FINAL REPORT

Project Title: Temperate Fruit Fly Workshop

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Cooperators: Jim McFerson, Tom Unruh, Pete Landolt, Vince Jones and other university and industry participants (see below)

Budget History:

Item	**Year 1:** 2006
Salaries	0
Benefits	0
Wages	0
Benefits	0
Equipment	0
Supplies	0
Travel	5,000[1]
Miscellaneous	0
Total	5,000

[1]The $5,000 (and another $5,000 from Cherry Research) was used to reimburse 7 scientists for their travel to and stay in Yakima for the workshop.

Objectives 2006

1) Have a focused update on the nature of our problem with fly pests.
2) Provide updates on what research is ongoing and relevant – both in the Pacific NW and nationally.
3) Discuss how we ought to revise our research strategy to develop more collaborative, productive research and implementation.

Significant Outcomes:

At the end of the workshop, the following were identified as items of high research priority for apple maggot fly:

- **IDENTIFICATION (WHAT IS IT?)**
  - A. Differentiate apple maggot fly (*Rhagoletis pomonella*) from snowberry maggot fly (*Rhagoletis zephyria*) using molecular markers.
  - B. Identify possible host races of apple maggot on apple and hawthorn using morphometric, genetic, and behavioral approaches.
  - C. Hybridization of and gene flow between apple maggot and snowberry maggot.
- **DETECTION (FINDING WHAT WE HAVE)**
  - A. Develop better attractants and traps used for detecting and monitoring flies on apples and on hawthorns.
  - B. Determine spatial distributions of flies within WA; genetic, ecological, host, and behavioral factors affecting apple maggot abundance in western and eastern WA.
- **APPLE MAGGOT CONTROL AND MANAGEMENT**
  - A. Improve attractants, bait formulations (efficacy, retention), and packaging for apple maggot kill.
  - B. Improve and test toxicants (neonicotinoids such as Assail) and repellents (such as kaolin, Rainguard) and better sprays to use in riparian areas for fly containment.
  - C. Sampling and trapping to determine where flies come from.
  - D. Determine meaning of fly catches; reproductive status of flies caught on traps.
  - E. Combined tactics, including parasitoid release, for fly containment in feral areas.
  - F. Determine dispersal of flies; where flies are coming from.
  - G. Validation of phenology model in Washington.
  - H. Host plant resistance; resistant apple varieties and chemical, other factors.
  - I. Systems approach for management to satisfy domestic and foreign markets.
- As a result of the workshop, collaborations were planned: Wee Yee, Peter Landolt, and Charlie Linn to on work on host attractants for apple maggot; Wee Yee, Tom Unruh, Jeff Feder, and Stewart Berlocher to work on morphometric and molecular diagnostics of apple maggot, apple maggot host races, and snowberry maggot flies.

History and Methods

The Washington Tree Fruit Research Commission initiated a discussion to address research that could expedite the management of cherry fruit flies on January 7, 2005 at the Cherry Institute Meeting in Yakima. Discussion initially centered on the cherry fruit fly, but at a second discussion that took place at the Apple Entomology Research Review in Yakima on January 28, 2006, it was expanded to include apple maggot. At the Review, discussion was centered on what fly problems occur in the Northwest and how the Commission can help in funding projects that potentially can solve these problems. A third discussion took place at the USDA's Yakima Agricultural Research Laboratory (YARL) on March 1, 2006, and it was here at YARL that the idea arose to hold a fly workshop at the Cherry Research Review in The Dalles in November 2005. Between this time and the Cherry Priority Setting session in Ellensburg on August 11, 2005, various fruit fly researchers were contacted for their possible participation for a November meeting. However, the November meeting conflicted with the Entomological Society of America's Annual Meeting, which is attended by almost all professional entomologists, and it was decided to postpone the fruit fly workshop to a

later time. At the Cherry Research Review in The Dalles on November 4, 2005, a question and answer session about the proposed fruit fly workshop was conducted in which Commission support for the workshop was gauged (research participants were Wee Yee, Pete Landolt, Vince Jones, and Mike Willett, moderated by Jim McFerson).

After more discussion, it was decided a meeting to plan the workshop should be held at the Western Orchard Pest and Disease Management Conference in Portland from January 11-13, 2006 to come up with a tentative agenda. The eight attendees in Portland were: Diane Alston, Utah State University, Rufus Isaacs, Michigan State University, Vince Jones, Washington State University, Gary Judd, Ag Canada, Pete Landolt, USDA-ARS, Howard Thistlewood, Ag Canada, Tom Unruh, USDA-ARS, and Dave Biddinger, Penn State University.

One of the main conclusions of the group was that several areas of research are relevant and need to be emphasized; a few additional ones (f and g) were added after the meeting in Portland:

a. Identification problems (esp. apple maggot and snowberry maggot) using molecular techniques
b. Behavioral studies, particularly migration of mated females, population biology, and phenology
c. Detection/security
d. What happens in the soil? Including biological control, possible use of nematodes
e. Management, including bait sprays, area-wide approaches, pesticide efficacy
f. Host range – likelihood of a fruit fly species infesting a certain host. Any objective measure of a commercially significant host range that could be explored
g. Survival of flies in different habitats in Washington

It was further agreed that the idea was not to ask Washington people to present their research, but to let experts from other parts of the country do this. Because there were seven identified areas, potentially seven outside researchers would participate, although there may be two participants under some of the areas. The plan was to have a maximum of 10 researchers invited to the workshop.

On April 10, 2006 in Ellensburg, a meeting was held to draft a workshop agenda and to decide which fruit fly researchers to invite to the workshop. The meeting was attended by Wee Yee, Vince Jones, Tom Unruh, and Jim McFerson, with Mike Willett calling in. From this meeting a draft was generated.

After much more correspondence, the list of invited researchers and the researchers' general areas of expertise was finalized:

1- Dr. Sue Opp, California State University – Dispersal of walnut husk fly
2- Dr. Charles Linn, Cornell University – Attraction of apple maggot races to fruit volatiles
3- Dr. Jeff Feder, University of Notre Dame – Genetic differences among apple maggot fly host races
4- Dr. Stewart Berlocher, University of Illinois – Genetics of and taxonomic relationships among fruit flies
5- Dr. Russ Messing, University of Hawaii – Biological control of fruit flies
6- Dr. Diane Alston, Utah State University – Insecticide control of western cherry fruit fly
7- Dr. Larry Gut, Michigan State University – Management of eastern cherry fruit fly and apple maggot fly using insecticides and baits

After several revisions, the final agenda was as follows:
Date and Location: August 28-29, 2006, USDA-ARS Lab in Wapato, WA

SUN, AUGUST 27

– Researchers fly in; evening get together of researchers, at Tom Unruh's house.

MONDAY, AUGUST 28

1. WELCOME & INTRODUCTION – WEE YEE – 8:00-8:10

2. OVERVIEW 8:10-8:30

MIKE WILLETT -- NORTHWEST HORTICULTURAL COUNCIL
Magnitude of Problems of Apple Maggot and Cherry Fruit Fly,
Quarantine issues; Distribution of apple maggot, etc.

3. OVERVIEW OF WASHINGTON RESEARCH LAST FIVE YEARS

Wee Yee and Tom Unruh USDA-ARS Wapato (8:35-8:55)

SECTION I. GENETICS AND LIFE HISTORY*

4. GENETIC VARIATIONS: (9:00-9:20)

Jeff Feder and Stewart Berlocher
- Host Use
- Identification
- Implications for Management

5. LIFE HISTORY: (9:25-9:45)

Charlie Linn
- Behavior
- Odor and Visual Cues
- Learning
- Detection- Trapping

BREAK (9:50-10:05)

6. FACILITATED DISCUSSION AND SYNTHESIS – SECTION I (10:05-12:00)

- Focus on areas ripe for collaboration, areas where info is missing or inadequate

LUNCH (12:-1:30)

***each person summarizing should give us at the end of their presentation, 3 areas that are researchable and key to understanding the life history and management of the flies**

SECTION II. POPULATION BIOLOGY AND MANAGEMENT*

7. POPULATION BIOLOGY: (1:30-1:50)

Sue Opp
- Dispersal
- Phenology
-Survival, abiotic and dietary factors

8. BIOLOGICAL CONTROL: (1:55-2:15)

Russ Messing
–Parasitoids & Predators
–Potential to reduce problems

9. MANAGEMENT: (2:20-3:05)

Larry Gut **(2:20-2:40)**
Diane Alston **(2:45-3:05)**
-Area Wide Suppression
- Bait Sprays
- Attract-and-Kill
- Pesticide Efficacy
- Thresholds

BREAK (3:10-3:25)

10. FACILITATED DISCUSSION AND SYNTHESIS – SECTION II (3:25-4:30)

4:30-5:15 – BREAKOUT GROUPS FOR FUTURE COLLABORATION

5:15-5:45 - CONTINUE BREAKOUT GROUPS AND/OR LAB TOUR

6:00 – 9:00 SILVERLAKE WINERY TOUR & SOCIAL WITH INDUSTRY REPS

***each person summarizing should give us at the end of their presentation, 3 areas that are researchable and key to understanding the life history and management of the flies**

TUESDAY, AUGUST 29

1. INTRODUCTIONS INDUSTRY AND SCIENTISTS (8:20-8:30)

SCIENTISTS' AND ORGANIZER'S MEETING (Synthesis of Monday's presentations and discussions) 8:30-10:30

(**Scientists and** Willett, Brunner, Landolt, McFerson, Yee, Unruh, Jones)

1. Give synthesis of where we are in PNW as of now
2. Emphasize the areas of needed research, areas ripe for collaboration, areas where info is missing or inadequate
3. Address in the presentation issues that we can't control
    a. Zero tolerance effects on IPM

10:30-10:45 BREAK

2. DISCUSSION WITH INDUSTRY (10:45-11:45)

Willett & McFerson

– Go through each area again (summary points only up on screen)
    - Ask for questions, comments, and suggestions in each area
    - Was anything missing?
    - Throw open for interactions

END BY 12:00; after lunch, researchers can leave.

1:30-3:00; ORGANIZER'S COMMITTEE (Willett, Brunner, Landolt, McFerson, Wee, Unruh, Jones)

- **Meets and modify presentation dependent on interactions in morning**
- **Set research priorities for industry. Or should this be done over a week's time?**

PARTICIPANTS IN ADDITION TO THE 7 SCIENTISTS:

Industry	Researchers and Others
McFerson	Klaus
Willett	Brunner
Craver	Landolt
Doornink	Yee
Hayden	Jones
Tim Smith	Unruh
Milne	Barcenas
Dan Griffith	

On August 28 and 29, 2006, the workshop was held at the YARL as planned. All invited scientists were present: Sue Opp, Charles Linn, Jeff Feder, Russ Messing, Stewart Berlocher, Diane Alston, and Larry Gut. The Washington entomologists and industry people were: Mike Willett, Vince Jones, Jim Doornink, Jim McFerson, Timothy Smith, Michael Klaus, Jay Brunner, Brent Milne, Dain Craver, Tom Unruh, Pete Landolt, and Wee Yee.

Not all the invited people could attend. The August 29 attendees were: Brent Milne, Jay Brunner, Dan Griffith, Charlie Linn, Russ Messing, Mike Willett, Vince Jones, Diane Alston, Larry Gut, Jim Doornink, Michael Klaus, Sue Opp, Tom Unruh, Pete Landolt, and Wee Yee.

The workshop in general followed closely the agenda outline for the first day.

The invited scientists were asked prior to the workshop to come up with three key research areas that will help understand fly biology and fly management:

The following were ones pertinent to apple maggot fly:

Jeff Feder: Genome Project using AM

Stewart Berlocher:

1-Surveys to determine basic ecological and biogeographical data on western *Rhagoletis*

2-Find molecular markers to distinguish *R. pomonella* (AM) from *R. zephyria* (SBM).

3 - Measure gene flow between AM & SBM

Russ Messing:

1 -Selectivity of parasitoids (long-term, high risk)

2-Mass-rearing technology and field testing of augmentation (medium-term, high risk)

3-Comparative economics of weekly GF-120 sprays area-wide, systems approach to population management strategies with integrated techniques (chemicals, parasitoids, nematodes) (medium-term, low risk)

Larry Gut:

1-Mode of insecticides; relationship to application timing

2-Improve bait formulations; potential use in non-commercial setting

3-Test, develop attractants/use in baits/monitoring

There was much discussion throughout the first day. Notes were taken during the workshop by Wee Yee. A condensed summary of the discussion pertinent to apple maggot flies follows:

The meeting began with an introduction by Wee Yee, who reiterated the purposes of the meeting:

1) Have a focused update on the nature of our problem with fly pests.

2) Provide updates on what research is ongoing and relevant – both in the Pacific NW and nationally

3) Discuss how we ought to revise our research strategy to develop more collaborative, productive research and implementation

This was followed by an overview of the fruit industry in the NW and issues with the World Trade Organization. Three areas important to export countries and the way these countries perceive our fruit fly problems were mentioned: 1) control of cherry fruit fly/apple maggot; 2) monitoring and ID; need more accurate traps, because we do not have much confidence in ones we have currently; 3) the difference between the biology of apple maggot vs. tropical fruit flies; host range (example, apricots use by apple maggot) and climate/adaptability. Indonesian examples: 1) flies from China are tropical species; 2) if we provide scientific, biological information to the export countries, this will stand up over the political issues.

SECTION I. GENETICS AND LIFE HISTORY

Jeff Feder and Stewart Berlocher presented on genetic variations in apple maggots. In addition to their technical points, they presented their researchable areas (see above):

Charlie Linn then presented on work done on developing assays to determine responses of flies to host odors and host odor discrimination.

Following the presentations, there were questions and comments.

A question arose as to the presence of host races in the NW. It was brought up that Stewart Berlocher and Bruce McPheron had done some work in the NW in the past - but Bruce did not sample enough to evaluate whether there are host races in NW. Now we can do that.

The situation in NW is different than in the East, because of different host plants – there are native haws, ornamental haws, and apples. We should also look at red haw. Can it be assumed that if there is no suitable host, flies will attack apples? There have been multiple catches in Yakima on hawthorn, but prior to just a few years ago, all larvae have been from hawthorns; now we know they infest apples too (2005, AM larvae in apples in the Selah).

Question: How much does not knowing where flies came in screw things up, as opposed to behavioral assays? Need both. 1) There are problems with host plants. There are 2 types of snowberries and several hawthorns. We have distribution records of hawthorns, but hybrids make ID difficult. Do fruit loads of trees here versus in the east differ? Do flies survive differently because of wet versus dry environments? However, in the SW (Texas), the environment is harsh, but AM can still survive there. 2) East coast eclosion times, are the emergence times here similar? We need flight tunnel tests, genetic tests of flies, and surveys of flies in eastern and western WA; maybe some flies not responding to apple? 3) Ovipositor lengths: problems; molecular tools needed to separate apple maggot from snowberry maggot; add more markers; none shows 100% separation, 7 or 8 markers; SNIPS may be valuable. 4) Morphometrics, may be more practical to use now than molecular tools? WSDA keeps specimens in hard medium; can extract DNA out of them.

LUNCH was between 12 pm and 1 pm.

After lunch, there was further discussion and synthesis of the talks in SECTION I, GENETICS AND LIFE HISTORY.
Notes, summaries of discussion and researchable areas and possible collaborations follow:

1) It was suggested that Charlie Linn get involved in studies on responses to fruit odors of flies in the East vs. West, flight tunnel tests, develop better detection methods; **2)** Charlie Linn can ID volatiles of snowberries; have candidate blends already; **3)** Charlie Linn can ID profiles of volatiles from black hawthorn, *Crataegus douglasii*; **4)** Question of genome project; Jeff Feder, Stewart Berlocher: Find how fly's brain organized; how genes expressed. Extension of USDA project; additional funds helpful. Jim McFerson-Set priorities – need robust set of markers. Not start with genome? The studies of Feder, Berlcoher with allozymes, microsatellites tie in with eclosion and wind tunnel studies. Then expand, additional monies data for all loci; put markers on linkage map; tissue samples. This is both applied and basic science – understanding physiological mechanisms. The question arose: Is there competition for funding with other insects? Mosquitoes, *Glossina* (Tsetse flies) genome project; honeybee genome project wrapping up. Apple maggot work supportable from 2 camps (USDA and basic research); **5)** Survey work of *Rhagoletis*: Basic survey work can be tied in with allozymes; CAPS money; Characterize the insects – this work supportable by NRI.

This was followed by a discussion on systems approaches: There are NAPPO standards for phytosanitary measures; systems approaches – partial quarantine areas- show areas are pest free; surveys, traps, research to back up use of traps; risk assessments. This includes odor perception, host races; molecular approaches.

SECTION II. POPULATION BIOLOGY AND MANAGEMENT
Talks were presented by Sue Opp, Russ Messing, Larry Gut, and Diane Alston.
Following their presentations were discussions.
The first topic was GF-120 and how it may be improved, and other areas; discussion was somewhat a free exchange of ideas sometimes not entirely following one train of thought.
The idea was put forth that GF-120 simply protects the spinosad, keeping it toxic longer. Poor spray coverage resulted in poor control. It was stated that for control studies, it is good to know your fly population, whether you are catching mostly mature or immature flies. Is a greater proportion of flies that is caught immature? GF-120 is not attractive to apple maggot. Black spots are attractive in flight

tunnel, so perhaps flies attracted to baits visually? Adding fruit volatiles to baits may improve attractiveness? When trapping in hawthorns, are haw volatiles useful? Does a dot, clumped bait made to resemble a fly increase attractiveness? A deterrent material such as Surround (kaolin) causes flies to disperse, which would not be good? Do flies feed on GF-120 on non-hosts? Yes, flies are found on non-host plants, and presumably would feed on the bait. Is MSG is a feeding stimulant? Stimulates feeding in Lepidoptera (moths), but for flies?

Other areas not related to GF-120 were then discussed: It was stated that apple maggot populations in arid areas have not gone very far; are there ecological relationship to survival of apple maggot; in neglected trees under which soil moisture is low? The tree still fruits, so climate is suitable for trees and flies? Hot in central WA.

This was followed by a discussion on fly survival in arid environments and central Washington: Marshall Johnson (Univ. Calif.) has done work with olive fly and temperatures – why not a problem: hot weather in CA and no food and water. It is hard to imagine how flies find water in arid environments; what effects on adult mortality, longevity? For olive fly, there was still 60% survival even after 5 days with no water; work by Jorge Hendrichs on apple maggot behavior of regurgitating droplets to concentrate the bubble. Way of conserving water? Actually the bubbling was to concentrate dilute sugar foods. Is penetration by females of fruit a factor in why populations are low in Nile Valley? Is the black hawthorn, *C. douglasii,* not a perfect host? Sheri Smith showed that apple maggot emergence was good even when soil was dry; so in some non-irrigated areas, soil moisture not a significant mortality factor? It was stated that there is variability in haws. Question was raised: do the xeric conditions affect quality of host and not fly itself? Suggestion that xeric conditions affect quality of host and not directly on the pupae.

A question was asked of two regulators – Mike Willett, Mike Klaus: what remediation measures have been taken against apple maggot? Willett: We need to keep insecticides out of the water; pest boards using up Imidan this year; took all the fruit from haws over water; the plan is to use traps to detect; then Pest Board sprays; Counties go in and treat where flies are caught so next year no flies; a few orchards are threatened this year. Willett stated that we want to create a low prevalence area, but Pest Boards are not likely to spray consistency.

Another participant stated that we have no idea of the effectiveness of remediation measures; we do not know the extent of the fly distribution; should we do something to make an area fly free?

Klaus was asked if there are researchable areas he sees for apple maggot: He stated that it would be valuable to determine high and low apple maggot population years as determined by trapping in the Nile Valley, a remote area, using sentinel-type sites over 10 years: and then relate to local climate data and infestation rates in fruit

Are there any trap crops? Haws for apple maggot? Maybe, but it is probably more of a risk if we use trap crops.

SETTING THE RESEARCH AGENDA: AUGUST 29, 2006

8/29 Attendees: Brent Milne, Jay Brunner, Dan Griffith, Charlie Linn, Russ Messing, Vince Jones, Diane Alston, Larry Gut, Jim Doornink, Michael Klaus, Sue Opp, Tom Unruh, Pete Landolt, Wee Yee

McFerson stated we need to maintain dialog with other scientists

Pete Landolt stated that what he gathered from the first day's open discussion fit into 3 research areas:

1) A problem area is finding out what we have, taxonomy, etc
2) Finding it, using traps
3) Management

The question was asked: Do we all agree: Are all these problems, anything overlooked? No one publicly disagreed. It was stated that we still need to know basic biology; if different, will affect control and all three areas. Characterization of biology, host species range, control options, and biology are threaded through all these three areas. Is it possible any of the "apple maggots" are

actually dogwood flies – do we need continued work on rearing flies from fruit – dogwood, serviceberry, cascara, pyracantha, etc? Why are we (WSDA) picking up single flies, are we missing some? Why are we not successfully finding them in higher numbers? Is the dogwood fly is the same fly as apple maggot? The dogwood fly is similar to apple maggot, but separate and may be a different species.

1. APPLE MAGGOT, WHAT WE HAVE:

Question: why apple maggot is not established in orchards, if the fly is all around us?

There is a disconnect - why do we detect, but do not manage the fly; hesitant to feel comfortable; are we detecting apple maggot in commercial areas? Yes, we have some threatened orchards in west Valley (of Yakima); if I were grower, I would file complaints against owners with infested backyard trees; there is a lot of development, some trees are cut, some trees are unmanaged; if we start to find flies, it may be because of these unmanaged trees. There is an educational component: for example, there is a giant hedgerow of black hawthorn near an orchard, which shouldn't be there. Can you detect apple maggot? Yes. Apple maggot is in both apple and black hawthorn. Where is apple maggot is coming from, and when will it infest the cities? It will be a mess when that happens. The third cover spray is when apple maggot is emerging. There is a push into organics, but we don't hear any growers complain about apple maggot. Do flies from haws attack apples? How ID? The best we have now for species ID is morphometrics. The preference for ID is morphometrics. Further, under the basic umbrella info, we also need to make methods available to people doing surveys, to separate apple maggot from snowberry maggot flies from dogwood flies. Hawthorn vs. apple fly phenologies are different. Is there any interest in volatiles - yes.

McFerson asked if everyone agrees that a major barrier is sibling species and races? An important researchable area is morphometrics. We also need to know if flies act/behave differently. There are at least two researchable areas: 1) Separation of snowberry maggot and apple maggot; 2) Ecology of host races. It depends on underlying questions, what interests are. Methods to use odors to ID the flies can be done. Flies can look alike, but act differently. If no "black hawthorn flies" go to volatiles, it will still mean something. We don't know if we have an apple maggot or black hawthorn fly. Emergence time is the critical thing; are some flies later emergers? Temperatures will shift the emergence period of flies. But this work has been done; flies do emerge at different times. Unlike in east, in Washington, when fruit are removed from each host, placed under a tree, all flies emerged at same time. However, on a calendar day basis, emergence may differ, but on a degree-day basis, emergence is the same.

A researchable issue then is: Determine eclosion/ecological data to characterize host races? Another researchable area then: snowberry maggot vs. apple maggot; within apple maggot, are there apple and haw races? There will be different methods for each analysis. Morphometrics is important, but boring. But it is possible to take from each specimen a leg for molecular work, and the rest of body for morphometrics. Morphometrics are for the short term, but maybe not.

2. APPLE MAGGOT, WHERE IT IS, DISTRIBUTION:

How to detect them: Detection and distribution are different. McFerson asked: what do we need to know about it? We need historical data. We are talking about different scales: in one orchard, the other along a specific creek, for example. One problem is that we are not sure what the flies are. What about wild vs. commercial settings? We don't trap commercial orchards; do we need to know? WSDA has been mapping apple maggot distribution in WA for 20 yrs; we need to slightly re-direct it; give WSDA tools to do better job. In the future, we need to know how apple maggot expands in commercial areas. McFerson stated that if we had more tools, we can analyze the situation better, right? We need detection in feral vs. commercial settings. We need new tools; traps become critical. Do we have a trap that works as well as we would like – the answer is no. What volatiles, traps, etc., will help do research? McFerson asked: We don't have tools yet? No, not the optimal tools.

Also, we can do it, but we don't always know which fly is apple or snowberry maggot. It comes down to the trap, what's now; contrary to experience in the East. There, traps are giving information you need; people in NY don't think of races. Traps in WA do not work same way as in East. Put traps around orchards – But trapping doesn't occur around orchards here.
Volatiles work in the East. Ladd traps (yellow panel with red sphere in middle) work, but cumbersome to use. McPhail traps work better in hot dry areas, but McPhail-type traps (yellow jacket traps) don't work well for apple maggot in WA. New volatile research needed; behavioral research also needed. McFerson asked if it is possible to pursue aggressive field sampling without new tools? Yes, we can start with current tools, but better tools should be pursued. Regulators can do distribution studies using what we have; we are not talking about that; we need new IPM tools; need something more attractive. We need to do IPM instead of calendar sprays – need better traps.
How flies are moving, how far, understanding what's happening; are there techniques to release-recapture, understand fundamental info? We don't have good info yet.

The problem with looking at dispersal is that with low populations, we will not recover any flies. There are areas in WA State with high apple maggot populations. How far can populations move from small orchards; is movement by apple maggot natural or caused by humans? One wonders if flies are moved by humans, because flies are found in recreation areas. Flies can go into cars also. It is coincidental if apple maggot is moving north. Some rate of movement has been plotted in the 1980's – first nothing in Seattle, now all over Skagit and Whatcom; natural movement? Was this a function of trapping intensity, as in Spokane? But these are not researchable areas. What happens when apple maggot moves from western to eastern WA? Suggest marking a source area and seeing where flies go. Some may fly, disperse a long way. The Manson (in Chelan County) catch in 2006 may be a result of long range dispersal. We may be seeing only the tip of the iceberg; a mated female may fly far. We detect larvae in tree, then come back to it, and find no larvae. What does this mean about spread?

Has anyone taken apple maggot from haw and see how well it develops in apples?
This is a researchable area: How apple maggot flies do in different hosts. Messina's work: very different- haw flies did not do well in apples.

3. APPLE MAGGOT, MANAGEMENT AND CONTROL:
Here in control, apple maggot and cherry fruit fly diverge; in one, management is keeping it out of the orchards, in the other, management is outside the orchards. Are the balls with the toxicants (curveballs) effective? These developed for eastern areas; needs moisture; not looked at in dry areas. It is not easy to make a ball, but maybe easier without rain. Do curveballs have relevance here in the NW (central WA)? Cannot put the curveballs on trees all over the roadsides, etc. It is important to make GF-120 better. Possible usefulness of Kaolin (Surround), and the use of a combination of tactics; whether they will ever be implemented is another question. Yes, a combination of tactics important, including the spread of parasites, everything. Agreed a combination of different strategies needed. There will be other benefits also.

This was followed by discussion on whether apple maggot can be prevented from spreading:
There is a bifurcation in control in feral vs. commercial settings. Researchable area: what are the chances of controlling apple maggot? It is better to use the terms containment or suppression, not control. McFerson asked if it was possible to contain it? Yes, in Kittitas County, the Pest Board is keeping it in feral trees. The Board is using Imidan now; we don't know what will happen if Assail (acetamiprid) is used. But Ellensburg (in Kittitas County) is a small area; apple maggot will spread in Yakima, since much bigger: 100,000 vs. 12,000 people, area much bigger. If apple maggot is not there currently, we can contain it; problem is if it infests towns; restricted areas right now.

How do we do it effectively? With apple maggot, growers never had to deal with it in central Washington; hope we don't get to that point; some trees have them, why don't we have it?
In the past, the consensus was that apple maggot would never get over to eastern WA; but it was only a matter of time, it will get here; making it here; it is here now. Yes, agree that apple maggot is new here (central Washington), a big unknown. We need to keep it where it's at; look at history, it's only a matter of time; we need to keep it out of orchards. We need treatments for organic apples.
Same question as with cherry fruit fly, if orchard is 100 m from a riparian area; can a fly disperse to the orchard? We don't know. With apple maggot, we are dealing with a completely different thing; need bait attractive to apple maggot and one that works. Which chemicals are effective for apple maggot? Neonicotinoids work for apple maggot. We have overstated the negatives – there is so much basic biology on apple maggot that needs to be done; is mating only visual? What are parasitoid effects on flies moving onto apples? For flies in riparian area, spray trees and follow dispersal. What does it mean when one fly is caught, are there many flies out there? When we catch flies, we need to pay attention to which type of flies, males or females, whether they are reproductively mature or immature.

END OF PERTINENT DISCUSSION

On the second day, the workshop ended at 12:00 pm, earlier than scheduled.

In summary: the research plan generated for the next three years was to work on host attractants and diagnostics: collaboration between Wee Yee, Peter Landolt, and Charlie Linn on host attractants for apple maggot; collaboration between Wee Yee, Tom Unruh, Jeff Feder, and Stewart Berlocher to work on morphometric and molecular diagnostics of apple maggot, host races, and snowberry maggots.