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AGGREGATE COSTS AND BENEFITS OF GOVERNMENT INVASIVE SPECIES CONTROL ACTIVITIES IN CALIFORNIA

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Abstract

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Government activities to exclude, detect, eradicate, contain and suppress invasive plant and animal species that affect agriculture are central to biosecurity. We identify and measure costs of such government activities in 2003 attributable to invasive species control in California for agriculture, and categorize expenditures by type of activity. We also explore potential economic costs from curtailing these activities, thereby increasing probability and severity of pest or disease occurrences. Potential loss in consumer and producer benefits is roughly proportional to the value of agricultural output, depending on relevant supply and demand relationships. We compare our projections of economic losses from invasive species of harm to agriculture, which would follow from removal of government control programs, to the direct costs incurred in government programs for control of invasive species. We find that expected costs of increased probability and severity of pest occurrences exceed by a large margin recent government budget outlays to protect against such occurrences. When benefits to consumers and producers are both considered for all affected commodities, the benefits cost ratios range from 2.8 to 5.3, all far above the threshold of 1.0. Some invasive species also have potential impacts on the non-agricultural environment or to human health, but evaluation of these broader consequences is left for further research.

Key words: invasive species, agricultural pest management, biosecurity

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This paper summarizes costs and provides estimates of benefits from government activities to control invasive pests and diseases that may affect California agriculture. Our research has developed data on costs of government activities undertaken to exclude, detect, eradicate, contain, and suppress exotic pests and diseases. We also explore the potential economic costs that would occur as a result of dropping these government activities and thereby increasing the probability and severity of pest or disease occurrences. The benefit-cost ratios are simulated approximations based on historical data on government costs and simulated benefits.

We have identified government activities and costs attributable to exotic pest and disease management activities in California, including those by the California Department of Food and Agriculture and the federal government, including the United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS), the USDA Commodity Credit Corporation, and activities assumed by the Department of Homeland Security (Kreith, 2004). By exotic pests we refer to invasive species, non-indigenous, non-native and foreign species (including animal or plant diseases and noxious weeds) that cause harm to agriculture and often beyond agriculture.

We also compiled a list of possible industry-pest combinations and a list of significant agricultural economic activities at risk. Benefits to producers and consumers from pest and disease management activities and programs can be quantified to the extent these activities prevent occurrences of economic impacts. Some industry-pest combinations include citrus canker for oranges and lemons, exotic Newcastle disease for poultry, foot and mouth disease for dairy and beef, and glassy-winged sharpshooter for grapes.

Our research did not undertake an assessment of the success or efficiency of particular programs or agencies, nor is it an assessment of the costs of specific pests or host-pest combinations. Rather, the intent is to determine the economic contribution of state and federal government invasive species activities in California.

Summary of methodology

We reviewed major invasive pests and diseases facing California agriculture and the major commodities at risk. We related these risks to the value of farm output (indicated by cash

receipts) to determine the potential value of output affected. The potential losses to consumers and producers are roughly proportional to the value of output depending on the relevant supply and demand elasticities. Losses to farmers, represented by unrealized producer net gains, depend on added per unit costs of production including loss of yields or output. The more elastic the supply and demand functions for the commodity affected the smaller the net gains relative to the total revenues. For California crops or livestock industries as a whole, the supply is relatively inelastic with respect to a overall changes in prices of farm output meaning aggregate production falls relatively little if the aggregate price of agricultural output declines. Alternatively, the supply of an individual commodity, say alfalfa hay, may be more responsive to a change in its own price as farmers substitute to alternative crops as the price of a single crop falls. Demand facing California agriculture as a whole also is relatively inelastic, whereas the demand for a single crop would be more elastic as consumers shift between items when relative prices change. Producers gain from higher market prices, but consumers lose from these same price increases.

Some public outlays may be considered investments to reduce cost of future pest incursions, other outlays deal with current pests. Past investments affect current reduced probabilities of incursions or reduce their severity and are balanced by current investments that have future payoffs. Thus with a continuing stream of investments (assuming a steady state) we consider the payoffs as a current stream of costs compared to the current stream of benefits.

The results of these considerations are that the benefits of government outlays have a relatively simple formulation and many complications may be relatively unimportant for broad approximations. The value at risk and the proportional expected value of that loss can determine the potential losses if pest outbreaks occur.

Costs of government programs for protection from and control of exotic pests and diseases affecting agriculture

Many pests and diseases affect California agriculture, and some of those are exotic in the sense that they may enter from elsewhere and cause harm. Table 1 lists some significant pests and some of the major commodities they affect. While costs for control of indigenous pests are in general borne by the private sector, activities undertaken to control invasive, non-indigenous pests and diseases are typically an expense to taxpayers.

Based on an extensive survey of budget documents and information supplied by state and federal government program managers we have compiled expenditure outlays on government exotic pest control activities in California. Our expenditure database is unique in that expenditures were further categorized as exclusion, detection, or containment/suppression/ eradication activities.

Roughly $450 million was spent by the state and federal governments on the control of exotic pests and diseases of agricultural plants and animals in California during the 2003 state and federal fiscal years. (California state expenditures for the July 1, 2002 through June 30, 2003, the state fiscal year, have been combined with federal expenditures for October 1, 2002

through September 30, 2003, the federal fiscal year.) California state expenditure for exotic pest and disease exclusion, detection, eradication and control was approximately $128 million. Federal expenditure was approximately $321million (Table 2).

Table 2 also provides a breakdown of government outlays in California on exotic pests and diseases. Not counting expenses to control exotic Newcastle disease (END) and Pierce's disease (PD) and the glassy-winged sharpshooter (GWSS), an important insect vector for the viral Pierce's disease, California spent $22.3 million to control exotic pests and diseases of animals and $85.9 million to control plant pests and diseases. Not counting expenditures on END the federal government spent another $1.8 million in California on the control of exotic pests and diseases of animals and $138.7 million on the control of plant pests and diseases during federal fiscal year 2003.

As Table 2 shows a large share (44%) of government expenditures on the control of exotic pests and diseases in California in the fiscal 2003 periods was attributable to programs controlling END and PD and GWSS. The (mainly federal) government costs of the successful eradication of END alone accounted for 37 percent of the total.

Table 3 further separates animal-related outlays by type of control activity. Of the $25.1 million in state outlays spent to control pests and diseases of animals, exclusion activities accounted for $5.2 million, detection $15.9 million, and activities associated with containment, suppression, or eradication accounted for $4.3 million. Of this last category END efforts comprised $2.7 million. All but $1.8 million in federal outlays were devoted to the END effort and almost all of that, $161.6 million, was categorized as eradication.

The eradication of END used $3.4 million from the USDA-APHIS Veterinary Service, plus $161.6 million in federal emergency funds from USDA Commodity Credit Corporation during fiscal 2003. As the Table 3 documents, this was 99 percent of all federal expenditures used to control exotic pests and diseases of animals in California during the federal fiscal year. That eradication also demanded the depopulation of more than 3 million birds. In addition, CDFA spent $2.7 million on END, about 11 percent of its fiscal 2003 budget to control exotic pests and diseases of animals. END is a fatal viral disease that affects all bird species. END was first detected October 1, 2002 in Southern California backyard poultry before spreading to commercial operations in the state, and to flocks in Nevada, Arizona and Texas. It was totally eliminated in California and the other states by September 2003. Eradication was achieved by quarantines combined with depopulation and extensive surveillance and laboratory detection. Benefits of this eradication program clearly extended beyond commercial agriculture.

As Table 4 documents, the outlays in California for plant-related pest control activities were less concentrated on a single pest or disease than was the situation with animal protection expenditures in 2003. Not counting PD and GWSS eradication and suppression costs, $8.6 million of state expenditures on plant pest and disease control were focused on exclusion activities, $46.7 million on detection, $23.3 million on eradication and $7.1 million on suppression activities. Again excluding the outlays on PD and GWSS, the federal expenditure

of $138.7 million on plant pests and diseases consisted of $123.3 million for exclusion, $15.4 million on detection, and less than $0.2 million on management and suppression activities.

The GWSS can rapidly spread PD, which kills grapevines and affects 460 other plant species, native and non native. The discovery of a single GWSS in California in 2000 led to major government efforts to contain that plant disease and eradicate or contain its insect vector. The state spent $17.4 million on the Pierce's Disease Program between July 1, 2002 and June 30, 2003, not counting industry assessments for research. This represented 17 percent of CDFA expenditures for control of invasive plant pests and diseases. USDA-APHIS spent $15.6 million for PD and GWSS control in California between October 1, 2002 and September 2003, accounting for 10 percent of the federal expenditures in California on control of exotic plant pests and diseases.

Total government outlays on agricultural invasive species control activities in California equaled approximately 1.7 percent of the $27 billion value of cash receipts for all California agriculture during 2003. State expenditure on pest control equals 0.45 percent of the value of California agricultural cash receipts. Federal outlays in California related to pests of California commodities were higher than state outlays primarily due to the cost of eradicating END that occurred during the period studied. We note that, in addition to benefits to California agriculture, those outlays benefit the natural ecosystem, consumer interests, and human health, as well as agriculture in states other than California. That is, federal programs that take place in California do not just benefit agriculture in California. (At the same time federal expenditures that are not directly connected to California programs also benefit California).

Approach to assessing costs of the increased likelihood and severity of a pest occurrence

To assess impacts on costs and benefits we consider how the supplies of and demands for important commodities may be affected by exotic agricultural pests and diseases.

Government exotic pest outlays are designed to reduce the probability of a pest occurrence through pest exclusion and detection programs and to reduce the impacts of an occurrence, through monitoring, containment, eradication and suppression. One value of these programs may be calculated based on the impact that they have on the expected value of supply and demand for affected commodities. The expected value of the impact of an occurrence is equal to the probability of a supply or demand shock multiplied by the magnitude of the shock, given that one occurs. The benefit of the policy is calculated as the difference in the expected values with and without the policy in place. For example, consider a program that reduces the probability of a pest infestation from 20 percent to 5 percent. Assume also that the program reduces the supply impact or severity of an infestation from a 30 percent shift back in supply to a 10 percent shift back in supply. In this case, the expected value of a supply loss with no program is (0.20) times (30%) or 6 percent. The expected value of a supply loss with the program in place is (0.05) times (10%) or 0.5 percent. The difference of 5.5 percent gain in expected supply (6.0% - 0.5%) represents the value of the government efforts to control

invasive species through exclusion, detection, and containment/eradication programs. A similar set of considerations may be applied to the demand shifts.

In our simulation models, we represent the effects of discontinuation of government outlays on exotic pests and disease policies by the differences in the expected impacts of pest occurrences with and without the programs. Thus, when we show an effect on supply of 5 percent this represents the combination of effects on the probabilities of an occurrence and the severity of the occurrence.

The simulation model is a simple mathematical representation of the concepts in Figure 1. In Figure 1, we show a shift back in the supply function from S_0 to S_1 for a California commodity caused by an exotic pest occurrence. At the same time the infestation causes international demand to shift back from DX_0 to DX_1 and total demand, the sum of international and domestic demand shifts back from D_0 to D_1. The result in this example is no change in the market price (a special case) and a decline in quantity sold from Q_0 to Q_1.

We specify approximate long-run supply and demand parameters for California agriculture as a whole, and for ten important commodities in the state. We specify demand elasticities for the domestic and international markets and overall supply elasticities for each of these ten commodities and for California agriculture as a whole and each commodity's share of export and shipments to the domestic market. The demand elasticities are taken from the economic literature, considering the market shares of California commodities and the potential substitutes for California farm output. Long-run supply elasticities incorporate the potential to substitute across crops in response to commodity-specific pests that may raise costs.

Table 5 provides an overview of gross receipts for California agriculture as a whole and for each of the top 10 commodities by gross receipts. Table 5 also includes the share (by weight) of international exports for each commodity. These export shares are used to weight the demand effects and to determine the share of costs borne by domestic and foreign consumers. Table 6 shows the demand and supply elasticity parameters used in the model. These are long-run parameters that reflect the market adjustments that could be expected if a pest outbreak were to occur and persist.

We next must specify the differences in the expected supply and demand shocks that would be imposed by the removal of the government activities now used to control invasive species. We can then solve for the new equilibrium prices and quantities and consider how the actions of public pest and disease programs influence the probability and severity of an occurrence.

From the impacts on prices and quantities we may calculate the effects on producer and consumer benefits. These benefit measures depend on the position and shape of the demand and supply functions. Shifts in these functions, as a consequence of an exotic pest occurrence, produce a new equilibrium of prices and quantities and therefore new consumer and producer benefits. We calculate the difference in benefits to consumers and producers under the alternative assumptions of pest infestation probabilities and severities that would occur with and without government control activities.

Economic impacts of exotic pest incidence: supply and demand shifts

We modeled three scenarios. Each scenario considers different impacts that exotic pest policy might have on the supply of the listed California commodities and domestic and export demand. The supply function is shifted when the pest directly increases per unit costs or lowers production of a commodity. Furthermore, producers would respond with measures to combat the infestations, which would limit yield losses, but also raise production costs. Overall, with a pest occurrence, we expect a shift back in supply and a lower quantity supplied.

The demand for a commodity is affected in some cases by potential negative impact on human health. More importantly, however, demand may be affected by embargos or restrictions on shipments of a commodity from California to regions or countries that are not yet infested with the pest. In order to account for such border measures and their impacts on demand, in the scenarios we apply shifts in domestic demand for a commodity and shifts in international demand (that is, shifts in the demand for exports of a commodity).

In order to consider policy measures, the important information is the amount by which government policies concerning invasive species are likely to reduce the probability and severity of an outbreak. As noted above, each case specifies not the direct impact of the potential pest, but the degree to which the current policies reduce expected losses. Table 7 provides an overview of the scenarios that were modeled and the assumed shift in supply and demand shifts for each scenario. These scenarios each represent an alternative specification of the potential loss incurred if government pest control measures to reduce the probability and severity of an outbreak were abandoned.

Scenario 1 serves to identify the impacts on the higher production costs and reduced production that a producer faces as a result of an exotic pest outbreak. Scenario 2 assumes a 5-percent decrease in the supply along with a 5-percent decrease in the domestic demand and a 5-percent decrease in the international demand. Scenario 3 simulates a situation where the international demand response to an exotic pest outbreak is larger than the domestic demand response as a consequence of, for example, an embargo of a particular export market for a commodity.

Costs from elimination of protection from exotic pests

Our analysis solves a system of supply and demand equations for a new set of industry prices and quantities. The solution of the model proceeds as follows. Producers exhibit higher marginal costs of production because of the exotic pest infestation and reduced production. In all three scenarios, we shift the supply curve back by 5 percent. The scenarios then vary according to the effect of the exotic pest infestation on domestic and export demand as detailed above.

The effects on producers and consumers and the overall benefits of the scenario with a supply shift only are detailed in Table 8. A reduction in supply of 5 percent raises the market price for each commodity and the consumed quantity of the commodity decreases. The elasticities of supply and demand determine effects on producers and consumers. If the change in expected costs from removal of the pest policies affects California agriculture as a whole, total domestic losses (producers plus consumers) are about $1.26 billion. The quantity marketed decreases by more than is offset by the price increase and California producers lose $664 million. Domestic U.S consumers lose $597 million. International consumers are only affected by the higher price resulting from the shift in the supply curve and experience small losses of $67 million. Total loss in global benefits is about $1.33 billion. Under this scenario of a supply shock only, California dairy producers lose $136 million, followed by the grape industry at $82 million and the greenhouse/nursery industry at $61 million.

The second scenario assumes a 5-percent shift back in the supply curve, together with a 5-percent downward shift in the domestic demand and a 5-percent downward shift in the export demand. The effects of this scenario are detailed in Table 9. As a result of the concurrent shifts in demand in this scenario, the new equilibrium price will be closer to the base price than in the previous scenario. In addition, the new equilibrium quantity is lower than in the previous scenario, because domestic and international demand for the commodity has decreased. Consequently, for California agriculture as a whole, the loss for producers almost doubles to $1.31 billion and domestic consumers experience losses of slightly more than $1.0 billion. International consumers lose $262 million, which brings global losses to $2.6 billion.

Under this scenario, the California dairy industry loses almost $203 million, followed by grapes at slightly over $122 million and greenhouse/nursery at $106 million. International consumers lose more than their domestic counterparts for commodities that are mainly exported. Sixty percent of the almonds produced in California are exported and therefore international consumer benefits decrease by $36 million compared to $21 million domestically.

The third scenario assumes a larger fall in international demand in response to exotic pest infestations in California. International demand responses are likely to be larger than the domestic demand response through international embargos against California products, which are independent of the magnitude of pest outbreak. Obviously, losses to producers are higher than with a smaller international demand shifts, but domestic consumers lose less. Table 10 shows losses to California producers are $1.4 billion, losses to domestic consumers are $813 million, and total domestic losses are $2.25 billion. Global losses are $2.75 billion.

Losses to dairy producers with the larger international demand shift are $206 million, followed by grapes at slightly over $132 million and the greenhouse/nursery sector at almost $107 million.

These results are on an annual basis and continue as long as the pest infestation continues. We note, however, that some demand embargo impacts may persist even after the outbreak is controlled, so that costs from a single pest occurrence may last several years. Therefore, these

effects of pest occurrences are conservatively compared to annual costs of pest control supplied by public program.

Benefit-cost ratios

The increased expected economic losses from exotic pests experienced by consumers and producers that would follow from removal of government pest control programs can be compared to the actual costs of providing protection from invasive species. That comparison shows that domestic benefits outweigh government outlay costs by several multiples.

The budget costs listed in Table 2 are generally small compared to the projected costs associated with the more probable and more severe outbreaks shown in Tables 8, 9 and 10. For example, if we consider only the domestic benefits associated with the 10 major commodities using the values in Table 8 (Scenario 1), which ignores any effects of an outbreak on demand, the cost of more likely and more severe pest and disease occurrences is $692 million. The total state and federal government costs of control, including the large one-time END eradication program, were $449.6 million in 2003, which is smaller than the projected costs to producers and consumers of allowing the pests and diseases to enter and remain in California, even under the limited scenario of Table 8.

Table 11 provides ratios that show the benefits of government programs from Tables 8, 9 and 10 (as the costs of the pest impacts that are avoided) divided by 449.6, which was the total government costs of those programs in 2003. The top two rows in Table 11 show the benefit-cost ratios for domestic benefits (i.e. to U.S. consumers and California producers) compared to the total costs of state and federal programs. The bottom two rows present ratios where only benefits to growers are used in the numerator. All the ratios exceed 1.0 except for the most restrictive case in which the full $449.6 million in government costs is compared to benefits that accrue only to California producers of the top 10 commodities. In this case the benefits equal costs and the ratio is 1.0. Even if we restrict the benefits only to California producers and ignore gains to U.S. and foreign consumers, the benefit-cost ratios are between 1.5 and 3.2. When we recognize that U.S. consumers benefit as well, then the benefit cost ratios range from 2.8 to 5.3.

Conclusions

This research has gathered and summarized costs borne by the state and federal governments to deal with exotic pests and diseases that affect California agriculture. We also projected potential benefits of those programs under reasonable assumption about their effects on the supply of and demand for California commodities. Extensions of our research would include more detailed linkages between government programs and specific pests and the industries they affect. In addition, it would be useful to investigate more detailed analysis of benefits by commodity and with more sensitivity testing across assumptions about market shocks from pest occurrences and elasticities of supply and demand. This would allow us to understand

better the short run as well as the long run consequences of policy change. Finally, detailed analysis of more partial policy changes would be helpful to policy makers.

Overall, the results presented here strongly support the position that costs of increased probability and severity of pest occurrences exceed the recent government outlays to protect against such occurrence.

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Table 1. Some important pests and major commodities affected

Pierces Disease	Grapes and many other horticultural and ornamental crops
Classical Swine Fever	Swine
Exotic Newcastle Disease	Poultry, birds
Curly Top Virus	Beets, tomatoes, peppers, beans, potatoes, spinach, cucurbits, ornamentals
Citrus Tristeza	Citrus
BSE	Cattle, sheep, elk
Foot and Mouth Disease	Cattle, sheep, goats, swine
Nematodes	Grapes, lettuce, cotton, and others
Citrus Canker	Citrus
Red Imported Fire Ant	Livestock, crop, and human land use
Karnal Bunt	Wheat, durum wheat, and triticale
Ash Whitefly	Olives, Apple, Plum, Pear
Avocado Thrips	Avocado
Persea Mite	Avocado
Rice Blast Disease	Rice
Yellow Starthistle	Beef and other livestock grazing

Source: Sumner, 2003.

Table 2. Government agricultural exotic pest and disease control expenditures in California, 2003[a]

Focus of program	Pest Control Activities	State	Federal	Total
			($ million)	
Plant	non PD & GWSS[b, c]	85.9	138.7	224.6
Plant	PD & GWSS only[c]	17.4	15.6	33.0
Plant	Subtotal	103.3	154.3	257.6
Animal	non END[d]	22.3	1.8	24.2
Animal	END only	2.7	165.0	167.8
Animal	Subtotal	25.1	166.9	192.0
Total		128.4	321.2	449.6

Source: Kreith, 2004.

[a] State fiscal year July 1, 2002 - June 30, 2003; Federal fiscal year October 1, 2002 - September 30, 2003

[b] PD is Pierce's disease; GWSS is glassy-winged sharpshooter.

[c] Does not include funds (research or non-research funds) to Universities for Pierce's disease or CDFA's $5 million annual assessment received from the wine grape industry for Pierce's disease research.

[d] END is exotic Newcastle disease.

Table 3. Agricultural animal-related invasive pest and disease control activities in California by state and federal governments, 2003 expenditures[a]

Animal focused activities	Exclusion	Detection	Containment/ Suppression/ Eradication	Total all activities
		($million)		
State, non END[b]	*5.2*	*15.9*	*1.6*	*22.3*
State, including END	5.2	15.9	4.3	25.1
Federal, non END	*0.7*	*1.2*	*0.0*	*1.8*
Federal, including END eradication	0.7	4.6	161.6	166.9

Source: Kreith, 2004.

[a] State fiscal year July 1, 2002 - June 30, 2003; Federal fiscal year October 1, 2002 - September 30, 2003

[b] END is exotic Newcastle disease.

Table 4. Agricultural plant-related invasive pest and disease control activities in California by state and federal governments, 2003 expenditures[a]

Plant focused activities	Exclusion	Detection	Eradication	Management/ Suppression	Total all activities
			($ million)		
State, non PD & GWSS[b]	*8.6*	*46.7*	*23.3*	*7.1*	*85.9*
State, including PD&GWSS	14.3	50.6	25.2	8.1	103.3
Federal, non PD & GWSS	*123.3*	*15.4*	*0.0*	*0.2*	*138.7*
Federal, including PD & GWSS	123.3	15.4	0.0	15.8	154.5

Source: Kreith, 2004.

[a] State fiscal year July 1, 2002 - June 30, 2003; Federal fiscal year October 1, 2002 - September 30, 2003

[b] PD is Pierce's disease; GWSS is glassy-winged sharpshooter.

Table 5. Revenue and export quantity shares[a] of California agriculture and top-10 commodities, 2003

Commodity	Revenue	Export quantity
	($ million)	*(percent)*
Total CA agriculture	26,890	20
Dairy products	4,162	5
Greenhouse/nursery	3,271	1
Grapes	2,511	23
Lettuce	1,460	10
Almonds	1,180	63
Cattle/calves	1,380	7
Strawberries	959	12
Poultry/eggs	979	2
Citrus	805	30
Cotton	640	90
Sum of top-10	17,346	

Source: USDA, Economic Research Service: Farm Income Data

[a] percentages are shares of the quantity that was marketed for export

Table 6. Long-run elasticities of supply and demand facing California agriculture

Commodity	Long-Run Elasticity		
	of supply	of domestic demand	of export demand
Total CA agriculture	1.0	-0.9	-2.0
Dairy products	1.0	-1.8	-4.0
Greenhouse/nursery	1.5	-1.9	-3.0
Grapes	1.0	-1.5	-2.5
Lettuce	1.5	-1.5	-1.5
Almonds	1.0	-1.0	-1.0
Cattle/calves	1.0	-3.6	-5.0
Strawberries	1.5	-1.0	-1.0
Poultry/eggs	2.0	-4.0	-4.0
Citrus	1.0	-1.8	-2.5
Cotton	2.0	-1.0	-4.0

Source: Huang (1993), Shumway and Lim (1993), Balagtas and Sumner (2003), Alston et al. (1995)

Table 7. Overview of scenarios reflecting expected effects of potential pest and disease infestations

	Scenario 1	Scenario 2	Scenario 3
		(percent)	
Supply Shift	-5	-5	-5
Domestic Demand Shift	0	-5	-5
Export Demand Shift	0	-5	-10

Source: Author compilation

Table 8. Effects of elimination of government invasive pest programs, which leads to more probable or more severe exotic pest or disease infestations and a reduction in supply by 5 percent (Scenario 1)

Commodity	California producer benefits	U.S. consumer benefits	Change in Domestic benefits	International consumer benefits	Global benefits
	a	b	c=a+b	d	c+d
			($ million)		
Total CA agriculture	-664.1	-596.8	-1,260.9	-67.3	-1,328.2
Dairy products	-136.4	-66.5	-202.9	-1.7	-204.6
Greenhouse/nursery	-61.4	-45.8	-107.2	-0.2	-107.5
Grapes	-82.3	-36.3	-118.7	-4.8	-123.5
Lettuce	-24.0	-22.8	-46.8	-1.2	-48.1
Almonds	-29.1	-19.8	-49.0	-9.3	-58.3
Cattle/calves	-54.1	-13.0	-67.1	-0.5	-67.6
Strawberries	-12.7	-17.8	-30.5	-1.2	-31.7
Poultry/eggs	-16.0	-7.9	-24.0	-0.1	-24.1
Citrus	-26.4	-11.2	-37.6	-2.0	-39.6
Cotton	-9.5	-3.4	-12.9	-2.9	-15.8
Sum of top-10	-451.9	-240.4	-692.3	-28.2	-720.5

Source: Author simulations using model described in text.

Table 9. Effects of elimination of government invasive pest programs, which leads to more probable or more severe exotic pest or disease infestations and a reduction in supply, domestic demand and international demand by 5 percent (Scenario 2)

Commodity	California producer benefits	U.S. consumer benefits	Change in Domestic benefits	International consumer benefits	Global benefits
	a	b	c=a+b	d	c+d
			($ million)		
Total CA agriculture	-1,311.4	-1,049.1	-2,360.5	-262.3	-2,622.8
Dairy products	-202.9	-96.4	-299.3	-5.1	-304.4
Greenhouse/nursery	-106.3	-78.9	-185.2	-0.8	-186.0
Grapes	-122.4	-47.1	-169.6	-14.1	-183.6
Lettuce	-47.4	-42.7	-90.1	-4.7	-94.9
Almonds	-57.5	-21.3	-78.8	-36.3	-115.1
Cattle/calves	-67.3	-15.6	-82.9	-1.2	-84.1
Strawberries	-31.2	-41.1	-72.3	-5.6	-77.9
Poultry/eggs	-23.9	-11.7	-35.5	-0.2	-35.8
Citrus	-39.3	-13.7	-53.0	-5.9	-58.9
Cotton	-15.6	-1.0	-16.6	-9.4	-26.0
Sum of top-10	-713.7	-369.7	-1,083.4	-83.2	-1,166.6

Source: Author simulation using model described in text.

Table 10. Effects of elimination of government invasive pest programs, which leads to more probable or more severe exotic pest or disease infestations and a reduction in supply and domestic demand by 5 percent and international demand by 10 percent (Scenario 3)

Commodity	California producer benefits	U.S. consumer benefits	Change in Domestic benefits	International consumer benefits	Global benefits
	a	b	c=a+b	d	c+d
			($ million)		
Total CA agriculture	-1,438.8	-812.7	-2,251.5	-499.0	-2,750.5
Dairy products	-206.2	-90.8	-297.0	-9.8	-306.8
Greenhouse/nursery	-106.7	-78.1	-184.9	-1.6	-186.4
Grapes	-131.5	-32.5	-164.0	-26.4	-190.5
Lettuce	-49.8	-38.3	-88.1	-9.1	-97.2
Almonds	-75.1	7.7	-67.4	-65.4	-132.7
Cattle/calves	-76.4	-14.2	-90.6	-2.3	-92.9
Strawberries	-33.4	-36.5	-69.8	-10.8	-80.7
Poultry/eggs	-24.0	-11.4	-35.4	-0.5	-35.9
Citrus	-43.1	-7.8	-50.8	-10.9	-61.7
Cotton	-21.0	6.4	-14.7	-15.9	-30.6
Sum of top-10	-767.1	-295.6	-1,062.7	-152.7	-1,215.4

Source: Author simulation using model described in text.

Table 11. Benefit-cost ratios for California and federal outlays under alternative supply and demand impacts

Scenarios:	Scenario 1[a] (5/0/0)	Scenario 2[b] (5/5/5)	Scenario 3[c] (5/5/10)
	——(benefit/cost ratios)——		
CA producers plus U.S. consumers			
Top-10 CA crops	1.5	2.4	2.4
All CA crops	2.8	5.3	5.0
Producers only			
Top-10 crops	1.0	1.6	1.7
All CA crops	1.5	3.3	3.2

Source: Author calculation.

[a] Scenario 1 assumes 5% decrease in supply.
[b] Scenario 2 assumes 5% decrease in supply, domestic demand and export demand.
[c] Scenario 3 assumes 5% decrease in supply and domestic demand and 10% decrease in export demand.