Spotted Wing Drosophila: Potential Economic Impact of a Newly Established Pest

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While significant gaps and uncertainties exist in scientific knowledge regarding spotted wing drosphila, it has the potential to cause substantial economic damage, particularly for specific crops and regions in California.

Spotted Wing Drosophila (SWD). Very little is known about the potential for crop damage due to SWD, but certain crops and regions may incur economic damage as a result of the establishment of this invasive species.

Photo by Martin Hauser, courtesy of University of California Statewide IPM Program

The spotted wing drosophila (*Drosophila suzukii*), a native of Southeast Asia, is a pest of berry and stone fruits. Its first detected North American invasion was in August 2008 in Santa Cruz County, California on strawberries and caneberries. In May 2009, additional infestations were detected in cherry orchards along California's Central Coast, in the Santa Clara Valley, and from Yolo to Stanislaus Counties.

Further trapping and identification efforts confirmed the presence of spotted wing drosophila (SWD) over a wide geographic range, extending the entire length of California's coastal counties north into British Columbia. SWD has been found on a variety of commercial and backyard host crops in these areas, including apples, blackberries, blueberries, cherries, grapes, nectarines, peaches, pears, plums, raspberries, and strawberries. The potential for its further expansion to additional soft-skinned fruit and vegetable hosts is unknown. SWD prefers a moderate climate such as that along the Pacific Coast, but it has been reported in relatively cold areas of northern Japan.

Although it is an invasive pest, by the time of its detection SWD had established itself to such an extent that eradication was deemed impossible by the California Department of Food and Agriculture. Relatively little is known about the biology of SWD, including its ability to overwinter, its seasonal cycle, or the determinants of its seasonal abundance. Similarly, little is known about potential biological and chemical controls for SWD, although a natural enemy of related non-pest drosophila species has been observed parasitizing SWD in Oregon. Given the extent of the invasion and this limited knowledge, there is the potential for SWD to create substantial economic damage, at least in the short term.

We provide preliminary estimates of the value of production of selected host crops that could be lost due to SWD infestations. Rather than predicting actual economic damage due to SWD, our estimates are intended to illustrate the *potential scope* of economic damages. The significant gaps in scientific knowledge regarding the biology and control of SWD, coupled with the substantial degree of uncertainty regarding the applicability of knowledge obtained elsewhere to the West Coast, prohibit definitive economic analysis.

SWD infestations can reduce marketable yields greatly. Yield loss estimates from 2009 observations range from negligible to 80%, depending on location and crop. Unlike related common vinegar fly species, which prefer overripe fruit, SWD prefers to lay its eggs in fresh soft fruit underneath the skin, rendering the fruit unmarketable. The larvae hatch, and then burrow inside the fruit to continue their development. Thus, in the earliest stage of infestation the only visible sign of damage to fruit is the oviposition sting, even when larvae have hatched inside the fruit.

Economic Impact on U.S. Production of Selected Host Crops

SWD infestations have the potential to affect significant shares of total U.S. production of certain host crops. The majority of U.S. small fruits production occurs in the Pacific Coast states. In

Table 1. Revenue Losses Due to SWD: 20% Yield Loss, 2008 Value of Production

	California	Oregon	Washington	Three-state Total
Strawberries				
Total farmgate value ($Million)	1,544.7	16.8	10.1	1,571.5
Share of U.S. production (%)	82	1	1	83
Total losses ($Million)	308.9	3.4	2.0	314.3
Blueberries (cultivated)				
Total farmgate value ($Million)	49.1	49.4	43.4	141.9
Share of U.S. production (%)	9	9	8	26
Total losses ($Million)	9.8	9.9	8.7	28.4
Raspberries and Blackberries				
Total farmgate value ($Million)	179.5	41.7	92.1	313.3
Share of U.S. production (%)	57	13	29	100
Total losses ($Million)	35.9	8.3	18.4	62.7
Cherries				
Total farmgate value ($Million)	194.5	58.7	297.1	550.3
Share of U.S. production (%)	30	9	45	84
Total losses ($Million)	$38.3	$9.9	$57.8	$105.9
ALL CROPS				
Total farmgate value ($Million)	1,967.9	166.5	442.6	2,577.0
Share of U.S. production (%)	58	5	13	76
Total losses ($Million)	393.0	31.4	86.9	511.3

Source: Authors' calculations based on data from the National Agricultural Statistics Service (NASS), 2009.

2008, California, Oregon, and Washington accounted for all commercial U.S. raspberry and blackberry production, 84% of the value of commercial cherry production, 83% of the value of strawberry production, and 26% of the value of blueberry production. For these four crops as a group, 76% of the total value of U.S. commercial production is grown in these three states, or $2.6 billion. Table 1 reports the value of production by state for each crop, and the share of each state's production in the national total.

The single estimate of a 20% yield loss does not reflect all information collected to date, although it serves as an average benchmark loss across the range of crops and production regions. While specific yield losses have not been observed for all crops in all regions, yield losses have been recorded for specific crop-region pairs. Of course, over time damage estimates may change, as additional infestations are documented. In addition, the development of effective control measures may mitigate yield losses relative to these early observations. On the other hand, as SWD becomes established at greater population densities, damage rates could increase. Table 2 reports estimated economic losses based on maximum reported yield losses: 40% for blueberries, 50% for blackberries and raspberries, and 33% for cherries. Losses for strawberries vary by location and end use.

California strawberries present an interesting case. To date, relatively little economic damage has been observed on strawberries, which is thought to be due at least in part to the short time interval between harvests of strawberries for the fresh market in California. Because there is a longer harvest interval for strawberries designated for processing, yield losses may be greater for this segment of the market. Thus, for processing strawberries we assume the yield loss of 20% observed in Oregon strawberries, which have a similar harvest interval.

When we include the upper bounds of the ranges of observed yield losses, economic losses increase substantially for Oregon and Washington, due to increased yield loss estimates for raspberries and blackberries. Losses for Oregon almost double. Losses for Washington increase by 85%. Because these states account for such a large share of U.S. production of these crops, the national impact on the value of production would be substantial. For California, losses decrease by almost 50% due to the relative importance of strawberries in the total value of production of the crops considered.

Economic Impact on Selected Coastal Berry-producing Counties in California

State-level estimates may not represent the importance of the economic impact of SWD for specific regions. Within each state, production of specific host crops may be concentrated regionally; for example, virtually all of California's strawberry and caneberry production is concentrated along the coast between San Diego and Monterey. These regions would bear the losses due to SWD. Tables 3 and 4 examine potential economic losses for three counties along the California coast that account for the vast majority of California's caneberry production and a substantial share of its strawberry production: Santa Cruz, where SWD was first detected, Monterey, and Ventura.

These counties are important to California agriculture. Monterey has the fourth highest value of agricultural production among all California counties, and Ventura ranks tenth. Berry crops are important components of the value of agricultural production in these coastal counties. Strawberries

are the single largest crop based on the value of production in Santa Cruz and Ventura Counties, and the second largest in Monterey. Raspberries are the second largest crop in Santa Cruz County and the fifth largest in Ventura County. Berries accounted for 17% of the total value of Monterey County's agricultural production, and just under a third of Ventura County's. Santa Cruz is distinguished from the other coastal counties by its high reliance on berries; 60% of its total value of agricultural production is berry crops. The importance of berries to these counties indicates that regional losses due to SWD damage could be significant.

We focus first on raspberries. Table 3 reports economic losses for a range of potential yield losses due to SWD infestation. As a benchmark, we include a zero percent loss, and extend the range to the maximum observed 50% yield loss. On average, raspberry yield losses to SWD damage in the Central Coast region were about 20% in the 2009 growing season. This average was not realized by every producer; a small share of growers (10%) is estimated to have sustained large losses (70%), a slightly larger share (20%) faced relatively small losses (10%), and a majority of growers (70%) did sustain the average loss of around 20%.

As shown in Table 3, at an average yield loss of 20%, revenue losses in these three counties were $42.9 million. Because raspberries are a particularly important crop for Santa Cruz County, the county's total value of agricultural production would decline by four percent. Because Monterey and Ventura Counties have much higher total values of agricultural production and raspberries are relatively less important, total revenues from agricultural production in Ventura County would decline by only one percent and the change in Monterey County's total agricultural revenues would be negligible.

Table 2. Revenue Losses Due to SWD: Maximum Observed Yield Losses, 2008 Value of Production

	California	Oregon	Washington	Three-state Total
Strawberries				
Total farmgate value ($Million)	1,544.7	16.8	10.1	1,571.5
Share of U.S. production (%)	82	1	1	83
Total losses ($Million)	28.0	3.4	2.0	33.4
Blueberries (cultivated)				
Total farmgate value ($Million)	49.1	49.4	43.4	141.9
Share of U.S. production (%)	9	9	8	26
Total losses ($Million)	19.7	19.7	17.3	56.7
Raspberries and Blackberries				
Total farmgate value ($Million)	179.5	41.7	92.1	313.3
Share of U.S. production (%)	57	13	29	100
Total losses ($Million)	89.8	20.8	46.0	156.6
Cherries				
Total farmgate value ($Million)	194.5	58.7	297.1	550.3
Share of U.S. production (%)	30	9	45	84
Total losses ($Million)	63.2	16.3	95.3	174.8
ALL CROPS				
Total farmgate value ($Million)	1,967.9	166.5	442.6	$2,577.0
Share of U.S. production (%)	58	5	13	76
Total losses ($Million)	200.6	60.2	160.7	421.5

Source: Authors' calculations based on data from NASS, 2009.

Although to date SWD damage has largely not been observed on California strawberries, this situation may change. Higher pest population densities may lead to greater infestations of strawberry fields. In addition, because the SWD is a mobile pest, management decisions and pest populations on nearby fields can influence populations and yield damage in a given field.

As strawberry fields transition into harvesting for processing, SWD could move from the old crop to new strawberry crops in nearby fields, due to overlaps between summer and fall plantings. This could increase yield damage on new fields when the fresh-market harvest begins. Based in part on observed infestations and damage in Oregon strawberries, wet weather also increases yield losses. Strawberry fields near caneberry plantings may also sustain infestations, especially when the caneberry harvest and SWD control are not managed effectively. Due to such considerations, Table 4 presents economic losses for a range of yield losses due to SWD damage in strawberries. The maximum yield loss considered is 20%, the loss observed in Oregon strawberries.

As shown in Table 4, due to the large value of the strawberry crop

Table 3. Revenue Losses due to SWD as a Function of Yield Loss: Raspberries

Yield Loss	Revenue Loss ($Million)			
(%)	Santa Cruz	Monterey	Ventura	Total
10%	10.6	2.4	8.5	21.5
20%	21.2	4.8	16.9	42.9
30%	31.7	7.2	25.4	64.4
40%	42.3	9.6	33.8	85.8
50%	52.9	12.1	42.3	107.3

Source: Authors' calculations based on data from NASS, 2009.

Table 4. Revenue Losses due to SWD as a Function of Yield Loss: Strawberries

Yield Loss	Revenue Loss ($Million)			
(%)	Santa Cruz	Monterey	Ventura	Total
1%	1.6	6.2	3.9	11.7
2%	3.2	12.4	7.9	23.5
5%	8.0	31.0	19.7	58.7
10%	16.0	61.9	39.4	117.3
20%	32.1	123.9	78.7	234.6

Source: Authors' calculations based on data from NASS, 2009.

in these three counties, even a small percentage yield loss can lead to significant revenue reductions.

Caveats

Any economic impact analysis is subject to the uncertainties in underlying scientific analysis. In the case of SWD, because it is a recent invader and the international literature on the species surprisingly limited, the scientific uncertainty is high and further research is required. Here we focused attention on a very limited set of host crops. SWD has been observed on other hosts, and the full potential range of fruit and vegetable hosts is unknown. If a larger number of hosts had been considered, potential economic losses would have been larger.

The estimated yield losses are based on a limited number of field observations to date. Estimates of yield losses, and the factors that influence them, will evolve over time as additional data are collected. Furthermore, realized yield losses will depend on the efficacy of available control methods. As efficacious control methods for various host crops are identified and implemented, realized yield losses will decline, all else equal.

In addition, our analysis computes losses based solely on the value of production for these crops. We do not take into account any changes in price that may result from a reduced supply from the three states considered. Any increase in price due to a reduced supply would offset to some extent the reduction in revenues due to the reduction in the quantity produced. Similarly, we do not consider any changes in consumer welfare that may occur; our analysis is limited solely to the effects on producer revenues.

The net effect of these considerations on our analysis is indeterminate. To the extent that competing domestic and international suppliers can increase production to offset reduced production in California, Oregon, and Washington, prices will not rise, so consumers will be unaffected but producers will face larger revenue losses. If trading partners impose trade restrictions due to SWD infestation, then either growers will no longer have access to those markets or they will have to implement potentially costly phytosanitary practices in order to continue to export to those countries. Finally, while efficacious control methods will reduce realized yield losses, they will also raise production costs to an unknown extent. Nonetheless, in spite of these many considerations, it is apparent that there is substantial potential for certain crops and regions to incur economic damage as a result of the establishment of SWD.

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For further information, the authors recommend:

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