Area-wide management is less of a concern for growers in Washington, where many farms are over 1,000 acres and each farmer almost has their own 'area-wide' approach on their orchard. In BC, however, residential and agricultural land is intermingled and a grower is significantly impacted by their neighbours.

The SIR Program was established to provide an innovative, effective, and environmental option for managing codling moth in BC. It contributes to clean water, clean food, worker safety, and resident safety. The program has led to an enormous reduction in spray costs and kept codling moth damage below their 0.2% target for 90% of BC apple orchards – interviews with growers and industry experts confirmed the effectiveness of the program. It is the opinion of this program evaluation that if maintaining an apple industry in British Columbia is a policy objective, then the SIR program should be supported and a sustainable, resilient funding model should be developed to ensure long term operational continuity.

VIII. Appendix: Opportunities

While not the focus of this Program Evaluation, Cascadia Partners began assessing the opportunities for a sustainable funding model that the SIR Program could consider moving forward. As the program has identified, with the municipal tax and parcel tax alone the program is unable to continue offering services to local growers on a financially sustainable basis. There are several opportunities that could be explored; they are not mutually exclusive and several could be done in tandem. All would at least require short-term funding to bridge the gap during the transition to a new funding model. Most require revisiting and adjusting the SIR Program's governance, which would need to be approached thoughtfully. Each of these ideas, of course, would require more financial analysis and consideration as to their viability and the risks involved with each.

A. CONTINUE CURRENT MODEL WITH FUNDING

This option would be "business as usual", but with some external funding source. The SIR governance structure would continue as they are currently operating, the program would keep prioritizing moths for Okanagan and Similkameen growers and selling excess moths to Washington and/or other jurisdictions. The current available capacity for export is about 6,000 dishes per week, but could increase if BC's apple acreage continues to decline, assuming the facility capacity remains constant.

For further exploration:

- Assess the price elasticity per dish of moths being sold to Washington distributor
- Explore options for selling to some Washington growers only during second half of summer when there is more of a need; this would only be if there is excess capacity to sell
- Analyze maximum number of moth dishes being distributed to Okanagan and Similkameen growers and assess diminishing returns; perhaps 4 dishes for infested properties is not ideal and fewer could be delivered; this would increase excess capacity for Washington sales and offset costs with additional revenue

B. SEPARATE BC-DAS AND EXPAND THE SERVICE

There is an opportunity to consider offering DAS as an independent and separate service to BC growers – it is a service with strong support and there is a clearly articulated demand from growers and horticulturalists to keep DAS as an extension tool. Separating DAS from SIR would allow DAS to seek more targeted funding, from government and growers alike, and potentially to expand its user base to other types of growers such as grapes, cherries, etc.

For further exploration:

- Explore adjacent industries that may be interested in DAS access or a DAS-like solution
- Continue regular horticulturalist panel review of product recommendations, and consider an approach for validating recommendations to other BC fruit industries

C. PUBLIC / PRIVATE OR PUBLIC / NOT-FOR-PROFIT MODEL

Perhaps one of the biggest departures from the current model, but an opportunity to be considered, would be to move into a public / private or public / not-for-profit model. In either of these scenarios, moth delivery and extension services would continue to be offered by SIR (public) while the moth-production facility would be operated by a private or not-for-profit entity. There would likely be an agreement between the two partners to guarantee a certain number of dishes of moths to SIR each year at a predictable price.

The facility may have expansion opportunities by a private entity, with the possibility of growing moth sales. There are also different R&D funding grants available to private agritech firms, and the facility could then more easily explore automation, an increased capacity and/or footprint, new or adjusted technology, shipping pupae instead of adults, etc. A private entity may also be able to leverage their existing sales channels or marketing strength, making it easier to expand moth or pupae sales outside of BC.

There is much to analyze for this option and it is complex. Some items to explore:

- The implications of a private vs not-for-profit vs public entity operating the facility
- The pros / cons of selling vs leasing the land and the building to the private or not-for-profit partner
- This opportunity would require a restructuring of the governance and would need to be explored carefully so as not to risk losing some of the elements that make the SIR program successful

D. EXPAND EXPORTS

Historically, SIR has explored business development opportunities in several markets – Europe, New Zealand, and Washington, for example. Past experience exporting moths by air have not made it an obvious market expansion opportunity – air travel is expensive, moths need to be kept cool in a container, these containers either need to be returned or disposed of, the carbon impact of flying moths is not in strict alignment with SIR's environmentally-conscious program, and other complexities.

There may be an opportunity, with the right sales channels, marketing, investment, and R&D, to explore exporting pupae or moths to other markets. This would likely require an expansion to the current facilities if the program is to continue serving its local users and growing its exports.

For further exploration:

- Within one of the new business models mentioned in Opportunity C, further analysis of the market entry opportunities including price elasticity and breakeven analysis
- Consider R&D lead time to explore radiation of pupae, or other technology advancements that would make this opportunity viable

E. EXPAND TO OTHER PESTS AND SERVICES

Many of those interviewed in the Okanagan and Similkameen area mentioned that they would be very interested if SIR expanded into other pests or other services. This expansion could be as simple as monitoring for other pests while on-site or as complex as new R&D into technologies that would support the management of other pests.

For further exploration:

- This opportunity would also require a restructuring of the program governance to allow it to expand beyond codling moth
- With operational and industry experts, identify the potential opportunities within this area and complement with a market scan on new / existing technology or GMO that could be leveraged; follow with a categorization of the low hanging fruit and the longer-term opportunities.

IX. Sources

In addition to interviews, Cascadia Partners consulted various industry reports, conferences and academic papers. Below are a number of selected sources.

1. Agriculture and Agri-Food Canada. *Statistical overview of the Canadian Fruit Industry.* 2020
2. Deloitte, prepared for Ministry of Agriculture, Food and Fisheries of British Columbia. *Economic Contribution Study of British Columbia's Tree Fruit Sector.* September 2021
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4. Ministry of Agriculture, *Food and Fisheries of British Columbia. 2020 BC Cherry and Apple Acreage Report.* 2020
5. Ministry of Agriculture, Food and Fisheries of British Columbia. *The Path Forward: A blueprint for BC's Tree Fruit Industry.* 2021
6. Okanagan School of Business, Okanagan College. *A Benefit-cost analysis of the Okanagan Kootenay Sterile Insect Release Program.* July 2014
7. Washington State University. *Codling Moth Summit.* February 24, 2022

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