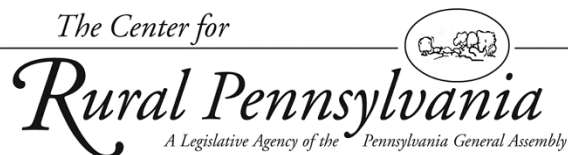# Potential Economic Impact of the Spotted Lanternfly on Agriculture and Forestry in Pennsylvania

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December 2019

Executive Summary

The spotted lanternfly (SLF) is an invasive insect species that is currently having a destructive impact on vulnerable agricultural crops and tree species within Pennsylvania. This study estimates the total economic impact of the SLF within the entire state of Pennsylvania. The analysis considers several scenarios, which vary based on geographic scope and the estimated potential severity of damages. These include estimates based on damages (1) if the SLF is successfully limited to the 14 counties in the quarantine zone only (Berks, Bucks, Carbon, Chester, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Philadelphia, and Schuylkill counties), (2) if the SLF expands to the 12 counties adjacent to the quarantine zone (Adams, Columbia, Cumberland, Franklin, Lackawanna, Luzerne, Montour, Northumberland, Perry, Pike, Wayne, and York counties), and (3) if the SLF expands statewide, directly affecting all 67 counties in Pennsylvania.

To calculate the direct impacts of SLF on Pennsylvania agriculture, the researchers used data from the 2017 Census of Agriculture and a survey of crop production experts. From this data, it is estimated that the expected overall annual direct economic impact of SLF damage on Pennsylvania agriculture is $13.1 million in the quarantine zone, $7.7 million in the adjacent counties, and $42.6 million statewide. Losses to SLF are projected to fall particularly heavily on several types of agricultural operations: nursery operators ($8.0 million in the quarantine zone and $22.9 million statewide), fruit growers (especially grape growers), and Christmas tree growers. If the worst-case scenario occurs, where damage is estimated to be the maximum projected by the experts, then the overall annual impact of the SLF damage on Pennsylvania agriculture is estimated to be $29.6 million in the quarantine zone, $20.4 million in the adjacent counties, and $99.1 million statewide.

To calculate the direct impacts of SLF on the Pennsylvania forestry industry, the researchers used data from the U.S. Department of Agriculture's (USDA) Forest Inventory and Analysis database, quarterly price data from the PA Timber Market Report, and a survey of forestry production experts. The overall annual impact of the SLF feeding on forest trees is estimated to

be $16.7 million in the quarantine zone, $15.6 million in the adjacent counties, and $152.6 million statewide. SLF feeding on forests is projected to cause considerable economic damage over time, especially to soft maple, various oak species, and black walnut. If the worst-case scenario occurs, where damage is estimated to be the maximum projected by the experts, then the overall annual impact of the SLF feeding on forest trees is estimated to be $25.8 million in the quarantine zone, $25.2 million in the adjacent counties, and $236.3 million statewide.

The analysis also used IMPLAN to estimate how damage from SLF will affect Pennsylvania's larger economy (including direct, indirect, and induced effects). Indirect effects are the negative impact on the purchase of goods and services from local industries from the direct losses caused by SLF. Induced effects are the negative impact on household spending from the direct losses caused by SLF. These impacts are expressed as changes in employment, labor income, total value added, and output. Overall, the expected impact of SLF in the quarantine zone is currently estimated to be $50.1 million total per year with a loss of 484 jobs. If the worst-case scenario occurred, these losses would be expected to increase to $92.8 million total per year with a loss of 927 jobs. If the SLF spreads into the adjacent counties, expected losses would increase to $89.2 million total per year with a loss of 843 jobs. In this case, if the worst-case scenario occurred, these losses would increase to $168.8 million total per year with a loss of 1,665 jobs. If SLF spread throughout Pennsylvania, then the expected losses would amount to $324.9 million annually with a loss of 2,810 jobs. Under the worst-case scenario, losses would increase to $554.0 million, with a loss of 4,987 jobs.

Best management practices (BMPs) developed by the Pennsylvania Department of Agriculture for SLF seek to slow the spread of SLF populations. They vary from fairly simple tactics like employee education and pest monitoring to much more intensive practices involving inspection, phytosanitation, and *Ailanthus altissima* eradication. Overall, a conservative estimate of the cost of the BMPs for agricultural operations would initially be $27.9 million in the quarantine zone, $19.8 million in the adjacent counties, and $106.4 million statewide. A similar estimate for the timber industry would be $23.2 million in the quarantine zone, $30.3

million in the adjacent counties, and $219.6 million statewide. Implementation of certain BMPs represent one-time costs like those for training and permitting and others, like ailanthus eradication, will have costs that will likely decline over time. Others, like inspection and phytosanitation, will continue for a long time. Use of these types of practices is necessary to provide the time needed to develop effective SLF management practices, including biological control. However, the cost of these BMPs fall rather heavily on certain sectors of the economy, including the timber and nursery industries.

The impact of the SLF in the quarantine zone is already significant and its spread throughout the state could be potentially devastating for Pennsylvania's agriculture and forestry industries. This indicates that the vigorous response by the Pennsylvania Department of Agriculture, USDA, and Pennsylvania State University to limiting the spread of SLF is clearly warranted. The potential spread of this pest to neighboring states with major timber and grape industries argues for the continuance of existing programs and strengthening of research and management efforts.

Contents

Introduction

The spotted lanternfly (SLF) is an invasive insect species that is currently having a destructive impact on vulnerable agricultural crops and trees species within Pennsylvania. This study estimates the total economic impact of the SLF within the entire state of Pennsylvania. The analysis considers several scenarios, which vary based on geographic scope and the estimated potential severity of damages. These include estimates based on damages (1) if the SLF is successfully limited to the 14 counties in the quarantine zone only (Berks, Bucks, Carbon, Chester, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Philadelphia, and Schuylkill counties), (2) if the SLF expands to the 12 counties adjacent to the quarantine zone (Adams, Columbia, Cumberland, Franklin, Lackawanna, Luzerne, Montour, Northumberland, Perry, Pike, Wayne, and York counties)[1], and (3) if the SLF expands statewide, directly affecting all 67 counties in Pennsylvania. For each geographic area, the analysis considers the economic impact based on expected damage as determined by agricultural and forestry experts, and a worst-case scenario. The analysis estimates the impacts to agriculture and forestry separately as well as the total combined damages. After determining the direct impact of SLF damages to agricultural crops and the forestry industry, the indirect and induced effects on other industries in the commonwealth will be estimated using IMPLAN. For each region and level of damage, the analysis first considers the individual impacts to agriculture and forestry, and then the total combined damages across both sectors. These results include the direct impact of SLF damages on the primary agricultural and forestry industries affected, as well as the indirect and induced effects on other industries within the commonwealth.

This study focuses on the economic impacts of SLF damage in Pennsylvania. It ignores the potential economic impacts of this damage in neighboring states, which have confirmed populations of SLF including New Jersey, Delaware, Maryland, and Virginia. It similarly ignores

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[1] At the request of the Center for Rural Pennsylvania, Adams and Franklin counties were added to this group because of climactic and crop production similarities to the counties in the quarantine zone.

potential economic impacts in Pennsylvania resulting from SLF damage in these neighboring states.

Definition of "Economic Impact" Used in this Study

An "economic impact" is a change in the employment, income, and output in an area based on an activity or shock that affects the local economy. The shock at hand in this study is the damage to agricultural crops and timber due to the invasive SLF. Economic impact includes three components: direct impacts, indirect impacts, and induced impacts. The direct impacts include the losses in the agricultural and forestry sectors that occur as a result of the damages caused by the SLF, such as crop or timber losses due to the weakening or death of the plant due to feeding. Indirect impacts measure the effect of these direct impacts on the businesses in the economy who sell products or services to the agricultural and forestry sector, such as fertilizer or farm equipment, who would experience lower sales to these sectors due to the SLF damage. Induced impacts are the effects resulting from changes in spending by employees in the agricultural and forestry sector, as well as employees in other businesses indirectly affected by SLF. For example, if employees work fewer hours or are laid off because of crop or timber losses to SLF damage, they'll have less money to spend on groceries, clothing, local entertainment, and other household items. The indirect and induced effects, which measure how money ripples through other sectors of the economy, is also referred to as the economic multiplier effect. These impacts are measured in four different ways; (1) employment, which reflects the change in full-time equivalent jobs as a result of the SLF damage, (2) labor income, which measures the loss in wages, salaries and other remuneration due to these job losses, (3) total value added, which is the difference between the value of output and the cost of intermediate inputs, and (4) output, which reflects the total change in economic activity, including the value of sales and changes in inventory.

Estimating the Direct Economic Impact of SLF on Pennsylvania Agriculture

The economic impact on Pennsylvania agriculture from the SLF is very dependent on the individual crop. The market values used in this study are based on county data from USDA's 2017 Census of Agriculture for Pennsylvania, Table 2. Market Value of Agricultural Products

Sold Including Food Marketing Practices and Value-Added Products: 2017 and 2012 (https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_ County_Level/Pennsylvania/). Based on these data, the value of agricultural and nursery crops for the state is estimated to be $2.096 billion, with $620.742 million within the 14-county quarantine zone (30% of the state) and $560.856 million within the 12 adjacent counties (27% of the state) (Table 1). Value of production is reported in the Census of Agriculture for certain individual crops, but is aggregated for others including hay, vegetables, and fruits, berries, and nuts (which includes grapes).

Table 1. Value of agricultural crops in the SLF quarantine zone, adjacent counties, and Pennsylvania.

Crop	Quarantine Zone Crop Value ($1,000)	% state	Adjacent County Crop Value ($1,000)	% state	PA Crop Value ($1,000)
Field crops:					
Corn	$208,917	34%	$172,783	28%	$619,460
Wheat	$16,774	35%	$18,714	40%	$47,357
Soybean	$88,474	31%	$91,718	32%	$286,880
Sorghum	$524	17%	$1,363	45%	$3,062
Barley	$3,093	30%	$3,513	34%	$10,303
Other grains	$3,419	25%	$2,458	18%	$13,914
Hay	$72,008	20%	$59,177	17%	$355,214
Tobacco	$32,329	90%	$3,030	8%	$35,994
Specialty crops:					
Fruits/Nuts/Berries	$28,142	16%	$88,775	52%	$171,575
Vegetables	$54,116	29%	$51,195	27%	$187,319
Bedding/Garden plants, Cutflowers, Foliage plants, Potted flowering plants	$55,631	27%	$46,909	23%	$204,690
Nursery stock	$41,877	41%	$10,522	10%	$100,920
Transplants, Cuttings, Liners, and Plugs	$5,321	21%	$384	1%	$25,660
Christmas trees	$10,113	35%	$9,963	34%	$28,893
Maple syrup	$4	0%	$351	6%	$5,408
Value of production	$620,742	30%	$560,856	27%	$2,096,649

Data: USDA-NASS, 2017 Census of Agriculture for Pennsylvania, Table 2. Market Value of Agricultural Products Sold Including Food Marketing Practices and Value-Added Products: 2017 and 2012. (https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Pennsylvania/).

The next step is to estimate the impact of SLF on the value of agricultural products. An online survey was conducted in March-May 2019 to gather input from researchers, extension educators, pest management professionals, administrators, and government employees in Pennsylvania and neighboring states on the potential impact of the SLF on agriculture and forestry. Potential survey respondents were contacted via e-mail using a combination of Penn State internal faculty and staff lists and lists of participants at the SLF Working Group meeting held at Albright College in Reading, PA in July 2018, and the SLF Summit held by the Pennsylvania Department of Agriculture in Harrisburg, PA in March 2019 (the lists included state and federal government researchers and employees and university researchers and extension specialists from Pennsylvania and surrounding states). The objective of the survey was to find out which crops are the most susceptible to damage by the spotted lanternfly (a copy of the survey instrument can be found in Appendix 1). A total of 83 agricultural and forestry researchers and extension specialists completed the surveys assessing the susceptibility of various crops to SLF damage (Table 2). Respondents were asked to rate susceptibility of each crop within their area of expertise to SLF damage on a scale of not susceptible (0), slightly susceptible (1), moderately susceptible (2), and highly susceptible (3). Respondents could also indicate that they had no opinion on the impact of SLF on a given crop, in which case they were excluded from the calculation of an estimate of average susceptibility. Average susceptibility was rated as very low for most field crops, with the exception of tobacco. No specialists rated any field crop as being highly susceptible to SLF and only a couple rated any field crops as being moderately susceptible. Most specialists rated vegetable crops as being not susceptible to SLF. No specialists rated any vegetable crop as being highly susceptible to SLF and only a couple rated any vegetables as being even moderately susceptible. Tree fruits were rated as being slightly to moderately susceptible on average, while small fruits are rated as being only slightly susceptible to SLF. Grapes, hops, and nut trees were rated as being highly susceptible to damage by SLF. Unlike field crops and vegetables, many individual specialists rated tree fruits, small fruit, grapes, nut trees, and hops as being highly susceptible to SLF damage. In nursery crops, there is considerable variability in susceptibility, with cut flowers

Table 2. Results of specialist survey rating of the susceptibility of agricultural crops to SLF damage.

Crop	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Highly Susceptible	Responses with Ratings	No Opinion Responses	Total Responses	Average Susceptibility
Field crops:								
Barley	8	1	0	0	9	3	12	0.1
Corn	7	3	0	0	10	2	12	0.3
Dry beans	5	4	0	0	9	3	12	0.4
Oats	9	1	0	0	10	2	12	0.1
Sorghum	9	1	0	0	10	2	12	0.1
Soybeans	5	6	0	0	11	1	12	0.5
Tobacco	4	3	2	0	9	3	12	0.8
Wheat	9	1	0	0	10	2	12	0.1
Grass hay	9	1	0	0	10	2	12	0.1
Alfalfa hay	7	3	1	0	11	0	11	0.5
Vegetable crops:								
Asparagus	9	1	1	0	11	4	15	0.3
Beans	8	2	0	0	10	5	15	0.2
Beets	10	0	0	0	10	5	15	0.0
Broccoli	10	1	0	0	11	4	15	0.1
Cabbage	10	0	0	0	10	5	15	0.0
Cantaloupes/muskmelons	9	2	0	0	11	4	15	0.2
Carrots	10	0	0	0	10	5	15	0.0
Cauliflower	9	1	0	0	10	5	15	0.1
Cucumbers	8	3	1	0	12	3	15	0.4
Eggplant	7	2	0	0	9	6	15	0.2
Garlic	10	0	0	0	10	5	15	0.0
Lettuce	9	0	0	0	9	6	15	0.0
Onions	11	0	0	0	11	4	15	0.0
Peas	9	1	1	0	11	4	15	0.3
Peppers	8	3	0	0	11	4	15	0.3
Potatoes	11	0	0	0	11	4	15	0.0
Pumpkins	9	1	0	0	10	5	15	0.1
Squash	8	2	0	0	10	5	15	0.2
Sweet corn	8	3	0	0	11	4	15	0.3

Crop	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Highly Susceptible	Responses with Ratings	No Opinion Responses	Total Responses	Average Susceptibility
Tomatoes	8	3	0	0	11	4	15	0.3
Watermelons	8	2	0	0	10	5	15	0.2
Tree fruits, small fruits, nuts, and hops:								
Apples	1	8	9	6	24	1	25	1.8
Apricots	1	7	9	2	19	5	24	1.6
Cherries, sweet	1	6	10	2	19	5	24	1.7
Cherries, tart	1	6	9	3	19	5	24	1.7
Hops	0	1	6	12	19	6	25	2.6
Peaches/Nectarines	1	5	14	2	22	3	25	1.8
Pear	1	6	11	3	21	3	24	1.8
Plum	1	6	10	2	19	5	24	1.7
Grapes	0	0	1	25	26	0	26	3.0
Blueberries	1	10	5	2	18	7	25	1.4
Cane berries	3	8	3	2	16	9	25	1.3
Strawberries	8	4	1	2	15	9	24	0.8
Nut trees	1	2	8	7	18	7	25	2.2
Nursery:								
Bedding plants	5	2	1	1	9	2	11	0.8
Cut flowers/florist greens	6	1	1	0	8	3	11	0.4
Nursery stock	1	3	3	4	11	1	12	1.9
Vegetable transplants	5	3	1	0	9	2	11	0.6
Maple syrup and Christmas trees:								
Maple syrup	0	3	7	4	14	3	17	2.1
Christmas trees	4	4	4	2	14	4	18	1.3

Note: These data are from an online survey completed by 83 agricultural and forestry researchers and extension specialists assessing the susceptibility of various crops to SLF damage. Respondents only rated SLF damage to crops within their area of expertise. A copy of the survey instrument can be found in Appendix 1.

rated as generally not susceptible, vegetable transplants and bedding plants being slightly susceptible, and nursery stock being moderately susceptible. Overall, this indicates that the impact of SLF will not fall on a wide range of agricultural crops. The crops that are relatively susceptible, however, include high-value crops like tree fruits, grapes, and nursery stock.

To estimate the impact of SLF on agricultural producers and nursery operators it is necessary to use the crop-specific susceptibility ratings obtained from the specialist surveys and combine them with crop-specific market values. Market value data is readily available from the 2017 Census of Agriculture for crops like corn, wheat, soybeans, sorghum, barley, and tobacco. Nursery crops are also broken out into several categories and Christmas trees and maple syrup market values are reported separately. However, tree fruits, nuts, and berries are combined into one market value and all vegetables are lumped into another. Because of a lack of crop specific market values for tree fruits, nuts, berries, and vegetables it was necessary to use value of production estimates derived from Penn State Extension sources (see Appendix B for a list of some of the relevant publications; some sources are unpublished or part of works in progress) weighted by 2017 Census of Agriculture county crop acreage information (Table 29. Vegetables, Potatoes, and Melons Harvested for Sale: 2017 and 2012, Table 31. Fruits and Nuts: 2017 and 2012, and Table 33. Berries: 2017 from the 2017 Census of Agriculture) as proxies for estimating the value of individual crops.

The expected direct economic impact of SLF was determined by multiplying each crop's average susceptibility rating based on the specialist survey by a projected percentage loss times the estimated value of each field crop in the quarantine zone, the adjacent counties, and Pennsylvania. A worst-case scenario is also calculated by multiplying each crop's maximum susceptibility rating based on the specialist survey by a projected percentage loss times the estimated value of each field crop in the quarantine zone, the adjacent counties, and Pennsylvania. The projected yearly percentage loss varies by crop category and was determined

by a combination of discussions with production specialists, preliminary research results, and in observed losses (Table 3). Because there is very limited information on crop specific SLF damage currently, these estimates are unrefined and subject to revision in the future as new research information becomes available. For example, it is often difficult to distinguish the exact cause or relative contribution of losses, as in the case of winter injury and SLF feeding on grapes.

Table 3. Estimated annual losses from SLF for slightly susceptible, moderately susceptible, and highly susceptible crops.

Crop or enterprise	Slightly susceptible	Moderately susceptible	Highly susceptible
Field crops	1%	2%	3%
Vegetable crops	1%	2%	3%
Pome fruits, stone fruit	1%	2%	3%
Berries and nuts	2.5%	5%	7.5%
Grapes	16.7%	33.3%	50%
Nursery, Christmas trees, and maple syrup	6.7%	13.3%	20%
Timber	0.25%	0.50%	0.75%

Note: Estimated losses based on potential losses for broad categories of crops or enterprises determined by a combination of discussions with production specialists, preliminary research results, and observed losses. Published data on SLF damage to specific crops do not currently exist. These estimates are based on consultation with crop specialists and are subject to change as more is learned regarding the nature and extent of the damage. Potential losses for nursery, Christmas trees, and maple syrup are based on reduced sales reported by a limited number of producers.

Field crop losses to SLF damage annually are expected to be quite low based on the specialist survey results. The direct economic impact of SLF on field crops in the quarantine zone, the adjacent counties, and Pennsylvania was estimated by multiplying the value of production for each field crop (Table 1) by the average susceptibility rating for each field crop (Table 2), and then multiplying by 1% (Table 3). Based on this, the annual estimated direct economic impact of the SLF on field crops is estimated to be only $1.6 million in the quarantine zone, $1.2 million in the adjacent counties, and $4.8 million statewide (Table 4). A worst-case scenario where the

maximum individual field crop estimated loss is either 1 or 2% would generate losses of $5.0 million in the quarantine zone, $3.8 million in the adjacent counties, and $15.8 million statewide (Table 4).

Annual losses to SLF damage on vegetable crops are expected to be very low based on the specialist survey results. The direct economic impact of SLF on vegetable crops in the quarantine zone, the adjacent counties, and Pennsylvania was estimated by multiplying the value of production for vegetable crops (Table 1), by their share of the total vegetable value of production (based on Census acreage and Penn State value of production estimates), by the average susceptibility rating for each vegetable crop (Table 2), and then multiplying by 1% (Table 3). The annual estimated direct economic impact of the SLF on vegetable crops is estimated to be negligible (Table 4). A worst-case scenario where the maximum individual vegetable crop estimated loss is either 0 or 1% would generate losses of less than $0.5 million in the quarantine zone, less than $0.5 million in the adjacent counties, and about $1.5 million statewide (Table 4).

Annual losses to SLF damage are expected to be more significant for tree fruits, berries, grapes, and tree nuts based on the specialist survey results. The direct economic impact of SLF on these crops in the quarantine zone, the adjacent counties, and Pennsylvania was estimated by multiplying the value of production of these crops (Table 1) by their share of the total fruit, nut, and berry value of production (based on Census acreage and Penn State value of production estimates) by the average susceptibility rating for each of these crops (Table 2), and then multiplying by 1% for tree fruits, 2.5% for berries and nuts, and 16.7% for grapes (Table 3). The annual estimated direct economic impact of SLF on tree fruits, berries, grapes, and tree nuts is estimated to be $2.5 million in the quarantine zone, $1.8 million in the adjacent counties, and $11.0 million statewide (Table 4). A worst-case scenario where the maximum loss is 3% for tree fruit, 7.5% for berries and nuts, and 50% for grapes would generate losses of $3.2 million in the

quarantine zone, $3.1 million in the adjacent counties, and about $14.1 million statewide (Table 4).

Table 4. Estimated annual direct economic impacts of SLF damage on field crops and specialty crops in Pennsylvania.

	Expected direct economic impact			Worst-case direct economic impact		
	Quarantine	Adjacent		Quarantine	Adjacent	
Crop	zone	counties	PA	zone	counties	PA
	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)
Field crops:						
Corn	$627	$518	$1,858	$2,089	$1,728	$6,195
Wheat	$17	$19	$47	$168	$187	$474
Soybean	$483	$500	$1,565	$885	$917	$2,869
Sorghum	$1	$1	$3	$5	$14	$31
Barley	$3	$4	$11	$31	$35	$103
Other grains	$3	$2	$14	$34	$25	$139
Hay	$205	$154	$975	$1,095	$859	$5,300
Tobacco	$251	$24	$280	$647	$61	$720
Specialty crops:						
Fruits/Nuts/Berries/Grapes	$2,517	$1,841	$10,998	$3,225	$3,126	$14,108
Vegetables	$78	$79	$294	$427	$417	$1,520
Bedding/Garden plants, Cutflowers, Foliage plants, Potted flowering plants	$2,470	$2,271	$9,090	$9,839	$8,818	$37,161
Nursery stock	$5,333	$1,340	$12,851	$8,380	$2,105	$20,194
Transplants, Cuttings, Liners, and Plugs	$197	$14	$951	$710	$51	$3,423
Christmas trees	$867	$854	$2,478	$2,024	$1,994	$5,781
Maple syrup	$1	$48	$747	$1	$70	$1,082
Total losses	$13,052	$7,671	$42,162	$29,559	$20,407	$99,099

Note: Crop categories reported for this table are based on Census of Agriculture groupings (see Table 1). Losses calculated based on data from Tables 1, 2, and 3.

A more detailed estimate of the impact of SLF on tree fruits, berries, grapes, and tree nuts is provided in Table 5. Tree fruits are further broken down into whether they are pome fruits

(apples and pears) or stone fruits (peaches, nectarines, plums, and cherries). The impact of SLF on grapes is projected to cause 81% of the direct economic losses to this group of specialty crops in the quarantine zone and almost 72% of the direct economic losses to this group of specialty crops in the state. The impact of SLF on grapes is projected to only cause 10% of the direct economic losses to the fruit, nut, and berry crop in the adjacent counties because of the large acreages of apples and peaches there and the relatively small acreages of grapes. Although hops are suspected to be very susceptible to SLF damage, they are not included in the analysis because there are no data available on either acreage or value of production in the 2017 Census of Agriculture.

Table 5. Estimated direct economic impact of SLF on tree fruits, berries, grapes, and tree nuts in Pennsylvania.

| | Expected direct economic impact | | | Worst-case direct economic impact | | |
| | Quarantine | Adjacent | | Quarantine | Adjacent | |
Crop	zone	counties	PA	zone	counties	PA
Pome fruits	$168,410	$1,274,619	$1,862,396	$276,692	$2,087,277	$3,054,330
Stone fruits	$84,282	$219,714	$379,241	$143,377	$373,584	$646,000
Berries	$235,337	$162,474	$841,828	$749,955	$477,939	$2,380,991
Grapes	$2,026,779	$184,510	$7,887,372	$2,052,781	$186,877	$7,988,560
Tree nuts	$1,873	$0	$27,428	$2,593	$0	$37,978
Total losses	$2,516,680	$1,841,316	$10,998,264	$3,225,398	$3,125,677	$14,107,859
Grapes %	81%	10%	72%	64%	6%	57%

Note: Pome fruits include apples and pears. Stone fruits include peaches, nectarines, plums, and cherries. Berries include raspberries, blueberries, and strawberries. Calculations based on data from Table 4 apportioned using each crops share of total fruit, nut, and berry value of production (based on Census acreage and Penn State value of production estimates).

Annual losses to SLF damage are also expected to be very significant for nursery crops and Christmas trees based on the specialist survey results. The direct economic impact of SLF on various classes of nursery crops and Christmas trees in the quarantine zone, the adjacent counties, and Pennsylvania was estimated by multiplying the value of production for each of these crops (Table 1) by the average susceptibility rating for each of these crops (Table 2) and then multiplying by 6.7% (Table 3). The annual estimated direct economic impact of the SLF on

all nursery crops and Christmas trees is estimated to be $8.9 million in the quarantine zone, $4.5 million in the adjacent counties, and $25.4 million statewide (Table 4). The impact on maple syrup is quite limited in the quarantine zone and adjacent counties due to the low number of sugar maples in these areas, but it is expected to be approximately $1.1 million statewide.

The overall annual direct economic impact of SLF damage on Pennsylvania agriculture is estimated to be $13.1 million in the quarantine zone, $7.7 million in the adjacent counties, and $42.6 million statewide. Losses due to SLF are projected to fall particularly heavily on several types of agricultural operations: nursery operators ($8.0 million in the quarantine zone and $22.9 million statewide), fruit growers (in particular, grape growers), and Christmas tree growers. If the worst-case scenario occurs where damage is estimated to be the maximum projected by the specialists, then the overall annual impact of the SLF damage on Pennsylvania agriculture is estimated to be $29.6 million in the quarantine zone, $20.4 million in the adjacent counties, and $99.1 million statewide.

Estimating the Direct Economic Impact of SLF on the Pennsylvania Timber Industry

The economic impact on the Pennsylvania timber industry from the SLF is potentially very large. The estimated values for standing timber in the quarantine zone, the adjacent counties, and for the entire state (Table 6) are based on county timber volume estimates from USDA's Forest Inventory and Analysis website[2] (https://www.nrs.fs.fed.us/fia/default.asp) multiplied by the average of quarterly price data for 2017 and 2018 from the PA Timber Market Report

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[2] The USDA Forest Inventory and Analysis (FIA) website provides access to data on the status and trends in forests including area and location, tree species, size, growth, health, and mortality, and timber harvest. USDA's FIA Program provides an annual inventory of our nation's forests and is used to evaluate current forest management practices.

(https://extension.psu.edu/timber-market-report-archives). Based on these data, the value of timber for the state is estimated to be $37.822 billion, with $4.465 billion within the 14-county quarantine zone, and $4.335 billion within the 12 adjacent counties (Table 6).

The next step is to estimate the impact of SLF on the value of timber. Nineteen researchers and extension specialists assessed the susceptibility of various timber species to SLF damage as part of the larger Spring 2019 specialist survey (Table 7). The specialists were asked to rate susceptibility on a scale of not susceptible (0), slightly susceptible (1), moderately susceptible (2), and highly susceptible (3). Specialists could also indicate that they had no opinion on the impact of SLF on a specific timber species, in which case they were excluded from the calculation of an estimate of average susceptibility. Estimated susceptibility varied from a low of 0.5 for hemlock to a high of 2.7 for black walnut (Table 2). The average susceptibility based on timber volume for all tree species was rated 1.5 on a scale of 0 to 3. Overall, this indicates that timber specialists are quite concerned about the impact of SLF on some of the most valuable timber species in Pennsylvania's forests.

Based on conservative losses of 0.25% for slightly susceptible tree species, 0.50% losses for moderately susceptible species, and 0.75% losses for the most susceptible species, the estimated direct economic impact of the SLF on the timber industry is detailed in Table 8. The expected direct economic impact was determined by multiplying each timber species susceptibility rating by the estimated value of each timber species for the quarantine zone, the adjacent counties, and Pennsylvania. Although these annual impacts appear to be quite small, damage from SLF feeding will affect the growth and health of the forest over a long period of time. Combined with the large value of the timber inventory, these levels of damage represent considerable economic damage over time, especially to soft maple, various oak species, and black walnut. The overall annual impact of the SLF feeding on forest trees is estimated to be $16.7 million in the quarantine zone, $15.6 million in the adjacent counties, and $152.6 million

statewide. If the worst-case scenario occurs where damage is estimated to be the maximum projected by the specialists, then the overall annual impact of the SLF feeding on forest trees is estimated to be $25.8 million in the quarantine zone, $25.2 million in the adjacent counties, and $236.3 million statewide.

Table 6. Value of timber by tree species for the SLF quarantine zone, adjacent counties, and Pennsylvania.

Timber species	Average Timber Prices[1] ($/M bd. ft.)	Quarantine Zone Timber Volume[2] (M bd. ft.)	Adjacent County Timber Volume[2] (M bd. ft.)	PA Timber Volume[2] (M bd. ft.)	Quarantine Zone Timber Value (million $)	Adjacent County Timber Value (million $)	PA Timber Value (million $)
Black Cherry	$592	330,436	552,074	14,057,393	$195.6	$326.8	$8,322.0
Black Walnut	$1,130	328,992	76,204	851,279	$371.8	$86.1	$961.9
Hard Maple	$305	130,727	880,259	9,143,263	$39.9	$268.5	$2,788.7
Hemlock	$54	332,737	967,921	6,792,333	$18.0	$52.3	$366.8
Misc. Hardwoods	$129	2,217,814	2,317,259	17,849,099	$286.1	$298.9	$2,302.5
Mixed Oak	$303	3,037,915	3,284,254	14,397,640	$920.5	$995.1	$4,362.5
Northern Red Oak	$477	1,874,050	1,958,717	16,585,948	$893.9	$934.3	$7,911.5
Soft Maple	$231	2,081,144	1,885,812	19,491,945	$480.7	$435.6	$4,502.6
White Ash	$235	1,143,056	655,132	5,767,473	$268.6	$154.0	$1,355.4
White Oak	$387	780,675	1,137,184	6,380,001	$302.1	$440.1	$2,469.1
White Pine	$79	392,567	996,938	6,040,293	$31.0	$78.8	$477.2
Yellow Poplar	$222	2,960,369	1,192,002	9,017,889	$657.2	$264.6	$2,002.0
Totals		15,610,482	15,903,756	126,374,556	$4,465.4	$4,335.1	$37,822.1

1. Average timber prices calculated from quarterly data for 2017 and 2018 from the Pennsylvania Timber Market Report (https://extension.psu.edu/timber-market-report-archives)
2. Compiled from county timber volume estimates from USDA's Forest Inventory and Analysis website (https://www.nrs.fs.fed.us/fia/default.asp)

Table 7. Results of specialist survey rating of the susceptibility of timber species to SLF damage.

Timber Species	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Highly Susceptible	Responses with Ratings	No Opinion Responses	Total Responses	Average Susceptibility
Red maple	0	3	6	9	18	1	19	2.3
Black cherry	0	4	5	5	14	5	19	2.1
Northern red oak	3	6	5	0	14	5	19	1.1
White oak	2	8	4	0	14	3	17	1.1
Yellow poplar	1	6	7	0	14	4	18	1.4
Sugar maple	0	3	8	4	15	4	19	2.1
Chestnut oak	1	7	6	0	14	4	18	1.4
White ash	6	2	4	0	12	6	18	0.8
American beech	2	5	3	0	10	8	18	1.1
Hickory	2	3	6	0	11	7	18	1.4
Eastern hemlock	8	2	2	0	12	6	18	0.5
Sweet birch	0	4	5	4	13	5	18	2.0
Eastern white pine	7	4	4	0	15	3	18	0.8
Black walnut	0	0	5	11	16	3	19	2.7

Note: These data are from an online survey completed by 83 agricultural and forestry researchers and extension specialists assessing the susceptibility of various crops to SLF damage. Respondents only rated SLF damage to crops within their area of expertise. A copy of the survey instrument can be found in Appendix 1.

Table 8. Annual value of direct economic losses to timber species from SLF for the quarantine zone, adjacent counties, and Pennsylvania.

Timber species	Quarantine Zone Timber Values Totals (million $)	% state	Adjacent County Timber Values Totals (million $)	% state	PA Timber Values Totals (million $)	Expected direct economic impact Quarantine zone (million $)	Adjacent counties (million $)	PA (million $)	Worst-case direct economic impact Quarantine zone (million $)	Adjacent counties (million $)	PA (million $)
Black Cherry	$195.6	2.4%	$326.8	3.9%	$8,322.0	$1.0	$1.7	$43.1	$1.5	$2.5	$62.4
Black Walnut	$371.8	38.6%	$86.1	9.0%	$961.9	$2.5	$0.6	$6.5	$2.8	$0.6	$7.2
Hard Maple	$39.9	1.4%	$268.5	9.6%	$2,788.7	$0.2	$1.4	$14.4	$0.3	$2.0	$20.9
Hemlock	$18.0	4.9%	$52.3	14.3%	$366.8	$0.0	$0.1	$0.5	$0.1	$0.3	$1.8
Misc. Hardwoods	$286.1	12.4%	$298.9	13.0%	$2,302.5	$1.1	$1.2	$8.9	$2.1	$2.2	$17.3
Mixed Oak	$920.5	21.1%	$995.1	22.8%	$4,362.5	$2.6	$2.8	$12.5	$4.6	$5.0	$21.8
Northern Red Oak	$893.9	11.3%	$934.3	11.8%	$7,911.5	$2.6	$2.7	$22.6	$4.5	$4.7	$39.6
Soft Maple	$480.7	10.7%	$435.6	9.7%	$4,502.6	$2.8	$2.5	$26.3	$3.6	$3.3	$33.8
White Ash	$268.6	19.8%	$154.0	11.4%	$1,355.4	$0.6	$0.3	$2.8	$1.3	$0.8	$6.8
White Oak	$302.1	12.2%	$440.1	17.8%	$2,469.1	$0.9	$1.3	$7.1	$1.5	$2.2	$12.3
White Pine	$31.0	6.5%	$78.8	16.5%	$477.2	$0.1	$0.2	$1.0	$0.2	$0.4	$2.4
Yellow Poplar	$657.2	32.8%	$264.6	13.2%	$2,002.0	$2.3	$0.9	$7.1	$3.3	$1.3	$10.0
Total value	$4,465.4	11.8%	$4,335.1	11.5%	$37,822.1	$16.7	$15.6	$152.6	$25.8	$25.2	$236.3

Note: Losses calculated based on data from Tables 3, 6, and 7.

Estimating the Total Economic Impacts of SLF

The total economic impacts of SLF were estimated by entering the estimated direct economic impacts into the economic impact tool IMPLAN. IMPLAN is among the most widely used economic impact models and is frequently used nationally to estimate the job and income effects of local activities, such as tourism, closing of a factory, or the economic contributions of a sector of the economy. IMPLAN creates an economic model of the economy of interest and estimates how a change in economic activity in that economy will ripple across local businesses and workers. This analysis used IMPLAN to estimate how these damages from SLF will affect Pennsylvania's economy (including direct, indirect, and induced effects). Indirect effects are the negative impact on the purchase of goods and services from local industries from the direct losses caused by SLF. Induced effects are the negative impact on household spending from the direct losses caused by SLF. These impacts are expressed as changes in employment, labor income, total value added, and output. The results of the IMPLAN analysis will be reported for the quarantine zone, the quarantine zone and adjacent counties, and Pennsylvania.

Total Economic Impact in the Quarantine Zone

This section of the results estimates the economic impact in Pennsylvania resulting from SLF damage to agriculture and forestry within the quarantine zone. This analysis assumes that the SLF can be successfully limited to the quarantine zone, which contains 14 counties: Berks, Bucks, Carbon, Chester, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Philadelphia, and Schuylkill. The following results are displayed for "Expected Impact" and "Worst-Case Scenario" estimates of the damages. The "Expected Impact" scenario refers to the average projected damage estimate of the crops and timber researchers and extension specialists.

Expected Impact in Quarantine Zone for Agriculture

When the agricultural damages in Table 4 are considered within IMPLAN, the analysis indicates that roughly $22.4 million in economic activity across Pennsylvania, supporting about 285 jobs,

will be lost due to SLF (Table 9). This includes about $12.9 million in lost economic activity in direct impacts, $4.9 million lost economic activity in businesses that provide services and products to the agricultural sector, and about $4.6 million lost economic activity due to reduced spending by employees in the agriculture and non-agriculture sectors. About 206 of these jobs will be in the agricultural sector, 47 jobs will be in supporting businesses, and 32 jobs will be affected due to lower employee spending.

Table 9. Quarantine Zone, Agriculture Only, Expected Impact from SLF: Total Impact Summary				
Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-206	-$2,903,907	-$6,300,306	-$12,858,037
Indirect Effect	-47	-$2,169,534	-$3,072,792	-$4,928,625
Induced Effect	-32	-$1,660,604	-$2,779,378	-$4,638,320
Total Effect	-285	-$6,734,045	-$12,152,476	-$22,424,982

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the greenhouse, nursery, and floriculture production sector, suggesting a loss of 126 jobs and about $9.4 million in economic activity (Table 10). Fruit farming will experience the second largest negative impact, with a loss of about $2.5 million in output.

Expected Impact in Quarantine Zone for Forestry

When the forestry-related damages in Table 8 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $27.7 million in economic activity, supporting about 199 jobs (Table 11). About $16.1 million of this lost activity will be direct impacts, about $1.8 million will be in businesses who provide goods and services to the forestry sector, and about $9.6 million will be in other businesses due to reduced spending by employees.

Table 10. Quarantine Zone, Agriculture Only, Expected Impact from SLF:

Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-126	-$2,423,905	-$4,654,510	-$9,372,617
Fruit farming	-68	-$512,635	-$1,505,263	-$2,525,837
Support activities for agriculture and forestry	-25	-$992,860	-$888,448	-$978,646
All other crop farming	-9	-$40,626	-$85,319	-$186,250
Grain farming	-5	-$3,969	-$27,527	-$618,769
Wholesale trade	-3	-$301,930	-$566,772	-$820,784
Tobacco farming	-3	-$59,274	-$108,464	-$235,751
Real estate	-2	-$62,253	-$380,238	-$514,498
Hospitals	-2	-$151,845	-$168,790	-$309,838
Full-service restaurants	-2	-$36,408	-$40,533	-$78,747

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Table 11. Quarantine Zone, Forestry Only, Expected impact from SLF:

Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-109	-$9,948,769	-$13,950,797	-$16,144,716
Indirect Effect	-22	-$982,854	-$1,239,815	-$1,871,272
Induced Effect	-67	-$3,460,804	-$5,794,339	-$9,649,223
Total Effect	-199	-$14,392,426	-$20,984,951	-$27,665,211

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 110 jobs and about $16.2 million in economic activity (Table 12). Wholesale trade will experience the second largest negative impact, with a loss of about $0.7 million in output.

Table 12. Quarantine Zone, Forestry Only, Expected Impact from SLF: Top 10 Industries Affected by Employment				
Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-110	-$9,954,432	-$13,958,738	-$16,153,907
All other crop farming	-8	-$36,817	-$77,319	-$168,787
Support activities for agriculture and forestry	-6	-$238,444	-$213,369	-$235,031
Hospitals	-4	-$302,354	-$336,095	-$616,950
Forestry, forest products, and timber tract production	-4	-$354,466	-$345,136	-$436,817
Full-service restaurants	-3	-$70,997	-$79,043	-$153,563
Wholesale trade	-3	-$259,819	-$487,721	-$706,306
Real estate	-3	-$73,466	-$448,721	-$607,162
Limited-service restaurants	-3	-$52,475	-$128,627	-$226,908
Individual and family services	-2	-$67,815	-$60,497	-$82,938

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Expected Impact in Quarantine Zone for Agriculture and Forestry

When damages to agriculture and forestry are considered together within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $50.1 million in economic activity, supporting about 484 jobs (Table 13). This includes about $29.0 million combined in the agriculture and forestry sectors, about $6.7 million in losses to businesses that

provide goods and services to these two sectors, and about $14.3 million in losses to other businesses due to reduced employee spending.

Table 13. Quarantine Zone, Agriculture and Forestry, Expected Impact from SLF: Total Impact Summary				
Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-315	-$12,852,676	-$20,251,103	-$29,002,754
Indirect Effect	-70	-$3,152,388	-$4,312,607	-$6,799,897
Induced Effect	-100	-$5,121,407	-$8,573,717	-$14,287,543
Total Effect	-484	-$21,126,471	-$33,137,427	-$50,090,194

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 110 jobs and about $16.2 million in economic activity (Table 14). Greenhouse, nursery, and floriculture production will experience the second largest negative impact, with a loss of about $9.4 million in output.

Table 14. Quarantine Zone, Agriculture and Forestry, Expected Impact from SLF: Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-126	-$2,425,899	-$4,658,338	-$9,380,326
Commercial logging	-110	-$9,955,039	-$13,959,589	-$16,154,891
Fruit farming	-69	-$513,211	-$1,506,956	-$2,528,678
Support activities for agriculture and forestry	-31	-$1,231,304	-$1,101,817	-$1,213,677
All other crop farming	-17	-$77,442	-$162,638	-$355,037
Wholesale trade	-6	-$561,749	-$1,054,493	-$1,527,090
Hospitals	-6	-$454,199	-$504,884	-$926,788
Real estate	-5	-$135,719	-$828,958	-$1,121,660
Full-service restaurants	-5	-$107,405	-$119,576	-$232,310
Grain farming	-5	-$3,997	-$27,724	-$623,186

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst Case Scenario in Quarantine Zone for Agriculture Only

When the agriculture-related damages in Table 4 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $51.0 million in economic activity, supporting about 626 jobs (Table 15). About $29.0 million of this lost activity will be direct impacts, about $11.5 million will be in businesses that provide goods and services to the forestry sector, and about $10.4 million will be in other businesses due to reduced spending by employees.

Table 15. Quarantine Zone, Agriculture Only, Worst-Case Scenario from SLF:

Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-446	-$6,479,250	-$13,635,247	-$29,017,487
Indirect Effect	-108	-$4,965,893	-$7,145,308	-$11,504,370
Induced Effect	-73	-$3,745,202	-$6,268,418	-$10,460,781
Total Effect	-626	-$15,190,345	-$27,048,973	-$50,982,637

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the greenhouse, nursery, and floriculture production sector, suggesting a loss of 298 jobs and about $22.1 million in economic activity (Table 16). Fruit farming will experience the second largest negative impact, with a loss of about $3.2 million in output.

Table 16. Quarantine Zone, Agriculture Only, Worst-Case Scenario from SLF: Top 10 Industries Affected by Employment				
Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-298	-$5,726,619	-$10,996,556	-$22,143,365
Fruit farming	-88	-$658,295	-$1,932,970	-$3,243,532
Support activities for agriculture and forestry	-55	-$2,195,367	-$1,964,495	-$2,163,937
All other crop farming	-46	-$214,874	-$451,261	-$985,098
Grain farming	-16	-$14,076	-$97,631	-$2,194,585
Tobacco farming	-9	-$152,186	-$278,484	-$605,293
Wholesale trade	-8	-$708,203	-$1,329,411	-$1,925,219
Real estate	-6	-$151,162	-$923,280	-$1,249,286
Vegetable and melon farming	-4	-$50,567	-$245,231	-$431,147
Hospitals	-4	-$342,346	-$380,549	-$698,553

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario in Quarantine Zone for Forestry

When the forest-related damages in Table 10 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $41.8 million in economic activity, supporting about 301 jobs (Table 17). About $24.4 million of this lost activity will be direct impacts, about $2.8 million will be in businesses that provide goods and services to the forestry sector, and about $14.5 million will be in other businesses due to reduced spending by employees.

Table 17. Quarantine Zone, Forestry only, Worst-Case Scenario from SLF:

Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-165	-$15,036,011	-$21,084,451	-$24,400,219
Indirect Effect	-34	-$1,485,430	-$1,873,787	-$2,828,135
Induced Effect	-102	-$5,230,464	-$8,757,239	-$14,583,295
Total Effect	-301	-$21,751,905	-$31,715,477	-$41,811,649

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 166 jobs and about $24.4 million in economic activity (Table 18). Wholesale trade will experience the second largest negative impact, with a loss of about $1.1 million in output.

Table 18. Quarantine Zone, Forestry only, Worst-Case Scenario from SLF:

Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-166	-$15,044,571	-$21,096,454	-$24,414,109
All other crop farming	-12	-$55,643	-$116,856	-$255,096
Support activities for agriculture and forestry	-9	-$360,371	-$322,473	-$355,212
Hospitals	-6	-$456,961	-$507,954	-$932,424
Forestry, forest products, and timber tract production	-6	-$535,720	-$521,619	-$660,180
Full-service restaurants	-5	-$107,301	-$119,461	-$232,086
Wholesale trade	-4	-$392,675	-$737,115	-$1,067,471
Real estate	-4	-$111,032	-$678,171	-$917,631
Limited-service restaurants	-4	-$79,308	-$194,399	-$342,937
Individual and family services	-3	-$102,492	-$91,432	-$125,347

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario in Quarantine Zone for Agriculture and Forestry

When agriculture and forest-related damages in the quarantine zone are considered together within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $92.8 million in economic activity, supporting about 927 jobs (Table 19). This includes about $53.4 million combined in the agriculture and forestry sectors, about $14 million in losses to businesses that provide goods and services to these two sectors, and about $25.0 million in losses to other businesses due to reduced employee spending.

Table 19. Quarantine Zone, Agriculture and Forestry, Worst-Case Scenario from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-611	-$21,515,261	-$34,719,699	-$53,417,705
Indirect Effect	-142	-$6,451,323	-$9,019,095	-$14,332,505
Induced Effect	-174	-$8,975,666	-$15,025,657	-$25,044,076
Total Effect	-927	-$36,942,250	-$58,764,450	-$92,794,286

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 166 jobs and about $24.4 million in economic activity (Table 20). Greenhouse, nursery, and floriculture production will experience the second largest negative impact, with a loss of about $22.1 million in output.

Table 20. Quarantine Zone, Agriculture and Forestry, Worst-Case Scenario from SLF:

Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-298	-$5,729,633	-$11,002,342	-$22,155,016
Commercial logging	-166	-$15,045,851	-$21,098,249	-$24,416,186
Fruit farming	-88	-$659,167	-$1,935,529	-$3,247,826
Support activities for agriculture and forestry	-64	-$2,555,738	-$2,286,969	-$2,519,149
All other crop farming	-58	-$270,516	-$568,118	-$1,240,194
Grain farming	-16	-$14,119	-$97,928	-$2,201,261
Wholesale trade	-12	-$1,100,878	-$2,066,526	-$2,992,689
Real estate	-10	-$262,194	-$1,601,451	-$2,166,917
Hospitals	-10	-$799,307	-$888,504	-$1,630,977
Tobacco farming	-9	-$152,442	-$278,951	-$606,309

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Economic Impact if SLF Spreads to Counties Adjacent to the Quarantine Zone

This section of the results estimates the potential economic impact in Pennsylvania resulting from damage to agriculture and forestry if the SLF spreads to counties adjacent to the quarantine zone before its spread is halted. The analysis assumes that the SLF affects agriculture and forestry in 26 counties: Berks, Bucks, Carbon, Chester, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Philadelphia, and Schuylkill in the quarantine zone and the adjacent counties of Adams, Columbia, Cumberland, Franklin, Lackawanna, Luzerne, Montour, Northumberland, Perry, Pike, Wayne, and York.

The following results are displayed including "expected impact" and "worst-case scenario" estimates of the damages. The "expected impact" scenario is not that which produces the least damages but refers to the most accurate estimate of the damages according to experts.

Expected Impact for Quarantine Zone and Adjacent Counties for Agriculture

When the agriculture-related damages in Table 4 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $35.5 million in economic activity, supporting about 457 jobs (Table 21). About $20.3 million of this lost activity will be direct impacts, about $7.8 million will be in businesses that provide goods and services to the forestry sector, and about $7.3 million will be in other businesses due to reduced spending by employees.

Table 21. Quarantine Zone and Adjacent Counties, Agriculture only, Expected Impact from SLF: Total Impact Summary				
Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-330	-$4,481,553	-$9,922,381	-$20,357,538
Indirect Effect	-76	-$3,478,170	-$4,916,902	-$7,864,969
Induced Effect	-50	-$2,605,223	-$4,360,403	-$7,276,770
Total Effect	-457	-$10,564,946	-$19,199,686	-$35,499,277

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the greenhouse, nursery, and floriculture production sector, suggesting a loss of 190 jobs and about $14.1 million in economic activity (Table 22). Fruit farming will experience the second largest negative impact, with a loss of about $4.3 million in output.

Table 22. Quarantine Zone and Adjacent Counties, Agriculture Only, Expected Impact from SLF: Top 10 Industries Affected by Employment				
Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-190	-$3,649,125	-$7,007,243	-$14,110,229
Fruit farming	-118	-$887,545	-$2,606,123	-$4,373,085
Support activities for agriculture and forestry	-41	-$1,613,349	-$1,443,684	-$1,590,251
All other crop farming	-17	-$80,545	-$169,155	-$369,264
Grain farming	-8	-$7,271	-$50,429	-$1,133,563
Wholesale trade	-5	-$474,726	-$891,138	-$1,290,524
Real estate	-4	-$100,195	-$611,982	-$828,070
Tobacco farming	-4	-$65,194	-$119,297	-$259,297
Hospitals	-3	-$238,208	-$264,791	-$486,062
Oilseed farming	-3	-$23,747	-$280,997	-$795,759

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Expected Impact for Quarantine Zone and Adjacent Counties for Forestry

When the forest-related damages in Table 8 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $53.7 million in economic activity, supporting about 386 jobs (Table 23). About $31.3 million of this lost activity will be direct impacts, about $3.6 million will be in businesses that provide goods and services to the forestry sector, and about $18.7 million will be in other businesses due to reduced spending by employees.

Table 23. Quarantine Zone and Adjacent Counties, Forestry Only, Expected Impact from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-212	-$19,293,533	-$27,054,619	-$31,309,263
Indirect Effect	-43	-$1,906,037	-$2,404,359	-$3,628,936
Induced Effect	-131	-$6,711,497	-$11,236,896	-$18,712,628
Total Effect	-386	-$27,911,066	-$40,695,874	-$53,650,826

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 212 jobs and about $31.3 million in economic activity (see Table 24). Wholesale trade will experience the second largest negative impact, with a loss of about $1.4 million in output.

Table 24. Quarantine Zone and Adjacent Counties, Forestry Only, Expected Impact from SLF: Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-212	-$19,304,516	-$27,070,021	-$31,327,087
All other crop farming	-15	-$71,398	-$149,945	-$327,327
Support activities for agriculture and forestry	-12	-$462,412	-$413,783	-$455,792
Hospitals	-7	-$586,352	-$651,784	-$1,196,445
Forestry, forest products, and timber tract production	-7	-$687,411	-$669,318	-$847,114
Full-service restaurants	-6	-$137,684	-$153,287	-$297,803
Wholesale trade	-6	-$503,863	-$945,833	-$1,369,730
Real estate	-6	-$142,471	-$870,199	-$1,177,463
Limited-service restaurants	-5	-$101,764	-$249,444	-$440,041
Individual and family services	-4	-$131,513	-$117,322	-$160,840

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Expected Impact for Quarantine Zone and Adjacent Counties for Agriculture and Forestry

If the SLF spreads to counties adjacent to the quarantine zone, and agriculture and forestry damages are considered together within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $89.1 million in economic activity, supporting about 843 jobs (Table 25). This includes about $51.6 million combined in the agriculture and forestry sectors, about $11.5 million in losses to businesses that provide goods and services to these two sectors, and about $26.0 million in losses to other businesses due to reduced employee spending.

Table 25. Quarantine Zone and Adjacent Counties, Agriculture and Forestry, Expected Impact from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-543	-$23,775,086	-$36,977,000	-$51,666,801
Indirect Effect	-119	-$5,384,207	-$7,321,261	-$11,493,905
Induced Effect	-181	-$9,316,719	-$15,597,299	-$25,989,398
Total Effect	-843	-$38,476,012	-$59,895,560	-$89,150,104

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 212 jobs and about $31.3 million in economic activity (Table 26). Greenhouse, nursery, and floriculture production will experience the second largest negative impact, with a loss of about $14.1 million in output.

Table 26. Quarantine Zone and Adjacent Counties, Agriculture and Forestry, Expected Impact from SLF: Top 10 Industries Affected

Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-212	-$19,305,502	-$27,071,403	-$31,328,686
Greenhouse, nursery, and floriculture production	-190	-$3,652,992	-$7,014,667	-$14,125,179
Fruit farming	-119	-$888,664	-$2,609,407	-$4,378,595
Support activities for agriculture and forestry	-52	-$2,075,761	-$1,857,467	-$2,046,043
All other crop farming	-32	-$151,943	-$319,100	-$696,591
Wholesale trade	-11	-$978,589	-$1,836,971	-$2,660,254
Hospitals	-10	-$824,560	-$916,575	-$1,682,506
Real estate	-10	-$242,666	-$1,482,181	-$2,005,533
Full-service restaurants	-9	-$194,890	-$216,976	-$421,535
Grain farming	-8	-$7,326	-$50,810	-$1,142,129

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario for Quarantine Zone and Adjacent Counties for Agriculture

When the agriculture-related damages in Table 4 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $86.0 million in economic activity, supporting about 1,070 jobs (Table 27). About $48.9 million of this lost activity will be direct impacts, about $19.5 million will be in businesses that provide goods and services to the forestry sector, and about $17.5 million will be in other businesses due to reduced spending by employees.

Table 27. Quarantine Zone and Adjacent Counties, Agriculture Only, Worst-Case Scenario from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-764	-$10,700,941	-$22,918,551	-$48,965,704
Indirect Effect	-184	-$8,473,300	-$12,163,554	-$19,536,147
Induced Effect	-121	-$6,274,211	-$10,501,272	-$17,524,566
Total Effect	-1,070	-$25,448,451	-$45,583,377	-$86,026,416

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the greenhouse, nursery, and floriculture production sector, suggesting a loss of 482 jobs and about $35.9 million in economic activity (Table 28). Fruit farming will experience the second largest negative impacts, with a loss of about $6.4 million in output.

Table 28. Quarantine Zone and Adjacent Counties, Agriculture Only, Worst-Case Scenario from SLF: Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-482	-$9,272,597	-$17,805,730	-$35,854,750
Fruit farming	-173	-$1,295,484	-$3,803,966	-$6,383,070
Support activities for agriculture and forestry	-96	-$3,797,902	-$3,398,503	-$3,743,531
All other crop farming	-85	-$397,110	-$833,980	-$1,820,568
Grain farming	-29	-$26,073	-$180,840	-$4,064,974
Wholesale trade	-13	-$1,187,852	-$2,229,791	-$3,229,125
Real estate	-10	-$257,945	-$1,575,501	-$2,131,803
Tobacco farming	-9	-$167,415	-$306,351	-$665,865
Vegetable and melon farming	-9	-$99,858	-$484,277	-$851,418
Hospitals	-7	-$573,498	-$637,496	-$1,170,216

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario for Quarantine Zone and Adjacent Counties for Forestry

When the forest-related damages in Table 8 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $82.7 million in economic activity, supporting about 595 jobs (Table 29). About $48.3 million of this lost activity will be direct impacts, about $5.6 million will be in businesses that provide goods and services to the forestry sector, and about $28.8 million will be in other businesses due to reduced spending by employees.

Table 29. Quarantine Zone and Adjacent Counties, Forestry Only, Worst-Case Scenario from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-327	-$29,752,805	-$41,721,275	-$48,282,416
Indirect Effect	-67	-$2,939,323	-$3,707,792	-$5,596,228
Induced Effect	-201	-$10,349,885	-$17,328,561	-$28,856,984
Total Effect	-595	-$43,042,013	-$62,757,629	-$82,735,628

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 327 jobs and about $48.3 million in economic activity (Table 30). Wholesale trade will experience the second largest negative impact, with a loss of about $2.1 million in output.

Table 30. Quarantine Zone and Adjacent Counties, Forestry Only, Worst-Case Scenario from SLF: Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-328	-$29,769,742	-$41,745,026	-$48,309,902
All other crop farming	-24	-$110,104	-$231,231	-$504,775
Support activities for agriculture and forestry	-18	-$713,092	-$638,101	-$702,883
Hospitals	-11	-$904,221	-$1,005,125	-$1,845,053
Forestry, forest products, and timber tract production	-11	-$1,060,066	-$1,032,165	-$1,306,345
Full-service restaurants	-9	-$212,325	-$236,386	-$459,246
Wholesale trade	-9	-$777,014	-$1,458,581	-$2,112,278
Real estate	-9	-$219,707	-$1,341,945	-$1,815,780
Limited-service restaurants	-8	-$156,931	-$384,671	-$678,593
Individual and family services	-6	-$202,808	-$180,923	-$248,034

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario for Quarantine Zone and Adjacent Counties for Agriculture and Forestry

If the SLF spreads to counties adjacent to the quarantine zone and agriculture and forest-related damages are considered within IMPLAN, the analysis indicates that the potential effects on other businesses and workers will be a loss of roughly $168.8 million in economic activity, supporting about 1,665 jobs (Table 31). This includes about $97.2 million combined in the agriculture and forestry sectors, about $25.1 million in losses to businesses that provide goods and services to these two sectors, and about $46.4 million in losses to other businesses due to reduced employee spending.

Table 31. Quarantine Zone and Adjacent Counties, Agriculture and Forestry, Worst-Case Scenario from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-1,091	-$40,453,745	-$64,639,827	-$97,248,119
Indirect Effect	-251	-$11,412,623	-$15,871,346	-$25,132,375
Induced Effect	-323	-$16,624,096	-$27,829,833	-$46,381,550
Total Effect	-1,665	-$68,490,464	-$108,341,006	-$168,762,044

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 328 jobs and about $48.3 million in economic activity (Table 32). Greenhouse, nursery, and floriculture production will experience the second largest negative impact, with a loss of about $35.9 million in output.

Table 32. Quarantine Zone and Adjacent Counties, Agriculture and Forestry, Worst-Case Scenario from SLF: Top 10 Industries Affected by Employment

Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-483	-$9,278,559	-$17,817,179	-$35,877,804
Commercial logging	-328	-$29,771,963	-$41,748,141	-$48,313,506
Fruit farming	-173	-$1,297,209	-$3,809,030	-$6,391,567
Support activities for agriculture and forestry	-114	-$4,510,994	-$4,036,604	-$4,446,413
All other crop farming	-108	-$507,214	-$1,065,211	-$2,325,344
Grain farming	-30	-$26,158	-$181,427	-$4,078,184
Wholesale trade	-22	-$1,964,866	-$3,688,371	-$5,341,404
Real estate	-19	-$477,652	-$2,917,446	-$3,947,583
Hospitals	-18	-$1,477,719	-$1,642,621	-$3,015,269
Full-service restaurants	-15	-$350,494	-$390,214	-$758,098

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Economic Impact if SLF Spreads Across the Commonwealth of Pennsylvania

This section estimates the economic impact resulting from damage to agriculture and forestry if SLF spreads statewide. In other words, the analysis considers the impacts if the quarantine zone is unsuccessful in stopping the spread of the SLF. The following results are displayed including "expected impact" and "worst-case scenario" estimates of the damages. The "expected impact" scenario is not that which produces the least damages but refers to the average level of damage expected from the specialist survey.

Expected Impact Scenario for Commonwealth of Pennsylvania for Agriculture

When the agriculture-related damages in Table 4 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $72.2 million in economic activity, supporting about 993 jobs (Table 33). About $41.5 million of this lost activity will be direct impacts, about $15.8 million will be in businesses that provide goods and services to the forestry sector, and about $14.9 million will be in other businesses due to reduced spending by employees.

Table 33. Entire Commonwealth, Agriculture Only, Expected Impact from SLF: Total Impact Summary				
Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-735	-$9,201,242	-$20,658,923	-$41,470,914
Indirect Effect	-155	-$7,106,352	-$9,936,526	-$15,826,313
Induced Effect	-103	-$5,337,995	-$8,934,279	-$14,909,880
Total Effect	-993	-$21,645,589	-$39,529,729	-$72,207,108

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the greenhouse, nursery, and floriculture production sector, suggesting a loss of 361 jobs and about $26.8 million in economic activity (Table 34). Fruit farming will experience the second largest negative impact, with a loss of about $11.0 million in output.

Table 34. Entire Commonwealth, Agriculture only, Expected Impact from SLF: Top 10 Industries Affected

Sector	Employment	Labor Income	Value Added	Output
Greenhouse, nursery, and floriculture production	-361	-$6,938,081	-$13,322,869	-$26,827,776
Fruit farming	-299	-$2,238,947	-$6,574,281	-$11,031,669
Support activities for agriculture and forestry	-86	-$3,401,112	-$3,043,441	-$3,352,421
All other crop farming	-72	-$336,824	-$707,372	-$1,544,184
Grain farming	-13	-$11,840	-$82,121	-$1,845,953
Wholesale trade	-11	-$938,137	-$1,761,035	-$2,550,285
Real estate	-8	-$197,956	-$1,209,094	-$1,636,020
Hospitals	-6	-$488,141	-$542,613	-$996,046
Full-service restaurants	-5	-$117,018	-$130,279	-$253,104
Oilseed farming	-5	-$37,944	-$448,994	-$1,271,511

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Expected Impact Scenario for Commonwealth of Pennsylvania for Forestry

When the forest-related damages in Table 8 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $252.7 million in economic activity, supporting about 1,818 jobs (Table 35). About $147.5 million of this lost activity will be direct impacts, about $17.1 million will be in businesses that provide goods and services to the forestry sector, and about $88.1 million will be in other businesses due to reduced spending by employees.

Table 35. Entire Commonwealth, Forestry Only, Expected Impact from SLF: Total Impact Summary				
Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-1,000	-$90,875,757	-$127,431,767	-$147,471,847
Indirect Effect	-203	-$8,977,750	-$11,324,930	-$17,092,891
Induced Effect	-615	-$31,612,268	-$52,927,653	-$88,139,599
Total Effect	-1,818	-$131,465,775	-$191,684,350	-$252,704,337

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 1,000 jobs and about $147.6 million in economic activity (Table 36). Wholesale trade will experience the second largest negative impacts, with a loss of about $6.5 million in output.

Table 36. Entire Commonwealth, Forestry only, Expected Impact from SLF:

Top 10 Industries Affected

Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-1,000	-$90,927,491	-$127,504,312	-$147,555,800
All other crop farming	-72	-$336,296	-$706,264	-$1,541,766
Support activities for agriculture and forestry	-55	-$2,178,038	-$1,948,989	-$2,146,856
Hospitals	-34	-$2,761,816	-$3,070,013	-$5,635,454
Forestry, forest products, and timber tract production	-33	-$3,237,822	-$3,152,601	-$3,990,046
Full-service restaurants	-28	-$648,516	-$722,008	-$1,402,701
Wholesale trade	-27	-$2,373,279	-$4,455,029	-$6,451,657
Real estate	-26	-$671,063	-$4,098,782	-$5,546,045
Limited-service restaurants	-24	-$479,325	-$1,174,924	-$2,072,666
Individual and family services	-20	-$619,447	-$552,604	-$757,584

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Expected Impact Scenario for Commonwealth of Pennsylvania for Agriculture and Forestry

If the SLF spreads statewide and the potential agriculture and forest-related damages are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $324.9 million in economic activity, supporting about 2,811 jobs (Table 37). This includes about $188.9 million combined in the agriculture and forestry sectors, about $32.9 million in losses to businesses that provide goods and services to these two sectors, and about $103.0 million in losses to other businesses due to reduced employee spending.

Table 37. Entire Commonwealth, Agriculture and Forestry, Expected Impact from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-1,734	-$100,076,998	-$148,090,690	-$188,942,761
Indirect Effect	-358	-$16,084,102	-$21,261,456	-$32,919,205
Induced Effect	-718	-$36,950,263	-$61,861,932	-$103,049,479
Total Effect	-2,811	-$153,111,363	-$231,214,078	-$324,911,445

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 1,000 jobs and about $147.6 million in economic activity (Table 38). Greenhouse, nursery, and floriculture production will experience the second largest negative impact, with a loss of about $26.9 million in output.

Table 38. Entire Commonwealth, Agriculture and Forestry, Expected Impact from SLF: Top 10 Industries Affected

Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-1,000	-$90,929,603	-$127,507,275	-$147,559,229
Greenhouse, nursery, and floriculture production	-362	-$6,956,292	-$13,357,838	-$26,898,192
Fruit farming	-300	-$2,244,214	-$6,589,747	-$11,057,622
All other crop farming	-144	-$673,120	-$1,413,635	-$3,085,949
Support activities for agriculture and forestry	-141	-$5,579,150	-$4,992,429	-$5,499,277
Hospitals	-40	-$3,249,956	-$3,612,626	-$6,631,500
Wholesale trade	-37	-$3,311,416	-$6,216,064	-$9,001,943
Real estate	-34	-$869,019	-$5,307,876	-$7,182,065
Full-service restaurants	-33	-$765,534	-$852,287	-$1,655,805
Forestry, forest products, and timber tract production	-33	-$3,238,469	-$3,153,231	-$3,990,843

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario for Commonwealth of Pennsylvania, Agriculture Only

When the agriculture-related damages in Table 4 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $170.5 million in economic activity, supporting about 2,228 jobs (Table 39). About $97.2 million of this lost activity will be direct impacts, about $38.3 million will be in businesses that provide goods and services to the forestry sector, and about $35.0 million will be in other businesses due to reduced spending by employees.

Table 39. Entire Commonwealth, Agriculture Only, Worst-Case Scenario from SLF: Total Impact Summary				
Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-1,621	-$21,634,413	-$46,322,616	-$97,184,391
Indirect Effect	-363	-$16,705,982	-$23,864,543	-$38,298,377
Induced Effect	-243	-$12,546,932	-$21,000,032	-$35,045,143
Total Effect	-2,228	-$50,887,327	-$91,187,192	-$170,527,911

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the greenhouse, nursery, and floriculture production sector, suggesting a loss of 946 jobs and about $70.4 million in economic activity (Table 40). Fruit farming will experience the second largest negative impact, with a loss of about $14.2 million in output.

Sector	Employment	Labor Income	Value Added	Output
Table 40. Entire Commonwealth, Agriculture Only, Worst-Case Scenario from SLF: Top 10 Industries Affected				
Greenhouse, nursery, and floriculture production	-946	-$18,195,672	-$34,940,289	-$70,357,988
Fruit farming	-384	-$2,876,498	-$8,446,337	-$14,172,987
All other crop farming	-266	-$1,246,240	-$2,617,257	-$5,713,441
Support activities for agriculture and forestry	-191	-$7,571,944	-$6,775,655	-$7,463,542
Grain farming	-48	-$42,094	-$291,962	-$6,562,815
Wholesale trade	-26	-$2,324,239	-$4,362,972	-$6,318,344
Real estate	-19	-$496,813	-$3,034,479	-$4,105,941
Vegetable and melon farming	-16	-$180,079	-$873,322	-$1,535,407
Hospitals	-14	-$1,146,999	-$1,274,995	-$2,340,438
Full-service restaurants	-12	-$275,780	-$307,032	-$596,496

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario for Commonwealth of Pennsylvania for Forestry

When the forest-related damages in Table 8 are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $383.5 million in economic activity, supporting about 2,759 jobs (Table 41). About $223.8 million of this lost activity will be direct impacts, about $25.9 million will be in businesses that provide goods and services to the forestry sector, and about $133.8 million will be in other businesses due to reduced spending by employees.

Table 41. Entire Commonwealth, Forestry Only, Worst-Case Scenario from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-1,517	-$137,917,755	-$193,397,050	-$223,810,913
Indirect Effect	-309	-$13,625,098	-$17,187,300	-$25,941,057
Induced Effect	-933	-$47,976,415	-$80,325,747	-$133,765,220
Total Effect	-2,759	-$199,519,268	-$290,910,096	-$383,517,190

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 1,518 jobs and about $223.9 million in economic activity (Table 42). Wholesale trade will experience the second largest negative impact, with a loss of about $9.8 million in output.

Table 42. Entire Commonwealth, Forestry Only, Worst-Case Scenario from SLF: Top 10 Industries Affected				
Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-1,518	-$137,996,269	-$193,507,147	-$223,938,324
All other crop farming	-109	-$510,381	-$1,071,863	-$2,339,863
Support activities for agriculture and forestry	-83	-$3,305,503	-$2,957,886	-$3,258,181
Hospitals	-51	-$4,191,474	-$4,659,211	-$8,552,657
Forestry, forest products, and timber tract production	-51	-$4,913,886	-$4,784,551	-$6,055,500
Full-service restaurants	-43	-$984,221	-$1,095,757	-$2,128,812
Wholesale trade	-40	-$3,601,811	-$6,761,183	-$9,791,370
Real estate	-40	-$1,018,440	-$6,220,524	-$8,416,965
Limited-service restaurants	-36	-$727,448	-$1,783,125	-$3,145,585
Individual and family services	-30	-$940,105	-$838,660	-$1,149,748

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Worst-Case Scenario for Commonwealth of Pennsylvania for Agriculture and Forestry

If the SLF spreads statewide and the potential agriculture and forest-related damages are considered within IMPLAN, the analysis indicates that the effects on other businesses and workers will be a loss of roughly $554.0 million in economic activity, supporting about 4,987 jobs (Table 43). This includes about $321.0 million combined in the agriculture and forestry sectors, about $64.2 million in losses to businesses that provide goods and services to these two sectors, and about $168.8 million in losses to other businesses due to reduced employee spending.

Table 43. Entire Commonwealth, Agriculture and Forestry, Worst-Case Scenario from SLF: Total Impact Summary

Effect Type	Employment	Labor Income	Total Value Added	Output
Direct Effect	-3,139	-$159,552,168	-$239,719,666	-$320,995,304
Indirect Effect	-672	-$30,331,080	-$41,051,843	-$64,239,434
Induced Effect	-1,176	-$60,523,347	-$101,325,779	-$168,810,363
Total Effect	-4,987	-$250,406,595	-$382,097,288	-$554,045,101

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

The industry potentially suffering the greatest estimated loss is the commercial logging sector, suggesting a loss of 1,518 jobs and about $223.9 million in economic activity (Table 44). Greenhouse, nursery, and floriculture production will experience the second largest negative impact, with a loss of about $70.5 million in output.

Table 44. Entire Commonwealth, Agriculture and Forestry, Worst-Case Scenario from SLF: Top 10 Industries Affected				
Sector	Employment	Labor Income	Value Added	Output
Commercial logging	-1,518	-$138,000,734	-$193,513,408	-$223,945,569
Greenhouse, nursery, and floriculture production	-948	-$18,223,310	-$34,993,360	-$70,464,856
Fruit farming	-385	-$2,884,491	-$8,469,810	-$14,212,375
All other crop farming	-375	-$1,756,621	-$3,689,120	-$8,053,304
Support activities for agriculture and forestry	-274	-$10,877,447	-$9,733,541	-$10,721,722
Wholesale trade	-66	-$5,926,050	-$11,124,155	-$16,109,713
Hospitals	-65	-$5,338,473	-$5,934,206	-$10,893,096
Real estate	-59	-$1,515,253	-$9,255,004	-$12,522,906
Full-service restaurants	-55	-$1,260,001	-$1,402,789	-$2,725,308
Forestry, forest products, and timber tract production	-51	-$4,915,397	-$4,786,023	-$6,057,363

Note: Impacts on employment, labor income, total value added, and output are estimated using the IMPLAN model (IMPLAN, Huntersville, NC, website: IMPLAN.com)

Cost of Complying with Best Management Practices for Agricultural Operations

The Pennsylvania Department of Agriculture has published best management practices (BMPs) for agricultural producers and nursery operators to mitigate the spread of SLF. These BMPs range from relatively simple and straightforward actions, like training personnel about the SLF and how to identify its various life stages, to more complex and time-consuming activities, such as inspecting products and trucks and removing host plants. The purpose of this section is to provide some economic context for the implementation of the agricultural operation BMPs. This analysis of BMP costs assumes that all agricultural producers would be required to implement the BMPs at the same time; in reality, those who would be required to implement

or continue to use the various BMPs would adjust over time as conditions change. Various data are necessary to project the cost of following the BMPs for agricultural operations. These include estimates of the number of:

1) Agricultural operations in the quarantine zone, the adjacent counties, and Pennsylvania,
2) Producers and hired managers,
3) Paid and unpaid workers, and
4) Trucks used by agricultural operations.

The data were obtained from USDA's 2017 Census of Agriculture for Pennsylvania (https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Pennsylvania/). The number and type of farms and businesses in the quarantine zone, in the adjacent counties, and statewide was obtained from Census of Agriculture Table 44, Farms by North American Industry Classification System: 2017. The number of producers and hired managers on farms was obtained from Census of Agriculture Table 45, Selected Operation and Producer Characteristics: 2017. The number of paid and unpaid workers was obtained from Census of Agriculture Table 7, Hired Farm Labor -Workers and Payroll: 2017. The number of trucks used on agricultural operations was obtained from Census of Agriculture Table 39, Machinery and Equipment on Operation: 2017 and 2012. For the purpose of this evaluation, the following types of agricultural operations are included (type/North American Industrial Classification): Grain (1111), Vegetable and melon (1112), Fruit and nut (1113), Nursery (1114), Other crop (1119), Beef (11211), Feedlots (112112), Dairy (112212), Hog (1122), Poultry (1123), Sheep/goat (1124), and Aquaculture/other (1125, 1129). These data are summarized in Table 45.

Table 45. Number of farm operations, producers, hired managers, farm laborers, unpaid workers, and farm trucks in the quarantine zone, adjacent counties, and Pennsylvania.

	Quarantine Zone	Adjacent counties	State	Data source (2017 Census of Agriculture)
Total Number of Farms	13,855	9,727	53,157	Table 44. Farms by North American Industry Classification System: 2017
Number of producers	24,436	16,991	91,830	Table 45. Selected Operation and Producer Characteristics: 2017.
Number of hired managers	1,844	994	4,800	Table 45. Selected Operation and Producer Characteristics: 2017.
Number of hired farm laborers	25,856	12,927	61,019	Table 7. Hired Farm Labor-Workers and Payroll: 2017.
Number of unpaid workers	20,718	13,097	76,377	Table 7. Hired Farm Labor-Workers and Payroll: 2017.
Total people involved with operations	72,854	44,009	23,4026	Sum of producers, hired managers, hired farm laborers, and unpaid workers
Total people involved other than producers or managers	46,574	26,024	137,396	Sum of hired farm laborers and unpaid workers
Trucks	9,189	7,251	38,119	Table 39. Machinery and Equipment on Operation: 2017 and 2012.
Truck loads/year	1,654,020	1,305,180	6,861,420	Number of trucks times 180 truckloads/year per truck

The BMPs for the agricultural industry include those aimed at communications, monitoring, employee training, ailanthus removal, inspection, and sanitation. The published BMPs are broken down by who is expected to do what and when, but many are repetitive. For the purposes of estimating the cost, the BMPs are broken down by those that are most likely to apply to mangers, producers, hired managers, paid and unpaid laborers, and farm trucks. Control of the host plant *Ailanthus altissima* (tree of heaven) is believed to be critical to the management of SLF. Like SLF, Ailanthus is an invasive species from China, and it is believed that Ailanthus may play an important role in the reproductive cycle and spread of the SLF. Ailanthus control requires a combination of tree removal and herbicide treatments. For the purpose of this evaluation it is assumed that each agricultural operation has 100 ailanthus trees to control. At present there are models that map locations suitable for growth of ailanthus and surveys have been conducted to document areas where they are presently growing. However, there are currently no estimates of the total number of ailanthus trees and their relative densities across the commonwealth. This assumption of 100 trees per operation is done to show that even this

relatively small number of Ailanthus trees, with its relatively modest treatment cost, can have a large overall impact because of the number of producers affected. Of course, some producers may have no costs associated with ailanthus control while others may experience much higher costs. As better data on the acreage and location of ailanthus within Pennsylvania are collected, better estimates of where and on whom these costs will fall can be generated. An estimate of ailanthus removal and herbicide treatment costs for individual agricultural producers, sawmills and forest landowners is detailed in Table 46.

Table 46. Estimated cost for Ailanthus removal/herbicide treatment

Cost assumptions per 50 trees (forest landowner):

1) Removal cost: 15 minutes/tree = 12.5 hours
2) Labor cost: $15/hr.
3) Herbicide cost (2,4-D and triclopyr): 1 gallon at $49/gallon
4) Herbicide application time: 1 hour

Total cost per 50 trees: 12.5 hours * $15/hour + $49 + $15 = $251.50

Cost assumptions per 100 trees (agricultural operations and sawmills):

1) Removal cost: 15 minutes/tree = 25.0 hours
2) Labor cost: $15/hr.
3) Herbicide cost (2,4-D and triclopyr): 2 gallons at $49/gallon
4) Herbicide application time: 2 hours

Total cost per 100 trees: 25 hours * $15/hour + $98 + $30 = $503.00

Note: Control of ailanthus involves a two-step process of removing the tree followed by herbicide application to kill the root system. Control measures that do not address the regenerative capacity of the root system will fail. Estimated costs are based on estimated tree removal times (personal communications, PDA and USDA), typical agricultural labor costs, and herbicide application with a spray wand.

The list of BMPs and their per unit costs, by the applicable group, is shown in Table 47. Many of the BMPs have relatively small overall costs, such as those relating to training employees and notification. However, some are quite high, especially those involving control of ailanthus and removal of egg masses. Although most of the costs are small on a unit basis, they become very large when the number of units are considered (Table 48). Overall, a conservative estimate of the cost of the BMPs for agricultural operations would be $27.9 million in the quarantine zone, $19.8 million in the adjacent counties, and $106.4 million statewide. Only 5-6% of these costs are for training and notification, while 24.7-25.1% of the costs are for ailanthus control and 69.4-70.2% of the costs are for monitoring and inspection.

Table 47. Per unit cost of complying with Best Management Practices (BMPs) for Pennsylvania agricultural operations.

BMP#	Best Management Practice	Quantity	Unit	Rate	Cost
	Agricultural operations:				
1	If your business is in a quarantine zone, or moves in and out of the quarantine zone, you must secure an SLF permit in order to comply with the SLF Quarantine Order. In some situations, a compliance agreement may be needed.	1	hr/operation	$15.00	$15.00
2	Train all employees to look for signs or the presence of SLF including egg masses and various life stages of the insect. Require them to report any sign of the insect to company leadership. Additionally, empower them to teach others who are less knowledgeable about the insect.	1	hr/employee	$15.00	$15.00
3	Inform all outside companies with whom you work that you expect them both to have and to comply with all safety BMP protocols.	2	hr/operation	$15.00	$30.00
4	Communicate with your customers your dedication to a safe product and your commitment to ship only products that are SLF‐free.	1	hr/operation	$15.00	$15.00
5	Communicate with PDA of your company's decision to implement these BMPs for SLF. This information will be extremely helpful to demonstrate the strong commitment of the tree‐fruit industry in Pennsylvania to USDA and other states as additional quarantines are considered if conditions worsen.	0.25	hr/operation	$15.00	$3.75
	Producers:				
1	Monitor information about SLF in your county and neighboring counties, especially if your property is in or adjacent to a quarantine area.	0.25	hr/producer	$15.00	$3.75
2	Work with PDA and the PSU Extension community in knowing the predicted emergence, egg hatch and life stage maturation of the insect each year.	1	hr/producer	$15.00	$15.00
3	Understand the SLF life cycle, learn to identify its egg masses and watch for potential egg masses on any surface in, on or around your property. If found, remove and destroy all egg masses if possible and alert PDA.	0.25	hr/day for 6 months	$15.00	$675.00
4	Remove all female Ailanthus trees from property.	100	trees/operation	$503.00	$503.00
5	Make sure all employees under your leadership understand and comply with the industry's BMPs.	0.25	hr/laborer	$15.00	$3.75
	Hired managers:				
1	Talk with the business owner/supervisor about the presence of SLF in the state, county and area.	1	hr/manager	$15.00	$15.00
2	Understand the SLF life cycle, learn to identify its egg masses and watch for potential egg masses on any surface in, on or around the property. If found, remove and destroy all egg masses where possible and report to the property owner and alert PDA.	0.25	hr/day for 3 months	$15.00	$337.50
3	Understand how the SLF life stage present at any given time impacts the jobs being performed throughout the year. Egg laying begins in the fall and continues until an extended freeze kills the adults and ends the egg‐laying period. For this reason, supervisors must be "keyed‐in" to detecting the presence of both adults and egg masses in the course of daily work during this period. If either adults or egg masses are seen, in addition to notifying the authorities, rapid, clear communication with the farm owner/manager is necessary so decisions can be made to apply insecticides to kill the adults present. Egg masses must be destroyed.	0.25	hr/day for 3 months	$15.00	$337.50
	Paid and unpaid laborers:				
1	Workers should feel empowered to take action – either directly or through channels within the company to limit the spread and mitigate the presence of this invasive species.	1	hr/laborer	$15.00	$15.00
	Truck and truck drivers:				
1	Confirm if workers or supervisors on site have seen any signs or any stage of SLF. If SLF have been observed, inspect the truck and all containers before loading them on the truck to be sure living insects and egg masses are removed and destroyed.	0.25	hr/load	$17.50	$4.38
2	After the season, work with your supervisor and local extension agents to confirm that adult SLF have stopped egg-laying. After that time, pressure wash all surfaces of any truck used on the farm. This will eradicate any egg masses present.	1	hr/truck	$17.50	$17.50

Note: BMP# refers to the numbers assigned by PDA in its recommendations. Not all BMPs were included in this evaluation because: 1) several were repetitive, 2) some only applied to specific types of operations in a limited number of cases, and 3) many had implied timeliness impacts which could not be valued.

Table 48. Cost of complying with Best Management Practices (BMPs) for Pennsylvania agricultural operations.

BMP#	Best Management Practice	Number of units			BMP cost		
		Quarantine Zone	Adjoining Counties	State	Quarantine Zone	Adjoining Counties	State
	Agricultural operations:						
1	If your business is in a quarantine zone, or moves in and out of the quarantine zone, you must secure an SLF permit in order to comply with the SLF Quarantine Order. In some situations, a compliance agreement may be needed.	13,855	9,727	53,157	$207,825	$145,905	$797,355
2	Train all employees to look for signs or the presence of SLF including egg masses and various life stages of the insect. Require them to report any sign of the insect to company leadership. Additionally, empower them to teach others who are less knowledgeable about the insect.	46,574	26,024	137,396	$698,610	$390,360	$2,060,940
3	Inform all outside companies with whom you work that you expect them both to have and to comply with all safety BMP protocols.	13,855	9,727	53,157	$415,650	$291,810	$1,594,710
4	Communicate with your customers your dedication to a safe product and your commitment to ship only products that are SLF‑free.	13,855	9,727	53,157	$207,825	$145,905	$797,355
5	Communicate with PDA of your company's decision to implement these BMPs for SLF. This information will be extremely helpful to demonstrate the strong commitment of the tree‑fruit industry in Pennsylvania to USDA and other states as additional quarantines are considered if conditions worsen.	13,855	9,727	53,157	$51,956	$36,476	$199,339
	Producers:						
1	Monitor information about SLF in your county and neighboring counties, especially if your property is in or adjacent to a quarantine area.	24,436	16,991	91,830	$91,635	$63,716	$344,363
2	Work with PDA and the PSU Extension community in knowing the predicted emergence, egg hatch and life stage maturation of the insect each year.	24,436	16,991	91,830	$366,540	$254,865	$1,377,450
3	Understand the SLF life cycle, learn to identify its egg masses and watch for potential egg masses on any surface in, on or around your property. If found, remove and destroy all egg masses if possible and alert PDA.	13,855	9,727	53,157	$9,352,125	$6,565,725	$35,880,975
4	Remove all female Ailanthus trees from property.	13,855	9,727	53,157	$6,969,065	$4,892,681	$26,737,971
5	Make sure all employees under your leadership understand and comply with the industry's BMPs.	46,574	26,024	137,396	$174,653	$97,590	$515,235
	Hired managers						
1	Talk with the business owner/supervisor about the presence of SLF in the state, county and area.	1,844	994	4,800	$27,660	$14,910	$72,000
2	Understand the SLF life cycle, learn to identify its egg masses and watch for potential egg masses on any surface in, on or around the property. If found, remove and destroy all egg masses where possible and report to the property owner and alert PDA.	1,844	994	4,800	$622,350	$335,475	$1,620,000
3	Understand how the SLF life stage present at any given time impacts the jobs being performed throughout the year. Egg laying begins in the fall and continues until an extended freeze kills the adults and ends the egg‑laying period. For this reason, supervisors must be "keyed‑in" to detecting the presence of both adults and egg masses in the course of daily work during this period. If either adults or egg masses are seen, in addition to notifying the authorities, rapid, clear communication with the farm owner/manager is necessary so decisions can be made to apply insecticides to kill the adults present. Egg masses must be destroyed.	1,844	994	4,800	$622,350	$335,475	$1,620,000
	Paid and unpaid laborers						
1	Laborers should feel empowered to take action – either directly or through channels within the company to limit the spread and mitigate the presence of this invasive species.	46,574	26,024	137,396	$698,610	$390,360	$2,060,940
	Truck and truck drivers:						
1	Confirm if workers or supervisors on site have seen any signs or any stage of SLF. If SLF have been observed, inspect the truck and all containers before loading them on the truck to be sure living insects and egg masses are removed and destroyed.	1,654,020	1,305,180	6,861,420	$7,236,338	$5,710,163	$30,018,713
2	After the season, work with your supervisor and local extension agents to confirm that adult SLF have stopped egg‑laying. After that time, pressure wash all surfaces of any truck used on the farm. This will eradicate any egg masses present.	9,189	7,251	38,119	$160,808	$126,893	$667,083
	Total BMP costs for training and notification				$1,581,866	$1,010,456	$5,449,699
	Total BMP costs for Ailanthus control				$6,969,065	$4,892,681	$26,737,971
	Total BMP costs for monitoring and inspection				$19,353,068	$13,895,171	$74,176,758
	Total cost of SLF BMPs for agricultural operations				$27,903,999	$19,798,309	$106,364,427
	Percentage of BMP costs for training and notification				5.7%	5.1%	5.1%
	Percentage of BMP costs for Ailanthus control				25.0%	24.7%	25.1%
	Percentage of BMP costs for monitoring and inspection				69.4%	70.2%	69.7%

Note: BMP# refers to the numbers assigned by PDA in its recommendations. Not all BMPs were included in this evaluation because: 1) several were repetitive, 2) some only applied to specific types of operations in a limited number of cases, and 3) many had implied timeliness impacts which could not be valued.

Cost of Complying with Forestry Recommended Best Management Practices

The Pennsylvania Department of Agriculture has also published BMPs for the forestry industry to mitigate the spread of SLF. These BMPs range from relatively simple and straightforward actions like training personnel about the SLF and how to identify its various life stages to more complex and time-consuming activities involving inspection of logs and the loading of trucks. The purpose of this section is to provide some economic context for the implementation of the BMPs. This analysis of BMP costs assumes that all sawmills and forest landowners would be required to implement the BMPs at the same time; in reality, those who would be required to implement or continue to use the various BMPs would adjust over time as conditions change.

Various assumptions are necessary to project the cost of following the BMPs for forestry. These include estimates of the number of:

1) sawmills in the quarantine zone, the adjacent counties, and Pennsylvania,
2) sawmill workers,
3) logs processed,
4) truckloads of logs, and
5) forest landowners.

Much of the data was obtained from the Pennsylvania Timber Product Output Survey published in 2015 (Pennsylvania Bureau of Forestry, Pennsylvania Timber Product Output Survey. Harrisburg, PA: Department of Conservation and Natural Resources, April 2015. 56 pp. http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_20030708.pdf).[3] In this publication, the number of sawmills is estimated to be 43 in the quarantine zone, 58 in the adjacent counties, and 430 statewide (data from Figure 1 on page 14 of the Pennsylvania Timber Product Survey, 2015). This same publication provided an estimate of an average of

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[3] Note: There was also a Pennsylvania Timber Product Output Survey published in 2017, but this report does not provide information on the number of sawmills per county. Therefore, data from the 2015 publication were used in this evaluation.

20.825 workers per sawmill for the state (Pennsylvania Timber Product Survey, 2015, page 14). This publication also provided an estimate of the number of board feet processed in each county. By taking the number of board feet of lumber produced, an estimate of the number of logs this represents can be made assuming a given log size. In this case, a 16-foot long 20" DBH log containing 192 board feet of lumber (Doyle scale) was assumed. The assumptions used are based on these data and can be found in Table 49.

The number of private forest landowners in Pennsylvania is estimated to be around 738,000. These landowners make stewardship decisions for approximately 11.5 million acres or about 68% of the state's 16.8 million acres of forestland. (source: Pennsylvania Private Forest Landowners and Future Plans, https://ecosystems.psu.edu/research/centers/private-forests/news/2013/pennsylvania-private-forest-landowners-and-future-plans). This means that each private forest landowner manages approximately 15.6 acres. Using this information and county timber acreage estimates from USDA's Forest Inventory and Analysis database (https://www.nrs.fs.fed.us/fia/default.asp), the approximate number of forest landowners can be calculated for the quarantine zone and the adjacent counties (Table 50). Since the costs of many of the BMPs are based on inspection of logs, the number of loads of logs, and the cleaning of vehicles, estimates are needed for these items as well.

The BMPs for the forestry industry include those aimed at communications, monitoring, employee training, ailanthus removal, inspection, and sanitation. The published BMPs are broken down by who is expected to do what and when, but many are repetitive. For the purposes of estimating the cost of the BMPs, the BMPs are broken down by those that are most likely to apply to company management, forest landowners, loggers, truckers, and sawmill employees.

Table 49. Estimated number of sawmill workers, annual number of logs processed, truckloads of logs moved, and number of logging trucks operating in the SLF quarantine zone, adjacent counties, and Pennsylvania.

	Quarantine Zone	Adjacent counties	State
Number of sawmills[1]	43	58	430
Estimated number of sawmill workers[2]	896	1,208	8,955
Thousand board feet of lumber produced annually[3]	103,640	83,790	681,660
Estimated number of logs (rounded)[4]	540,000	436,000	3,550,000
Estimated number of truckloads of logs (rounded)[5]	27,200	22,100	179,400
Estimated number of trucks required[6]	38	31	249

Notes:
1. Pennsylvania Bureau of Forestry, Pennsylvania Timber Product Output Survey. Harrisburg, PA: Department of Conservation and Natural Resources, April 2015. Figure 1, page 14.
2. Based on an average of 20.825 workers per sawmill. Pennsylvania Bureau of Forestry, Pennsylvania Timber Product Output Survey. Harrisburg, PA: Department of Conservation and Natural Resources, April 2015. Page 18.
3. Pennsylvania Bureau of Forestry, Pennsylvania Timber Product Output Survey. Harrisburg, PA: Department of Conservation and Natural Resources, April 2015. Table A1, page 34.
4. Based on a 20" DBH log containing 192 board feet of lumber (Doyle scale).
5. Based on a tri-axle logging truck moving approximately 3,800 board feet of logs.
6. Based on an estimate of 3 loads per day, 240 days per year.

Table 50. Estimated number of forest landowners in the quarantine zone and adjacent counties.

Item	Value	Data source or calculation
Total forest acres in Pennsylvania	16.8 million acres	Pennsylvania Private Forest Landowners and Future Plans webpage
Number of forest landowners in PA	738,000	Pennsylvania Private Forest Landowners and Future Plans webpage
Number of acres per forest landowner	15.58 acres	=16,800,000/738,000
Private forest ownership	11.5 million acres	Pennsylvania Private Forest Landowners and Future Plans webpage
Percentage private ownership	68.45%	=11.5/16.8
Forest land in quarantine zone	1,690,100 acres	USDA's Forest Inventory and Analysis website
Forest land in adjacent counties	2,347,200 acres	USDA's Forest Inventory and Analysis website
Estimated number of forest landowners in quarantine zone	74,200	=1,690,000*68.45%/15.58 (rounded)
Estimated number of forest landowners in adjacent counties	103,100	=2,347,200*68.45%/15.58 (rounded)

Control of the host plant *Ailanthus altissima* (tree of heaven) is believed to be critical to the management of SLF in forests. Ailanthus control requires a combination of tree removal and herbicide treatments. For the purpose of this evaluation it is assumed that each forest landowner has 50 ailanthus trees to control and each sawmill has 100 ailanthus trees to control (in parking and drying areas). At present there are models that map locations suitable for growth of ailanthus and some surveys have been conducted to document areas where they are presently growing. However, there are no estimates of the total number of ailanthus trees and their relative densities across the commonwealth. This assumption of 50 trees per forest landowner and 100 trees per sawmill is done to show that even this relatively small number of Ailanthus trees, with its relatively modest treatment cost, can have a large overall impact because of the number of entities affected. In reality, some forest landowners and sawmill

operations may have no costs associated with ailanthus control while others may experience much higher costs. As better data on the acreage and location of ailanthus within Pennsylvania are collected, better estimates of where and on whom these costs will fall can be generated. An estimate of ailanthus removal and herbicide treatment costs for individual agricultural producers, sawmills and forest landowners is detailed in Table 46.

The list of BMPs and their costs, by the applicable group, is shown in Table 51. Many of the BMPs have relatively small one-time costs, such as those relating to training employees and notification. However, some are quite high, especially those involving control of ailanthus and inspection of logs and logging trucks. Although most of the costs are small on a unit basis, they become very large when the number of units are considered (Table 52). For example, although the potential cost of ailanthus control is quite small per forest landowner, a relatively high number of people falls in this category. However, depending on the success of ailanthus control, costs associated with ailanthus control are likely to decrease over time. The cost of inspection will be long-term and remain high when considering all the different times in which a log should be inspected for the presence of insects and egg masses. Overall, the estimated cost of the BMPs for the timber industry would be $23.2 million in the quarantine zone, $30.3 million in the adjacent counties, and $219.6 million statewide. Only 0.1% of these costs are for training and notification, while 80.1-85.8% of the costs are for ailanthus control and 14.1-19.8% of the costs are for monitoring and inspection.

Table 51. Per unit cost of complying with Best Management Practices (BMPs) for the Pennsylvania forest industry.

BMP#	Best Management Practice	Quantity	Unit	Rate	Cost
	Sawmill management:				
1	If your sawmill is in a quarantine zone or if you are receiving logs or lumber from the quarantine zone, you must sign compliance agreements to ship your products out of the quarantined area and permits will be required for drivers and employees in the quarantine zone. At least one employee must be trained by authorized trainers through the Department of Agriculture and then that person trains other employees.	2	hr/sawmill	$28.00	$56.00
2	The employee designated to train those who need work permits may also take the exam on-line.	2	hr/sawmill	$28.00	$56.00
3	Train all employees to look for signs of SLF and other invasive insects including egg masses and various life stages of the insects. Require them to report any sign of the insect to company leadership.	1	hr/employee	$15.00	$15.00
4	Work with logging and forestry crews and inform them you expect compliance with all safety BMP protocols.	0.5	hr/sawmill	$28.00	$14.00
5	Notify the Hardwoods Development Council of your company's decision to implement these BMPs for invasive insects.	0.5	hr/sawmill	$28.00	$14.00
	Forest landowners:				
1	Monitor information about SLF in your county and neighboring counties, especially if your property is in the quarantine area.	0.5	hr/owner	$15.00	$7.50
2	Remove all female/male Ailanthus trees from property.	50	trees/owner	$251.50	$251.50
	Loggers:				
1	If egg masses are found on the property, every log must be inspected prior to moving the log off the property. Every log should also be inspected on all four sides at the receiving log yard as a secondary defense. If found, the egg masses must be manually destroyed.	0.1	hr/log	$13.00	$1.30
2	During the months of July-December, equipment and vehicles must be monitored for adults which might fall into crevices and move out of the area.	0.5	hr/day for 120 days	$13.00	$780.00
	Truckers from the Forest to the Mill:				
1	All truckers working in a known quarantine zone must be trained and issued permits to work in the area.	2	hr/truck	$16.00	$32.00
2	Confirm if loggers or foresters working on site have seen any signs of SLF. If so, inspect all the logs before loading them on the truck to be sure living insects and egg masses are removed and remove any the loggers may have missed. If not, inspect the logs a second time for signs of egg masses or insects.	0.1	hr/log	$16.00	$1.60
3	If you see Ailanthus nearby, inspect those trees for signs of SLF.	0.1	hr/load	$16.00	$1.60
4	Inspect your truck tires and truck body for egg masses or other life stages before leaving a site, and be sure you are not moving SLF inside the cab of the truck.	0.33	hr/load	$16.00	$5.28

BMP#		Quantity	Unit	Rate	Cost
Parking:					
1	Herbicide and remove Ailanthus trees near parking areas according to recommended treatments.	50	trees/sawmill	$251.50	$251.50
2	Be aware if any logs coming into your facility are from quarantine zones.	0.1	hr/load	$13.00	$1.30
3	For all logs from a quarantine zone: inspect all four sides of every log for egg masses or signs of living SLF.	0.1	hr/log	$13.00	$1.30
De-Barkers and Sawyers:					
1	Watch for egg masses or adult bugs. If found, stop production until log yard workers and others in the supply chain can be notified and informed to inspect more carefully.	0.05	hr/log	$16.00	$0.80
Green Line Workers/Lumber stackers:					
1	Watch for egg masses or adult bugs. If found, stop production until Sawyers and others in the supply chain before you can be notified and informed to inspect more carefully.	0.05	hr/log	$13.00	$0.65
Air Drying:					
1	If you are not in a quarantined area, proceed with air drying storage as normal but constantly monitor your property for signs for SLF.	1	hr/day for 240 days	$15.00	$3,600.00
2	Be sure to remove all Ailanthus from near your sawmill drying yards.	50	trees/sawmill	$251.50	$251.50
3	If you are in a quarantine area (but not a hot spot where insects are heavily active) then monitor closely for any signs of the insects. If found, then attempt to move as much product indoors as possible. Try to keep product from tree line of property. Inform lumber graders on the dry line and the kiln operators to watch for signs and to remove egg masses.	1	hr/day for 240 days	$15.00	$3,600.00
Kiln Operators:					
1	Do not leave kilns open allowing insects to enter the kiln before or after the kiln drying.	0.1	hr/day for 240 days	$18.00	$432.00
2	Observe if kiln drying is killing the egg masses. It may not kill all egg masses because species of wood have different kiln schedules with higher/lower temperatures and shorter/longer exposure to the kiln. Check with the Hardwoods Development Council when there is more conclusive science regarding mortality of egg masses from kiln drying.	0.25	hr/day for 240 days	$18.00	$1,080.00
3	Watch for egg masses or adult insects. If found, stop production until green line operators and log yard workers are informed and improve their inspection methods.	0.25	hr/day for 240 days	$18.00	$1,080.00
Dry Line Workers					
1	Before stacking lumber on any pallets or runners, inspect them for potential egg masses on top and underneath the pallet.	0.25	hr/1,000 bd. ft.	$13.00	$3.25

Note: BMP# refers to the numbers assigned by PDA in their recommendations. Not all BMPs were included in this evaluation because: 1) several were repetitive, 2) some only applied to specific types of operations in a limited number of cases, and 3) many had implied timeliness impacts which could not be valued.

Table 52. Cost of complying with Best Management Practices (BMPs) for the Pennsylvania forest industry

BMP#	Best Management Practice	Number of units Quarantine Zone	Number of units Adjoining Counties	Number of units State	Quarantine Zone	BMP cost Adjoining Counties	State
	Sawmill management:						
1	If your sawmill is in a quarantine zone or if you are receiving logs or lumber from the quarantine zone, you must sign compliance agreements to ship your products out of the quarantined area and permits will be required for drivers and employees in the quarantine zone. At least one employee must be trained by authorized trainers through the Department of Agriculture and then that person trains other employees.	43	58	430	$2,408	$3,248	$24,080
2	The employee designated to train those who need work permits may also take the exam on-line.	43	58	430	$2,408	$3,248	$24,080
3	Train all employees to look for signs of SLF and other invasive insects including egg masses and various life stages of the insects. Require them to report any sign of the insect to company leadership.	896	1208	8955	$13,440	$18,120	$134,325
4	Work with logging and forestry crews and inform them you expect compliance with all safety BMP protocols.	43	58	430	$602	$812	$6,020
5	Notify the Hardwoods Development Council of your company's decision to implement these BMPs for invasive insects.	43	58	430	$602	$812	$6,020
	Forest landowners						
1	Monitor information about SLF in your county and neighboring counties, especially if your property is in the quarantine area.	74,200	103,100	737,400	$556,500	$773,250	$5,530,500
2	Remove all Ailanthus trees from property.	74,200	103,100	737,400	$18,661,300	$25,929,650	$185,456,100
	Loggers						
3	If egg masses are found on the property, every log must be inspected prior to moving the log off the property. Every log should also be inspected on all four sides at the receiving log yard as a secondary defense. If found, the egg masses must be manually destroyed.	540,000	436,000	3,550,000	$702,000	$566,800	$4,615,000
4	During the months of July-December, equipment and vehicles must be monitored for adults which might fall into crevices and move out of the area.	38	31	249	$29,640	$24,180	$194,220
	Truckers from the Forest to the Mill						
1	All truckers working in a known quarantine zone must be trained and issued permits to work in the area.	38	31	249	$1,216	$992	$7,968
2	Confirm if loggers or foresters working on site have seen any signs of SLF. If so, inspect all the logs before loading them on the truck to be sure living insects and egg masses are removed and remove any the loggers may have missed. If not, inspect the logs a second time for signs of egg masses or insects.	540,000	436,000	3,550,000	$864,000	$697,600	$5,680,000
3	If you see Ailanthus nearby, inspect those trees for signs of SLF.	27,200	22,100	179,400	$43,520	$35,360	$287,040
4	Inspect your truck tires and truck body for egg masses or other life stages before leaving a site, and be sure you are not moving SLF inside the cab of the truck.	27,200	22,100	179,400	$143,616	$116,688	$947,232
	Parking						
1	Herbicide and remove Ailanthus trees near parking areas according to recommended treatments.	43	58	430	$10,815	$14,587	$108,145

BMP#	Description						
2	Be aware if any logs coming into your facility are from quarantine zones. For all logs from a quarantine zone: inspect all four sides of every log for egg masses or signs of living SLF.	27,200	22,100	179,400	35,360	28,730	233,220
3		540,000	436,000	3,550,000	702,000	566,800	4,615,000
	De-Barkers and Sawyers:						
1	Watch for egg masses or adult bugs. If found, stop production until log yard workers and others in the supply chain can be notified and informed to inspect more carefully.	540,000	436,000	3,550,000	432,000	348,800	2,840,000
	Green Line Workers/Lumber stackers						
1	Watch for egg masses or adult bugs. If found, stop production until Sawyers and others in te supply chain before you can be notified and informed to inspect more carefully.	540,000	436,000	3,550,000	351,000	283,400	2,307,500
	Air Drying:						
1	If you are not in a quarantined area, proceed with air drying storage as normal but constantly monitor your property for signs for SLF.	43	58	430	154,800	208,800	1,548,000
2	Be sure to remove all Ailanthus from near your sawmill drying yards.	43	58	430	10,815	14,587	108,145
3	If you are in a quarantine area (but not a hot spot where insects are heavily active) then monitor closely for any signs of the insects. If found, then attempt to move as much product indoors as possible. Try to keep product from tree line of property, Inform lumber graders on the dry line and the kiln operators to watch for signs and to remove egg masses.	43	58	430	154,800	208,800	1,548,000
	Kiln Operators:						
1	Do not leave kilns open allowing insects to enter the kiln before or after the kiln drying.	43	58	430	18,576	25,056	185,760
2	Observe if kiln drying is killing the egg masses. It may not kill all egg masses because species of wood have different kiln schedules with higher/lower temperatures and shorter/longer exposure to the kiln. Check with the Hardwoods Development Council when there is more conclusive science regarding mortality of egg masses from kiln drying.	43	58	430	46,440	62,640	464,400
3	Watch for egg masses or adult insects. If found, stop production until green line operators and log yard workers are informed and improve their inspection methods.	43	58	430	46,440	62,640	464,400
	Dry Line Workers:						
1	Before stacking lumber on any pallets or runners, inspect them for potential egg masses on top and underneath the pallet.	103,640	83,790	681,660	336,830	272,318	2,215,395
	Total BMP costs for training and notification				$20,676	$27,232	$202,493
	Total BMP costs for Ailanthus control				$18,682,929	$25,958,824	$185,672,390
	Total BMP costs for monitoring and inspection				$4,617,522	$4,281,862	$33,675,667
	Total cost of SLF BMPs for timber industry				$23,321,127	$30,267,918	$219,550,550
	Percentage of BMP costs for training and notification				0.1%	0.1%	0.1%
	Percentage of BMP costs for Ailanthus control				80.1%	85.8%	84.6%
	Percentage of BMP costs for monitoring and inspection				19.8%	14.1%	15.3%

Note: BMP# refers to the numbers assigned by PDA in their recommendations. Not all BMPs were included in this evaluation because: 1) several were repetitive, 2) some only applied to specific types of operations in a limited number of cases, and 3) many had implied timeliness impacts which could not be valued.

Implications

The impact of SLF on agriculture and forestry in Pennsylvania could be considerable. The economic impacts on employment and economic output are summarized in Table 53. Overall, the expected impact of SLF in the quarantine zone is currently estimated to be $50.1 million total per year and a loss of 484 jobs. If the worst-case scenario occurred these losses would be expected to increase to $92.8 million total per year and a loss of 927 jobs. If the SLF spreads into the adjacent counties, expected losses would increase to $89.2 million total per year and a loss of 843 jobs. In this case, if the worst-case scenario occurred, these losses would increase to $168.8 million total per year and a loss of 1,665 jobs. If SLF spread throughout Pennsylvania, then the expected losses would amount to $324.9 million annually and a loss of 2,810 jobs. Under the worst-case scenario, losses would increase to $554.0 million and a loss of 4,987 jobs.

The impact of the SLF in the quarantine zone is already significant and the spread throughout the state could be potentially devastating for agriculture and forestry. This indicates that the vigorous response by the Pennsylvania Department of Agriculture, the U.S. Department of Agriculture, and Pennsylvania State University to limiting the spread of SLF is clearly warranted. The potential spread of this pest to neighboring states with major timber and grape industries argues for the continuance of existing programs and the strengthening of research and management efforts.

Best management practices developed by the Pennsylvania Department of Agriculture for SLF seek to slow the spread of SLF populations. They vary from fairly simple tactics, like employee education and pest monitoring, to much more intensive practices involving inspection, phytosanitation, and *Ailanthus altissima* eradication. Overall, a conservative estimate of the cost of the BMPs for agricultural operations would be $27.9 million in the quarantine zone, $19.8 million in the adjacent counties, and $106.4 million statewide. A similar estimate for the timber industry would be $23.2 million in the quarantine zone, $30.3 million in the adjacent counties, and $219.6 million statewide. Use of these types of practices are necessary to provide the time needed to develop effective SLF management practices, including biological control.

However, the cost of these BMPs fall rather heavily on certain sectors of the economy, including the timber and nursery industries. Government cost-share money may be needed to encourage the use of BMPs and reduce the impact of their cost on the bottom-line of affected businesses.

Table 53. Comparison of economic impacts of the SLF on the quarantine zone, the quarantine zone and adjacent counties, and Pennsylvania.

		Expected Impact				Worst-Case Scenario		
		Labor	Total Value			Labor	Total Value	
Effect Type	Employment	Income	Added	Output	Employment	Income	Added	Output
Quarantine Zone, Agriculture:								
Direct Effect	205.7	$2.9	$6.3	$12.9	445.5	$6.5	$13.6	$29.0
Indirect Effect	47.4	$2.2	$3.1	$4.9	108.1	$5.0	$7.1	$11.5
Induced Effect	32.1	$1.7	$2.8	$4.6	72.5	$3.7	$6.3	$10.5
Total Effect	285.3	$6.7	$12.2	$22.4	626.0	$15.2	$27.0	$51.0
Quarantine Zone, Forestry:								
Direct Effect	109.4	$9.9	$14.0	$16.1	165.4	$15.0	$21.1	$24.4
Indirect Effect	22.3	$1.0	$1.2	$1.9	33.6	$1.5	$1.9	$2.8
Induced Effect	67.3	$3.5	$5.8	$9.6	101.7	$5.2	$8.8	$14.6
Total Effect	199.0	$14.4	$21.0	$27.7	300.8	$21.8	$31.7	$41.8
Quarantine Zone, Agriculture and Forestry:								
Direct Effect	315.2	$12.9	$20.3	$29.0	610.9	$21.5	$34.7	$53.4
Indirect Effect	69.7	$3.2	$4.3	$6.8	141.7	$6.5	$9.0	$14.3
Induced Effect	99.5	$5.1	$8.6	$14.3	174.2	$9.0	$15.0	$25.0
Total Effect	484.3	$21.1	$33.1	$50.1	926.8	$36.9	$58.8	$92.8
Quarantine Zone and Adjacent Counties, Agriculture:								
Direct Effect	330.4	$4.5	$9.9	$20.4	764.0	$10.7	$22.9	$49.0
Indirect Effect	75.9	$3.5	$4.9	$7.9	184.2	$8.5	$12.2	$19.5
Induced Effect	50.4	$2.6	$4.4	$7.3	121.4	$6.3	$10.5	$17.5
Total Effect	456.7	$10.6	$19.2	$35.5	1,069.7	$25.4	$45.6	$86.0

Quarantine Zone and Adjacent Counties, Forestry:

Direct Effect	212.3	$19.3	$27.1	$31.3	327.3	$29.8	$41.7	$48.3
Indirect Effect	43.2	$1.9	$2.4	$3.6	66.6	$2.9	$3.7	$5.6
Induced Effect	130.5	$6.7	$11.2	$18.7	201.3	$10.3	$17.3	$28.9
Total Effect	386.0	$27.9	$40.7	$53.7	595.2	$43.0	$62.8	$82.7

Quarantine Zone and Adjacent Counties, Agriculture and Forestry:

Direct Effect	542.7	$23.8	$37.0	$51.7	1,091.3	$40.5	$64.6	$97.2
Indirect Effect	119.0	$5.4	$7.3	$11.5	250.8	$11.4	$15.9	$25.1
Induced Effect	181.0	$9.3	$15.6	$26.0	322.7	$16.6	$27.8	$46.4
Total Effect	842.7	$38.5	$59.9	$89.2	1,664.9	$68.5	$108.3	$168.8

Commonwealth of PA, Agriculture:

Direct Effect	734.5	$9.2	$20.7	$41.5	1,621.3	$21.6	$46.3	$97.2
Indirect Effect	155.0	$7.1	$9.9	$15.8	363.4	$16.7	$23.9	$38.3
Induced Effect	103.3	$5.3	$8.9	$14.9	242.8	$12.5	$21.0	$35.0
Total Effect	992.9	$21.6	$39.5	$72.2	2,227.6	$50.9	$91.2	$170.5

Commonwealth of PA, Forestry:

Direct Effect	999.8	$90.9	$127.4	$147.5	1,517.3	$137.9	$193.4	$223.8
Indirect Effect	203.4	$9.0	$11.3	$17.1	308.7	$13.6	$17.2	$25.9
Induced Effect	614.8	$31.6	$52.9	$88.1	933.1	$48.0	$80.3	$133.8
Total Effect	1,818.0	$131.5	$191.7	$252.7	2,759.1	$199.5	$290.9	$383.5

Commonwealth of PA, Agriculture and Forestry:

Direct Effect	1,734.3	$100.1	$148.1	$188.9	3,138.6	$159.6	$239.7	$321.0
Indirect Effect	358.4	$16.1	$21.3	$32.9	672.1	$30.3	$41.1	$64.2
Induced Effect	718.2	$37.0	$61.9	$103.0	1,176.0	$60.5	$101.3	$168.8
Total Effect	2,810.8	$153.1	$231.2	$324.9	4,986.6	$250.4	$382.1	$554.0

Appendix 1. Production Specialist/Educator SLF impact On-line Surveys (surveys conducted February-March 2019 through the Penn State Survey Research Center).

How would you describe yourself (check all that apply)?

- ◯ Researcher
- ◯ Extension specialist
- ◯ Faculty
- ◯ Extension educator
- ◯ Agronomic crops
- ◯ Entomologist
- ◯ Vegetable crops
- ◯ Tree fruits
- ◯ Small fruits
- ◯ Forest products
- ◯ Nursery crops
- ◯ Other _____

In what state are you located?

- ◯ Pennsylvania
- ◯ Delaware
- ◯ Maryland
- ◯ New Jersey
- ◯ New York
- ◯ Virginia
- ◯ Other

Timber/Woodland Crops Specialist survey: In your estimation, how susceptible are the following tree species to attack by the spotted lanternfly?

Tree species	No Opinion	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Very Susceptible
Red Maple	○	○	○	○	○
Black Cherry	○	○	○	○	○
Northern red oak	○	○	○	○	○
White oak	○	○	○	○	○
Yellow poplar	○	○	○	○	○
Sugar maple	○	○	○	○	○
Chestnut oak	○	○	○	○	○
White ash	○	○	○	○	○
American beech	○	○	○	○	○
Hickory	○	○	○	○	○
Eastern hemlock	○	○	○	○	○
Sweet birch	○	○	○	○	○
Eastern white pine	○	○	○	○	○
Black walnut	○	○	○	○	○
Other (list):	○	○	○	○	○

_____

In your estimation, how susceptible are the following woodland specialty crops to attack by the spotted lanternfly?

Woodland crop	No Opinion	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Very Susceptible
Maple syrup	○	○	○	○	○
Christmas trees	○	○	○	○	○

Tree Fruit, Small Fruit, and Hops Specialist survey: In your estimation, how susceptible are the following fruit species to attack by the spotted lanternfly?

Crop	No Opinion	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Very Susceptible
Apples	○	○	○	○	○
Apricots	○	○	○	○	○
Cherries, sweet	○	○	○	○	○
Cherries, tart	○	○	○	○	○
Hops	○	○	○	○	○
Peaches/Nectarines	○	○	○	○	○
Pear	○	○	○	○	○
Plum	○	○	○	○	○
Grapes	○	○	○	○	○
Blueberries	○	○	○	○	○
Cane berries	○	○	○	○	○
Strawberries	○	○	○	○	○
Nut trees	○	○	○	○	○
Other (list):	○	○	○	○	○

_____

Vegetable Specialist survey: In your estimation, how susceptible are the following vegetable crops to attack by the spotted lanternfly?

Crop	No Opinion	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Very Susceptible
Asparagus	○	○	○	○	○
Beans	○	○	○	○	○
Beets	○	○	○	○	○
Broccoli	○	○	○	○	○
Cabbage	○	○	○	○	○
Cantaloupes/ muskmelons	○	○	○	○	○
Carrots	○	○	○	○	○
Cauliflower	○	○	○	○	○

Crop					
Cucumbers	◯	◯	◯	◯	◯
Eggplant	◯	◯	◯	◯	◯
Garlic	◯	◯	◯	◯	◯
Lettuce	◯	◯	◯	◯	◯
Onions	◯	◯	◯	◯	◯
Peas	◯	◯	◯	◯	◯
Peppers	◯	◯	◯	◯	◯
Potatoes	◯	◯	◯	◯	◯
Pumpkins	◯	◯	◯	◯	◯
Squash	◯	◯	◯	◯	◯
Sweet corn	◯	◯	◯	◯	◯
Tomatoes	◯	◯	◯	◯	◯
Watermelons	◯	◯	◯	◯	◯
Other (list):	◯	◯	◯	◯	◯

_____

Agronomic Crops Specialist survey: In your estimation, how susceptible are the following agronomic crops to attack by the spotted lanternfly?

Crop	No Opinion	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Very Susceptible
Barley	◯	◯	◯	◯	◯
Corn	◯	◯	◯	◯	◯
Dry beans	◯	◯	◯	◯	◯
Oats	◯	◯	◯	◯	◯
Sorghum	◯	◯	◯	◯	◯
Soybeans	◯	◯	◯	◯	◯
Tobacco	◯	◯	◯	◯	◯
Wheat	◯	◯	◯	◯	◯
Grass hay	◯	◯	◯	◯	◯
Alfalfa hay	◯	◯	◯	◯	◯
Other (list):	◯	◯	◯	◯	◯

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Nursery Crops Specialist survey: In your estimation, how susceptible are the following nursery crops to attack by the spotted lanternfly?

Crop	No Opinion	Not Susceptible	Slightly Susceptible	Moderately Susceptible	Very Susceptible
Bedding plants	◯	◯	◯	◯	◯
Cut flowers/ florist greens	◯	◯	◯	◯	◯
Nursery stock	◯	◯	◯	◯	◯
Vegetable transplants	◯	◯	◯	◯	◯
Other (list):	◯	◯	◯	◯	◯

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Appendix 2. Published enterprise budget sources for specialty crop value of production used in SLF evaluation.

Bogash, S.M., W.J. Lamont Jr., R.M. Harsh, L.F. Kime, and J.K. Harper. "Potato Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, November 2013.

Bogash, S.M., A.J. Muzza, L.F. Kime, and J.K. Harper. "Table Grape Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, May 2018.

Crassweller, R.M., L.F. Kime, and J.K. Harper. "Apple Production." *Agricultural Alternatives* series. UA428. Penn State Cooperative Extension, February 2016.

Crassweller, R.M., L.F. Kime, and J.K. Harper. "Peach Production." *Agricultural Alternatives* series. UA429. Penn State Cooperative Extension, February 2016.

Demchak, K., J.K. Harper, and L.F. Kime. "Red Raspberry Production". *Agricultural Alternatives* series. Penn State Cooperative Extension, March 2014.

Demchak, K., J.K. Harper, and L.F. Kime. "Highbush Blueberry Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, March 2014.

Demchak, K., J.K. Harper, L.F. Kime, and W. Lantz. "Strawberry Production". *Agricultural Alternatives* series. Penn State Cooperative Extension, August 2017.

Ford, T.G., S.M. Bogash, M.D. Orzolek, L.F. Kime, and J.K. Harper. "Garlic Production." *Agricultural Alternatives* series. University Park, PA: Penn State Cooperative Extension, December 2014.

Harper, J.K. "Strawberries: Economics" in *The Mid-Atlantic Berry Guide for Commercial Growers, 2013-2014.* AGRS-97. University Park, PA: Penn State Cooperative Extension, August 2012. p. 68-74.

Harper, J.K. "Blueberries: Economics" in *The Mid-Atlantic Berry Guide for Commercial Growers, 2013-2014.* AGRS-97. University Park, PA: Penn State Cooperative Extension, August 2012. p. 126-130.

Harper, J.K. "Brambles: Economics" in *The Mid-Atlantic Berry Guide for Commercial Growers, 2013-2014.* AGRS-97. University Park, PA: Penn State Cooperative Extension, August 2012. p. 185-193.

Harper, J.K. and L.F. Kime. "Tree Fruit Production Budgets." *Penn State Tree Fruit Production Guide, 2018-2019.* Penn State Cooperative Extension, January 2018.

Orzolek, M.D., S.M. Bogash, L.F. Kime, and J.K. Harper. "Cantaloupe Production." *Agricultural Alternatives* series. University Park, PA: Penn State Cooperative Extension, May 2006.

Orzolek, MD., L.F. Kime, S.M. Bogash, and J.K. Harper. "Cucumber Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, July 2010.

Orzolek, MD., W.J. Lamont, L.F. Kime, S.M. Bogash, and J.K. Harper. "Watermelon Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, July 2010.

Orzolek, M.D., L.F. Kime, S.M. Bogash, J.K. Harper, and R.M. Harsh. "Pepper Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, July 2010.

Orzolek, MD., L.F. Kime, and J.K. Harper. "Sweet Corn Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, July 2011.

Orzolek, M.D., Lamont, W.J., Jr., L.F. Kime, and J.K. Harper. "Broccoli Production." *Agricultural Alternatives* series. Penn State Cooperative Extension, July 2012.

Orzolek, M.D., T.E. Elkner, W.J., Jr., L.F. Kime, and J.K. Harper. "Pumpkin Production". *Agricultural Alternatives* series. Penn State Cooperative Extension, July 2012.

Orzolek, M.D., L.F. Kime, and J.K. Harper. "Onion Production." *Agricultural Alternatives* series. Pennsylvania State Cooperative Extension, February 2013.

Orzolek, M.D., L.F. Kime, and J.K. Harper. "Asparagus Production." *Agricultural Alternatives* series. Pennsylvania State University, College of Agricultural Sciences, Cooperative Extension, March 2014.

Orzolek, M.D., S.M. Bogash, R.M. Harsh, L.F. Kime, and J.K. Harper. "Tomato Production." *Agricultural Alternatives* series. UA291. Penn State Cooperative Extension, October 2016.

Sanchez, E. S., F. De Gioia, L.F. Kime, L., and J.K. Harper. Agricultural Alternatives: Cucumber Production. *Agricultural Alternatives* series. Penn State Cooperative Extension, November 2018.

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