Putting Sterile Insect Technique into the Modern IPM Toolbox:
Over 20 years of successful area-wide integrated pest management in Canadian pome fruit
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Okanagan-Kootenay Sterile Insect Release Program

Success for Growers, the Environment, and Communities.

- 94% reduction in Codling Moth population
- 96% reduction in related pesticide use
- 250% return on investment for local community
OKSIR is the **ONLY** community-based, area-wide IPM Program in the world that uses the sterile insect technique to control codling moth.
Okanagan, BC, Canada

- Hot Dry Summer / Mild Winter
- High Tourism Area and Urban-Rural Interface
- Program area: 21,000 square km
- Pome fruit production area:
  - 1992 – 8,900 ha
  - 2017 – 3,500 ha (-60%)
An Apple a day keeps the Dr. away!

Apples and Pears are Important of Healthy Diet

- No. 2 in World Fruit Production
  (2008 - Apple/Pears 86.4 million tons; Watermelon 94.5 million tonnes)

- Top consumed fruit in Europe
  (ahead of the citrus category)

- Second most consumed fruit in the USA
  (second only to bananas)

The Pest: Codling Moth

- The larva of the codling moth is the proverbial “worm in the apple”.
- Codling moth was introduced to Canada from Europe in early part of last century.
- A key economic pest in most temperate regions, directly attacking the fruit.
- Left uncontrolled, damages 50-90% crop.

Cydia pomonella (L.)
(Lepidoptera: Tortricidae)
In 2016, 76.4 million metric tonnes of apples were produced.


*Source: Canada Production, Stats Canada Fruit and Vegetable Production 2012
Is CM still a problem in 2017?

Information from a recent Industry IPM Conference:
2017 Orchard Pest and Disease Management Conference, Portland, OREGON USA

- 10 of 22 talks were on codling moth control
- Changing climate, increase in generations of CM per season
- Concerns of resistance to chemical – no new development online
- *Cydia pomonella* Granulosis Virus – threat of resistance
- Pacific Biocontrol rep: “*With mating disruption, supplementary sprays are a reality.*”
- Recognition there is no stand-alone technology
Is there another way?

YES!

- Area wide IPM using SIT to control codling moth
  - Supplement with Sterile codling moth
Area-wide approaches work

- Reduced costs and increased efficiency.
- The same approach can be applied successfully to pest control.

Sterile Insect Technique is one of the most effective tools to include into Area Wide Integrated Pest Management.
- Initial CM SIT Research done in early 70’s by Dr. Jinx Proverbs
  Proved dramatic reduction of wild codling moth populations using SIT
  (Proverbs et al. 1978, 1982)

- Late 80’s SIT research revisited - Led by Ag Canada, Dr. Arnold Dyck
  local regional governments and industry revisited and reconsidered using SIT
  An area wide Program was developed to deliver mandatory control through a
  unique area wide partnership

- Concerns with increasing use of organophosphates/ CM resistance
  Commitment to an area wide approach was seen as the solution to address
  negative environmental, health, economic impacts
  to protect lakes, rural/urban interface, increase in agri-tourism.

- Construction of Mass Rearing Facility completed in 1993

- Phase-in Strategy beginning with orchard sanitation
  to reduce wild populations before sterile insect release began in 1994.
Governance and Funding

- **Board of Directors**
  - 5 local elected officials and 3 growers (including 1 organic)

- **Advisory Committees**
  - technical and regulatory matters

- **Funded through Municipal Taxation**
  - property tax assessment – all properties (60%)
  - grower parcel tax on planted acreage (40%)

- **Annual Program Budget**
  - $3.1 million CAD   (2.16 million EURO)
Program Services

• **Mandatory Area-wide Control Application**
  ✓ weekly sterile insect release on all orchard properties

• **Surveillance**
  ✓ Pheromone traps, banding, visual inspection, fruit damage

• **Enforcement**
  ✓ Inspection, fruit stripping, tree removal

• **Education**
  ✓ One-to-one consultations, GIS Maps, website, newsletters, meetings
• Production capacity 780 million sterile codling moth
• Weekly sterile released into all orchards at a rate of 2000 sterile moths per hectare/per week
• 1:1 ratio of males and females
Program Services

• Mandatory Area-wide Control Application
  ✓ weekly sterile insect release

• Monitoring
  ✓ Pheromone traps, banding, visual inspection, fruit damage

• Enforcement
  ✓ Inspection, fruit stripping, tree removal

• Education
  ✓ One-to-one consultations, GIS Maps, website, newsletters, meetings
• 1 Delta trap per hectare baited with 1 mg codlemone lure
• Staff checks traps weekly for sterile/wild captures
• Data uploaded in field w/smart phone app and noted on traps
• Available for growers to monitor website, by email or in field.
• Staff carry out visual fruit inspection – ongoing/harvest
• SIR staff band host trees primarily in 200 m buffer zone areas near commercial orchards.

• Banding is a useful tool that can aid in assessing the level of wild codling moth presence in particular trees.
Program Services

• Mandatory Area-wide Control Application
  ✓ weekly sterile insect release

• Surveillance
  ✓ Pheromone traps,, banding, visual inspection, fruit damage

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Program Services

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Program Area

Pome Fruit Production
1992 – 8900 ha
2016 – 3395 ha

Zone 1 – Sterile insect technique (SIT) 1994 - present

Zones 2/3 – SIT 2003 – 2010
MD 2011 – 2014
(Mating disruption trial)
SIT 2015 – present
Annual Average CM/Trap/Week, By Zone, 1995-2016

- SIT implemented 1994
- 2003
- Zone 1
- Zone 2
- Zone 3

Taiwan → Control Measures Required

OKSIR → Spray Threshold
Reducing Urban Problems

Urban Sites within 200 meter Buffer Zone

- **No. Sites**
  - 2000: 5000
  - 2005: 4000
  - 2016: 2000

- **Infested Sites**
  - 2000: 43%
  - 2005: 8%
  - 2016: 8%
Reduction in Pesticide Sales

Estimated Kg of Pesticide Active Ingredient Applied/ha for Control of Codling Moth, 1991 - 2015
Additional Benefits of Area-wide

• Surpassed Program goal of fruit damage at harvest below 0.2% in well over 90% orchards.

• Reduction in Pesticide used against CM
  ✓ Maintains social license and tax payer contributions
  ✓ Increase in beneficial insects

• AW systems approach supports export programs
  (apples and/or cherries: Taiwan, China, Japan)

• Area-wide structure able to support contract work on other pests (BCFGA, CFIA)
Benefit-Cost Analysis (L. Cartier, Okanagan College, 2014)

- 250% ROI (employment and producer benefits)
- Non-agricultural willingness to pay = 90.4% (n=506, 178 RDOS)
### 20+ Years and Still Relevant

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<th>Residents and Tourists</th>
<th>Orchardists</th>
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| ↑ Population & Development  
(desire for ‘pastoral’ lifestyle) | Changing Climate  
(timing and monitoring more important) |
| ↑ Environmental Awareness  
(local/provincial pesticide bans) | Changing Pests  
(early surveillance is key – Area Wide) |
| Changing Consumer Demands  
(local and sustainable/low-input/organic) | Changing Pesticide Rules  
(can chemicals keep pace?) |

**People Want Healthy Communities with a Tradition of Agriculture**

**Agricultural Pests are a Regional Problem that need Area-Wide Control**
OKSIR Positioned for the Future

- **Financially Strong:**
  No Tax Increase for the past 7 years
  Capital Replacement with surplus reserve

- **External Review:**
  International Experts recommend OKSIR as a role model for area-wide IPM using sterile insect technique

- **Strategic Plan:**
  Direction to expand scale and scope by collaboration with other regions; adding value by expanding to incorporate other pests.
Challenges/Opportunities Ahead

Local Program:
• Continued funding for CM that is no longer key pest
• New invasive pests (Brown Marmorated Stink Bug)
• Pressure for taxation to be redirected fund other services
• Fixed costs of facility running at 1/3 capacity

Expansion of Scope:
• Adjusting staff resources and structure to add value through including other area wide services; DAS, new invasive pests
Challenges/Opportunities Ahead

Expansion of Scale:

- Securing interest of other regions for sales of excess production capacity.
  - Pressure on world apple producers to address resistance and supplemental sprays (conventional and organic). Opportunity in 99.99% production to use area wide SIT.
- Permission to import and release sterile codling moth ie. requirement for veterinary certification, questions on authority to release beneficial control agent OKSIR CM SIT – ie. EPPO, Organic certifiers. [Precedent releases in Canada, NZ, SA and USA]
- Affordable and sustainable shipping logistics
- Adapting authority/governance of OKSIR Program from public sector to include “for profit”, taking on liabilities, restructuring staffing and administration to support commercial ventures
Next Phase: Diversification

1. Alternative Revenue Streams
   - Year round facility production? Commercialization?
   - Sterile moth Sales/ Egg Sheet Sales/ Active Ingredient Virus

2. Building Technical Network of Collaboration
   - Member of the FAO/IAEA Coordinated Research Program
   - Collaboration with WSU using Decision Aid System
   - Collaborating with NZ/USA on UAS for release

3. Inter-regional Global Co-operation
   - Work with global leaders in addressing invasive pests in a changing climate by:
     - Developing projects transferring area-wide knowledge
     - Building on opportunities to enhance value in IPM systems
     - Starting with the addition of CM SIT to the IPM toolbox for Pome fruit production
SIT into the Modern IPM Toolbox:

Call For Collaborations

Good for our Environment. Good for our Growers. Good for our Communities.

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