Potential Economic Impacts of the February 1, 2010 Department of Pesticide Regulation Draft Restrictions to Address Pesticide Drift and Runoff to Protect Surface Water: Case Study Analysis

Report Prepared for

California Department of Food and Agriculture

September 9, 2011

Rachael Goodhue, Peter Howard, Karen Klonsky, and Kaitlyn Smoot

Department of Agricultural and Resource Economics
University of California, Davis

Abstract

This report addresses selected potential economic impacts of the February 1, 2010 Department of Pesticide Regulation draft restrictions to address pesticide drift and runoff to protect surface water for twenty county-crop case studies. Total revenues for the 20 crop-county case studies were $3.01 billion in 2009, or about 12.9% of the total value of California's row crop, vegetable and melon, and fruit and nut production. One or two specific potential effects are considered per case study. Total revenue losses for the analyzed crop-county pairs were estimated to range between $11 million and $359 million, which is between 0.36% and 11.9% of total revenues. Net revenue losses for 18 of the county-crop pairs for which information was available were estimated to range between $12 million and $314 million. Due to limitations on information available regarding some effects, particularly effects on yields, the estimated minimum losses are likely biased downward. Both maximum and minimum net revenue loss estimates exclude any additional management costs due to the presence of buffer acreage, such as increases in application times, differences in the timing of treatments, increased record-keeping, and more intensive scouting to monitor any effects of differences in efficacy between treatments permitted in the buffer and treatments used in the rest of the field. 13,752 fields would be affected by the draft regulations for the analyzed crop-county pairs. Assuming that these costs are incurred on a per-field basis, even an additional cost of management per field of only $100 would result in additional costs of $1.4 million. The definition of sensitive aquatic site proposed in the draft regulations will be a critical determinant of the economic effects.

Acknowledgments

Many individuals assisted in the preparation of this report. The authors particularly wish to acknowledge the contributions of the University of California Cooperative Extension Farm Advisors and Specialists who graciously shared their expertise: Brenna Aegerter, Mark Bolda, Mick Canevari, Surendra Dara, Luis Espino, Steve Fennimore, Joseph Grant, Gene Miyao, Randall Mutters, Terry Pritchard, Larry Schwankl, Bob Van Steenwyk, and Paul Verdegaal. Rich Demoura of the Dept. of Agricultural and Resource Economics at UC Davis provided invaluable data collection services. Nathan Clough, Derek Farnsworth, and Jesse Unger provided conscientious research assistance. Any errors or omissions are solely the responsibility of the authors.

Executive Summary

The objective of this report is to provide estimates of selected potential economic impacts of the February 1, 2010 Department of Pesticide Regulation's draft restrictions to address pesticide drift and runoff to protect surface water. The report focuses on eight economically important crops in six selected counties. Analyzed crops include alfalfa, almonds, grapes, lettuce, processing tomatoes, rice, strawberries, and walnuts. Analyzed counties include Butte, Colusa, Fresno, Monterey, Santa Barbara, and Stanislaus. In total, 20 crop-county case studies are included in the analysis. Total revenues for the 20 crop-county pairs were $3.01 billion in 2009, or about 12.9% of the total value of California's row crop, vegetable and melon, and fruit and nut production. The specific county-crop pairs are presented in Table 1, which is reproduced from Chapter 3.

Table 1. Case Studies by County and Crop

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus
Alfalfa			X			X
Almond	X	X	X			X
Grapes (all)			X	X	X	
Lettuce				X	X	
Tomatoes (processing)		X	X			X
Rice	X	X				
Strawberries (fresh)				X	X	
Walnut	X					X

Each case study includes a partial equilibrium analysis of the market for that specific commodity from that specific county. We restrict attention to one or two key impacts per crop for several reasons, including the long list of active ingredients included in the draft regulations, the complexity of growers' pest management programs, and the complexity of the resulting analysis. Cost per acre, yield per acre, and output quality are allowed to respond to the draft regulations, while acreage is constant for each crop. Land in buffers is specified in the draft regulations as a function of the application method used. Land in buffers may affect the total quantity supplied, total revenues, total costs, and net revenues. Application methods are allowed to change in response to the draft regulations, when appropriate.

The final component of the analysis is the specification of how the price of a commodity changes in response to a change in the quantity produced in a particular county. Economists call such changes "price flexibilities" and estimate them using statistical techniques. The county-crop case study approach makes it particularly challenging to represent the price flexibility because production of a specific commodity in a specific county is generally not distinguishable from production elsewhere in California in any substantive way. We consider three cases. While individually each case has its drawbacks, as a group they provide a sense of the potential impacts. In the first case, only the case study county is affected by the draft regulations. In the second case, all of California is assumed to be affected by the regulations in exactly the same manner as the case study county. The third case assumes that the price flexibility is zero; price does not change with a change in the quantity produced in the case study county or in California as a whole because producers outside the study region increase output to offset the decline in California.

The analysis combines information from a number of sources. Price flexibilities were obtained from the economic literature. Base yields and prices were obtained from county agricultural commissioners' reports. Conversations with University of California Cooperative Extension Farm Advisors and Specialists were used as the basis for identifying one or two particularly critical impacts for the case study crops in terms of specific affected active ingredients or specific pests. The scientific literature was used to identify yield and cost effects of these identified impacts when relevant studies were available. University of California Cooperative Extension cost studies were used as the basis for computing changes in net revenues (http://coststudies.ucdavis.edu/current.php). List prices were obtained for specific pesticide products used in the analysis. Acreage and acreage in buffers were obtained from Demars and Zhang (2011), a draft report under preparation for CDFA. Table 2 summarizes the acreage in buffers, the share of total acreage in buffers, the number of fields affected, and the share of all fields affected for each crop-county case study pair.

Table 2. Acres in Buffers and Fields with Buffers under Draft Regulations by County, Crop, and Buffer Width

County	Crop Name	Total Acres	Total number of fields	25' Buffer: Acres affected	25' Buffer: Percent of acres affected	25' Buffer: Number of fields affected	25' Buffer: Percent of fields affected	100' Buffer: Acres affected	100' Buffer: Percent of acres affected	100' Buffer: Number of fields affected	100' Buffer: Percent of fields affected	150' Buffer: Acres affected	150' Buffer: Percent of acres affected	150' Buffer: Number of fields affected	150' Buffer: Percent of fields affected
Butte	Rice	103,197	1,850	639	0.6	1,538	83	10,656	10.3	1,726	93	17,608	17.1	1,743	94
	Walnut	31,601	1,380	101	0.3	360	26	1,024	3.2	562	41	1,772	5.6	602	44
	Almond	40,410	1,344	480	1.2	442	33	2,408	6.0	625	47	3,859	9.5	668	50
Colusa	Rice	147,603	3,097	1,453	1.0	2,767	89	18,395	12.5	3,026	98	30,018	20.3	3,034	98
	Almond	30,832	984	99	0.3	286	29	1,144	3.7	441	45	2,014	6.5	456	46
	Tomato	18,954	332	128	0.7	234	70	1,511	8.0	302	91	2,527	13.3	306	92
Fresno	Grape	258,380	6,114	2,982	1.2	1,839	30	11,818	4.6	2,154	35	17,612	6.8	2,256	37
	Tomato	114,625	797	1,378	1.2	368	46	5,262	4.6	396	50	7,704	6.7	405	51
	Alfalfa	98,942	988	1,814	1.8	515	52	6,976	7.1	569	58	10,199	10.3	579	59
	Almond	88,922	1,325	1,327	1.5	520	39	5,161	5.8	594	45	7,582	8.5	621	47
Montere y	Grape	42,426	354	583	1.4	178	50	2,316	5.5	191	54	3,485	8.2	199	56
	Lettuce	42,115	1,998	448	1.1	497	25	1,788	4.2	567	28	2,684	6.4	605	30
	Strawberry	11,484	251	140	1.2	86	34	566	4.9	98	39	855	7.4	107	43
Santa Barbara	Grape	26,445	186	206	0.8	44	24	765	2.9	46	25	1,083	4.1	47	25
	Lettuce	7,724	296	39	0.5	44	15	147	1.9	51	17	214	2.8	53	18
	Strawberry	6,159	110	29	0.5	20	18	113	1.8	20	18	168	2.7	20	18
Stanislau s	Almond	101,760	4,169	1,732	1.7	1,401	34	6,640	6.5	1,564	38	9,712	9.5	1,622	39
	Alfalfa	33,227	1,018	526	1.6	381	37	2,062	6.2	431	42	3,050	9.2	460	45
	Walnut	27,118	1,429	555	2.0	536	38	2,105	7.8	597	42	3,074	11.3	620	43
	Tomato	13,747	218	214	1.6	106	49	854	6.2	124	57	1,244	9.0	130	60

Source: Demars and Zhang, 2011

As with any analysis of this sort, there are a number of technical and practical caveats. Particularly important ones of those discussed in the full report include the following: 1.) List prices for pesticide products do not necessarily reflect the prices paid by individual growers. If relative price differences vary across products then the change in cost between the base treatment and the treatment that would be utilized under the draft regulations will be distorted. 2.) The identification of selected impacts was based in part on the extent of use of a specific active ingredient on a case study crop in a case study county. Critical active ingredients that are used on only a small share of acreage in any given year but have few or no substitutes for the management of one or more pests are not included in the analysis. 3.) Operating costs from cost studies are used to compute net revenues. To the extent that actual operating costs vary systematically from those reported in the crop studies, changes in net revenue will be distorted in absolute terms. 4.) Very new chemistries are not considered in the analysis. New chemistries may offer better alternatives than the ones considered in the case studies. 5.) The analysis does not incorporate compliance costs and the cost of potentially administering two management programs: one for land in buffers and one for other land. 6.) In many instances scientific information regarding yield effects of weeds and cost effects other than pesticide material costs is unavailable

We report results for total revenues and net revenues. Total revenues are the value of the crop: the price multiplied by the quantity sold. Net revenues are the difference between total revenues and total operating costs. Total operating costs are computed using the cost of the pesticide treatment(s) used currently and the cost of the treatment(s) specified to be used if the draft regulations are implemented, as well as all other operating costs included in the University of California Cooperative Extension cost and return studies. The results reported in this executive summary are those for which price does not change in response to a change in quantity. In other words, price is perfectly inflexible with respect to the quantity produced in the study area.

Potentially, losses could be substantial. When price does not change in response to a change in quantity, total revenue losses for the analyzed county-crop pairs were estimated to range between $11 million and $359 million, which is between 0.36% and 11.9% of total revenues. Table 3 (reproduced from Chapter 5) summarizes the minimum and maximum total revenue losses for each case study.

Table 3. County and crop case studies: Range of changes in total revenues ($ millions), Price does not change in response to a change in quantity

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus	TOTAL
Alfalfa							
Min. loss			-4.54			-1.32	-5.86
Max. loss			-4.54			-1.32	-5.86
Almond							
Min. loss	0.00	0.00	0.00			0.00	0.00
Max. loss	-0.85	-0.61	-3.01			-3.39	-7.86
Grape (all)							
Min. loss			0.00	0.00	0.00		0.00
Max. loss			-186.46	-36.94	-24.72		-248.12
Lettuce							
Min. loss				0.16	0.00		0.16
Max. loss				-11.31	-1.41		-12.72
Tomato (processing)							
Min. loss		-0.32	-1.14			-0.14	-0.60
Max. loss		-0.50	-5.49			-0.71	-6.7
Rice							
Min. loss	-2.44	-2.34					-4.78
Max. loss	-2.94	-2.8					-5.74
Strawberry (fresh)							
Min. loss				0.00	0.00		0.00
Max. loss				-38.08	-19.19		-57.27
Walnut							
Min. loss	0.00					0.00	0.00
Max. loss	-8.53					-6.64	-15.17
TOTAL							
Min. loss	-2.44	-2.66	-2.25	0.16	0.00	-0.46	**-10.84**
Max. loss	-12.32	-3.91	-196.07	-86.33	-45.32	-11.06	**-359.44**

As shown in Table 3, in many instances minimum losses are zero. These cases occur for county-crop pairs for which the best available information indicates that there is the possibility that no yield losses will occur due to the use of an alternative treatment if the draft regulations are implemented. Recognizing the many caveats regarding extending results from selected crops and counties, for all field crops, vegetables and melons, and fruits and nuts in California, the resulting losses would be between $84 million and $2.8 billion.

When price does not change in response to a change in quantity, net revenue losses for the 18 of the county-crop pairs for which information was available were estimated to range between $12.24million (112.9% of the minimum total revenue losses) and $314.12 million (87.4% of total revenue losses). Due to limitations on information available regarding some effects, particularly effects on yields as discussed above, the estimated minimum losses are likely biased downward. Table 4 (reproduced from Chapter 5) reports the range of estimated net revenue losses by crop and county.

Table 4. County and crop case studies: Range of changes in net revenues ($ millions), Price does not change in response to a change in quantity

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus	TOTAL
Alfalfa							
Min. loss			-4.34			-1.28	-5.62
Max. loss			-4.34			-1.28	-5.62
Almond							
Min. loss	-0.16	-0.08	-0.35			-0.36	-0.95
Max. loss	-1.01	-0.69	-3.38			-3.74	-8.82
Grape (all)							
Min. loss			-1.02	N.A.	N.A.		-1.02
Max. loss			-209.82	N.A.	N.A.		-209.82
Lettuce							
Min. loss				0.17	0.01		0.18
Max. loss				-11.64	-1.47		-13.11
Tomato (processing)							
Min. loss		-0.18	-0.42			-0.09	-0.69
Max. loss		-0.82	-2.03			-0.46	-3.31
Rice							
Min. loss	-1.91	-1.90					-3.81
Max. loss	-2.39	-2.27					-4.66
Strawberry (fresh)							
Min. loss				-0.13	-0.02		-0.15
Max. loss				-40.60	-20.54		-61.14
Walnut							
Min. loss	-0.02					-0.03	-0.05
Max. loss	-3.95					-3.69	-7.64
TOTAL							
Min. loss	-2.09	-2.16	-3.00	0.04	-0.01	-0.83	**-12.24**
Max. loss	-7.35	-3.78	-216.44	-52.24	-22.01	-8.24	**-314.12**

Net revenue loss estimates exclude any additional management costs due to the presence of buffer acreage, such as increases in application times, differences in the timing of treatments, increased record-keeping, and more intensive scouting to monitor any effects of differences in efficacy between treatments permitted in the buffer and treatments used in the rest of the field. 13,752 fields would be affected by the draft regulations in total for the county-crop pairs included in the case studies. Assuming that these costs are incurred on a per-field basis, even an additional cost of management of $100 per field would result in additional costs of $1.4 million.

A number of common issues that will almost certainly affect other crops emerged in the case studies, although the relative importance of these issues will vary by crop and county. 1.) The active ingredients listed in the regulations tend to be ones that have been on the market for some time. They tend to be cheaper to use. Alternatives tend to be newer and more expensive. It is also worth noting that: the case studies rely on list prices for pesticides; individual growers may face different prices; and some PCAs and growers may prefer specific products in spite of a slightly higher cost per acre, perhaps due to a different spectrum of control, effects on beneficial insects, or other considerations. 2.) Most active ingredients are listed for control of multiple pests. Active ingredients that can serve as substitutes for one target pest may not serve as substitutes for another. Thus, growers' choices regarding alternative active ingredients will depend on the specific set of pest populations they face. 3.) Some active ingredients are subject to application limitations for resistance management reasons. When a pest management program requires multiple applications, it can become important to maintain access to pesticides with different classes of action. 4.) It is very difficult to determine whether or not growers may simply move to alternatives entirely rather than administer (or pay their PCAs to administer) one pest management program in buffers and one on all other acreage. 5.) Pest control in a buffer and pest control in the rest of a field are not independent activities. Pest pressure is generally heaviest at the edge of a field or orchard. If growers must use less efficacious treatments along a field edge in order to comply with a buffer requirement, then increased pest pressure and associated yield damage may reduce production on interior acreage.

Finally, all economic effects of the draft regulations are critically dependent on the definition of sensitive aquatic site. Even though in several instances the width of the buffer stipulated on a pesticide label and the width of the buffer listed in the draft regulations are identical for a given application method, the definitions of sensitive aquatic site are not obviously identical. Thus, the draft regulations may have real effects on growers' pest management options even if label use restrictions exist currently. A broader definition will reduce acreage on which the pesticide product in question can be used.

Table of Contents

Chapter 1
Introduction

The objective of this report is to provide estimates of selected potential economic impacts of the February 1, 2010 Department of Pesticide Regulation draft restrictions to address pesticide drift and runoff to protect surface water for selected crop-county pairs. There are a number of factors that will influence these impacts. Information is not available to quantify all of these factors. There is the potential for substantial variability in the outcome of these impacts, depending on the decisions made by individual growers.

The report focuses on eight economically important crops in six selected counties. In total, 20 crop-county case studies are included in the analysis. One or two specific potential effects are considered per case study. Total revenues for the 20 crop-county pairs were $3.01 billion in 2009, or about 12.9% of the total value of California's row crop, vegetable and melon, and fruit and nut production.

Chapter Two examines the draft regulations and provides a brief review of the relevant issues. The chapter includes a comparison of existing dormant season pesticide use regulations and the draft regulations. There are a number of differences. It also includes a discussion of the potential implications of the definition of "sensitive aquatic site" in the draft regulations. While the discussion is from a layperson's point of view (no legal experts were consulted), the definition would be a critical determinant of the effects of the draft regulations.

Chapter Three presents the methodology for the analysis and information on the case study counties and crops. The crop profiles include an economic profile and a discussion of selected potential impacts of the draft regulations. We restrict attention to one or two key impacts per crop for several reasons, including the long list of active ingredients included in the draft regulations, the complexity of growers' pest management programs, and the complexity of the resulting analysis.

Chapter Four presents the results of the analysis for each crop-county pair, and Chapter Five concludes with a summary of the results and a discussion of common issues arising from the case studies that will almost certainly affect other regions and crops.

Chapter 2
Proposed Regulations

The draft regulations are intended to reduce runoff and drift into surface water due to pesticide use in agriculture and by non-agricultural pest control firms. Buffer zones are an important element. The buffer zones mandate the minimum distance from a sensitive aquatic site, which varies by application method. Other important elements include restrictions on the timing of applications when rain is anticipated, diverting or containing rain runoff for specified time periods, and miscellaneous provisions.

Although the draft regulations address both agricultural and non-agricultural uses, this report restricts attention to agricultural uses. This chapter compares the draft regulations to existing regulations regarding the use of dormant insecticides in section 2.1. To the extent that the draft regulations duplicate the existing ones there will be no marginal impact of the draft regulations on pesticide applications; the section identifies a number of differences. Section 2.2 discusses the proposed definition of sensitive aquatic site and how the definition may affect the economic implications of the draft regulations.[1] Section 2.3 concludes with a brief review of relevant literature.

2.1 Comparison to 3 CCR § 6960. Dormant Insecticide Contamination Prevention

The draft regulations have some requirements in common with existing regulations, and also propose new requirements and modifications of existing requirements. Rather than consider all existing regulations, this report focuses on comparing the draft regulations to 3 CCR § 6960, which includes use regulations for dormant insecticides in order to reduce surface water contamination. In addition to the discussion below, the Chapter Two Appendix provides a table that compares individual provisions of the two.

2.1.1 3 CCR § 6960. Dormant Insecticide Contamination Prevention

The current California regulations regarding dormant season pesticides applications, which went into effect in August 2006, are in the California Code of Regulation (CCR), Title 3: Food & Agriculture, Division 6: Pesticides and Pest Control Operations, Chapter 4: Environmental Protection, Subchapter 5: Surface Water, Article 1: Pesticide Contamination Prevention, § 6960: Dormant Insecticide Contamination Prevention. These regulations state that the only way that a grower can apply pesticides unrestricted during the dormant season is if they do at least one of the following: apply only a dormant oil or biological control agent; apply the pesticide to a hydrologically isolated site; or divert or contain runoff for 72 hours before releasing it into a sensitive aquatic site.[2]

[1] These discussions are from a layperson's perspective; no legal experts were consulted.

[2] Dormant season is left undefined in this part of the regulations, though the period from Oct. 1-March 31 is referred to in 3CCR section 6487.4 and in the "Runoff Management to Protect Surface Water- Agricultural Production" section of the draft regulations. "Dormant insecticide" refers to chemicals applied during the season when deciduous plants have no leaves.

If none of these three conditions are met, then the following restrictions apply: growers must obtain a written recommendation from a licensed pest control adviser (PCA) prior to application, an application cannot be made within 100 ft of a sensitive aquatic site, and applications can only be made when the wind speed is between 3-10 mph. No application of insecticide may occur during the dormant season if soil moisture is at field capacity and the NOAA or NWS forecasts a storm within 48 hours, or if a storm event likely to produce runoff from the treated area is forecast by NOAA/NWS for within the next 48 hours. Aerial applications of pesticides are subject to additional restrictions. They can only be made if soil conditions do not allow field entry or approaching bloom conditions necessitate aerial application; if made, the application must be 100 ft from any sensitive aquatic site and the wind speed must be 3-10 mph.

2.1.2 Proposed Changes

Proposed changes to the CCR, entitled "Department of Pesticide Regulation's Draft Restrictions to Address Pesticide Drift and Runoff to Protect Surface Water" were released on Feb. 1, 2010. The draft regulations would expand Subchapter 5: Surface Water significantly, adding sections on "Drift Management to Protect Surface Water" for agricultural use and for outdoor structural, residential, industrial and institutional use, as well as sections regarding "Runoff Management to Protect Surface Water" for agricultural production and non-production uses. For our purposes, we will only discuss the differences regarding agricultural use and production.

The most obvious difference between § 6960 and the draft regulations regards timing. The draft regulations list 68 pesticides that have a high potential to contaminate surface water and state that restrictions apply to those pesticides year round, not just during the dormant season. Other differences can be divided into four categories: proposed changes in regulatory definitions, changes specific to the drift management section, changes specific to the runoff management sections, and miscellaneous changes.

2.1.2.a Regulatory definitions

The draft regulations add or alter several definitions in the CCR. First, the definition of "sensitive aquatic site" (originally located in Division 6, Chapter 1, Subchapter 1) is altered from "any irrigation or drainage ditch, canal, or other body of water in which the presence of dormant insecticides could adversely impact any of the beneficial uses of the waters of the state specified in Water Code section 13050(f)" to "any irrigation or drainage ditch, canal, or other body of water in which the presence of pesticides could cause adverse impacts on human health or aquatic organisms." That is, the potential for damage to sensitive aquatic sites is extended to all pesticides, not just dormant insecticides, and the impacts of concern are simply human health and aquatic organisms. The definition of "hydrologically isolated site" is changed from "any treated area that does not produce runoff capable of entering any irrigation or drainage ditch, canal, or other body of water" to "any treated area that does not produce runoff capable of entering any sensitive aquatic site." The draft regulations introduce definitions for "surface water quality management plan," "pest management component," and "green or sustainable program." These definitions provide detailed requirements and components that must be included in a surface water quality management program in order to obtain an exemption from the draft runoff control regulations.

2.1.2.b Drift management to protect surface water

The draft regulations establish three different buffer distances for pesticide applications, depending on the application method rather than the 100 ft. uniform distance in the current regulations. For ground applications, the minimum distance to a sensitive aquatic site is reduced to 25 ft., while air-blast, high-pressure (>60 psi) wand or high-pressure hand gun applications must be made at least 100 ft. from sensitive aquatic sites. The buffer distance for aerial applications is 150 ft. As in the existing regulations, in the draft regulations aerial applications during the dormant season are only allowed if soil conditions prevent field entry or bloom conditions require aerial application, and with written permission from a licensed pest control adviser (PCA). The draft regulations list eleven uses and sites that are exempt from these requirements, including applications immediately incorporated into the soil, injections into the soil, and applications that are painted onto, injected into or wicked onto trees. Such exceptions are not enumerated in the current regulations.

2.1.2.c Runoff management to protect surface water

The proposed runoff management regulations tend to use the existing dormant season insecticide contamination regulations as a starting point and then add additional provisions. The most obvious additions are the extension of the regulated time period from the dormant season to the calendar year and the addition of herbicide active ingredients to the regulated set. There are other additions. The same rule from the current regulations prohibiting applications when soil moisture is at field capacity and a storm is forecast by the NOAA/NWS within 48 hours is restated, verbatim. There is an additional requirement in the draft regulations: a pesticide can only be applied if followed by the use of a technology or product that rapidly degrades or reduces offsite movement of the pesticide. The technology or product must be approved by DPR after consultation with the State Water Resources Control Board. These types of storms are most likely to occur during the dormant season, but nonetheless the rule is written so that it could apply to a wider time period.

The draft regulations restate the 72-hour runoff retention rule and include more detailed requirements. For four weeks after application, rain runoff must be diverted with an on-site recirculating system and/or contained and held for 72 hours before being released into a sensitive aquatic site. If there are sequential storms that would result in a holding period longer than 72 hours, then property owners are given permission to release proportional amounts of runoff consistent with the amount added from each storm 72 hours after that storm.

The draft regulations also state that the requirements are slightly different for active ingredients which are listed in section 6800(a) of CCR Title 3 as chemicals which have been detected in groundwater. (The relevant pesticides include atrazine, simazine, bromacil, diuron, and bentazon.) For these chemicals, different restrictions apply during the dormant and growing seasons. During the growing season, specifically from April 1- Sept. 30, the 72-hour retention rule described above applies. During the dormant season, specifically from Oct. 1-

March 31, additional restrictions apply, which are enumerated in section 6487.4 of CCR Title 3. Section 6487.4 requires one of the following additional treatments for the relevant pesticides: incorporation into soil within 48 hours, soil disturbance within seven days, banding applications, retention of runoff under specific conditions, or application between April 1 and July 31. This section of the new draft restrictions again lists the 11 exempt uses and sites, as in the first section.

Additionally, pesticide applications can be exempt from this section of the draft regulations if the operator of the property obtains and follows a written recommendation from a licensed PCA, according to criteria listed in CCR Title 3 section 6556(d). This is a change from the current dormant season insecticide contamination regulations, which do not list this exemption. These criteria include pest scouting records, economic threshold data, degree-day and other modeling reports, and other benchmarks or information used to guide the recommendation by the PCA. Also, the property owner must possess and be in the process of implementing a surface water quality management plan. These plans must include a pest management component and an irrigation or stormwater management component, and must be approved by the Director of DPR.

2.1.2.d Miscellaneous difference

There is no mention in the draft regulations of the 3-10 mph rule for pesticide applications, aerial or not.

2.2 Definition of Sensitive Aquatic Site

Currently, the CCR defines a "sensitive aquatic site" as "any irrigation or drainage ditch, canal, or other body of water in which the presence of dormant insecticides could adversely impact any of the beneficial uses of the waters of the state specified in Water Code section 13050(f)." As discussed in section 2.1, the draft regulations propose to alter this definition to "any irrigation or drainage ditch, canal, or other body of water in which the presence of pesticides could cause adverse impacts on human health or aquatic organisms." There are three related sources of concern regarding the proposed definition. First, it is unclear precisely what bodies of water are included. Second, it is unclear how in practice the proposed definition of "sensitive aquatic site" relates to the definition in the Water Code. Finally, it is unclear how this proposed definition relates to the various definitions of surface water and aquatic sites used by registrants to specify buffer zones for specific pesticide products.

2.2.1 Uncertainty Regarding Included Surface Water Features and Relationship to Water Code Definition

The precise extent of the definition of sensitive aquatic site is difficult to determine, in part because the adverse impacts of concern differ from those in the Water Code. Two rounds of comments received by CDPR regarding these proposed regulations indicate that this is an issue that concerns stakeholders (CDPR 2010A; CDPR 2010B). In its responses to comments from interested parties, CDPR has stated that the definition has been revised to be consistent with its statutory mandate, and noted that its mandate was different from the State Water Resources Control Board's mandate (CDPR 2010A). To the extent that any water features are considered sensitive under the draft regulations but not under the Water Code, or vice versa, growers' management plans intended to protect surface water quality will become more complex to design and administer. Obviously, the more stringent the definition adopted, the greater the acreage that will be affected, and the greater the magnitude of any total economic losses associated with the loss of specific pest management alternatives in buffer zones.

2.2.2 Implications of "Sensitive Aquatic Site" Definition for Economic Losses

Many pesticide products have label restrictions that specify buffers for surface water or aquatic sites, including pesticides listed in the draft regulations. Often these buffers have the same magnitude for a specified application method as the draft regulations. However, their definitions of surface water and aquatic sites vary, and do not match the definition of sensitive aquatic site in the draft regulations.

If the definition proposed in the draft regulations is more stringent than the ones specified on pesticide product labels then the use of those products will be affected by the implementation of the draft regulations. Specifically, the acreage on which they can be used will decrease. If available alternatives do not have efficacies and costs that provide comparable economic returns, losses will occur as a result of the implementation of the draft regulations. In short, specifying buffer widths equal to those on pesticide product labels does not imply that there will be no effect on growers' pest management options *unless* the definition of sensitive aquatic site is identical to the definitions used by registrants.

The language used by registrants varies. For example, the Lorsban 4E (chlorpyrifos) label specifies a buffer of 25 feet for ground boom applications and 150 feet for aerial applications adjacent to "permanent bodies of water such as rivers, natural ponds, lakes, streams, reservoirs, marshes, estuaries, and commercial fish ponds" (Dow AgroSciences n.d.). The Warrior II with Zeon (lambda-cyhalothrin) label specifies a buffer of 25 feet for ground boom applications and 150 feet for aerial applications for "aquatic habitats (such as, but not limited to, lakes; reservoirs, rivers; permanent streams; marshes; natural ponds; estuaries; and commercial fish ponds)" (Syngenta Crop Protection Inc. n.d.).

The economic analysis in this report relies on a GIS analysis of crop acreage affected by buffers that uses two sets of spatial data: a National Hydrology Dataset (U.S. Geological Survey) stream layer which includes minor feeder streams, and California Department of Water Resource land use layers that contain some hydrological features that are not present in the NHD layer (e.g. lakes and wetlands). See Demars and Zhang (2011) for additional information.[3]

[3] Demars and Zhang (2011) is an in-progress draft report for CDFA that was made available to this project team for purposes of preparing this draft report for CDFA. It is not available for general circulation.

2.3 Relevant Literature: A Brief Review

Existing research considers the physical effects of buffer zones on pesticide runoff and drift as well as the economic effects.

2.3.1 Pesticide Movement, Pesticide Properties, and Buffer Strips

Studies examining the effect of vegetative buffer strips and unsprayed field margins on pesticide movement have shown that movement occurs in the solution or particulate phases, and at different speeds, depending on the absorption properties of the pesticide in question. If a pesticide has a water solubility greater than 10 ppm, then it is more mobile in the soil and thus more likely to be lost to runoff (Wauchope 1978). These soluble pesticides include many herbicides, like isoproturon (Markel et al. 1989, Williams 1991, Harris 1994). By contrast, it was found that 20-46% of the losses of the moderately soluble herbicide metolachlor were carried in sediments, not the soil solution (Buttle 1990), and that less soluble pesticides which are strongly absorbed by the soil, like triasulfuron, have very low loss to runoff (Jones 1995). Arora et al. (1996) tested the amount of pesticide runoff from fields with drainage to buffer zone area ratios of 30:1 and 15:1, and found that increasing the relative size of the buffer significantly decreased the outflow of metolachlor. This was not true for cyanazine or atrazine, which are not as strongly absorbed by the soil as metolachlor. Prichard et al. (2010) includes a list of the key pesticides used in California wine grapes, their solubility levels, levels of absorbance to soil particles, and overall runoff risk. Diazinon is high for both solubility and soil absorbance, while chlorpyrifos is high for solubility but intermediate for absorbance. Both are rated as having a very high risk of being lost to runoff. Pesticides with a moderate overall runoff risk include carbaryl, malathion, and methomyl. Those rated as posing a low runoff risk include spinosad, dimethoate, and methoxyfenozide. Thus, the best combination of size and other properties of the buffer strip required to reduce pesticide runoff to a specific level will vary by pesticide, depending on water solubility and soil absorbance properties.

In turn, the choice of the acceptable level of runoff will depend on the environmental objective. Payne et al. (1988) created a technique for estimating the optimal width of buffer areas during pesticide application based on experimental spray drift data and laboratory toxicity results for permethrin in Canada. The study tested the mortality of the aquatic invertebrate *Aedes aegypti* to permethrin applications with different buffer zone widths, and then created an equation that can be used to determine buffer strip width given an acceptable level of mortality. The equation shows, for example, that a 20 m wide buffer zone is required in order to limit mortality of *A. aegypti* to 10% and mortality of rainbow trout to 0.1%. However, the results of this equation may not hold true in California or for other pesticides or species.

Spray drift is another concern that is important for soluble pesticides. A number of studies have shown that for a typical crop the volume of original pesticide spray that drift beyond 6 meters is only 1% (Harris et al. 1992, Goanzalmeier 1993, Lloyd and Bell 1993).

Most field experiments on buffer strips focus on either riparian buffer zones (RBZs), which contain trees and other vegetation and are widely used to control nitrate and phosphorous runoff in the Eastern United States, or on grass buffer zones, which are more applicable to California agriculture. Grass or dense herbaceous vegetation is also effective in trapping fertilizer runoff from overland storm flows, though woody vegetation is better for nitrate removal from groundwater (Parsons 1994). Mickleson and Baker (1993), working in Iowa on ground with a 4.6% slope, found that a 4.6 m grass buffer decreased losses of atrazine to runoff by 32%, while a 9.1 m grass buffer decreased atrazine losses by 55%. Gril et al. (1997) tested grass buffers of various widths between 6 and 20 m, and found that losses of isoproturon and diflufenican were reduced by 57% with a 5.7 m buffer and 68% with an 11.1 m buffer. Another study, in France, found that 6 m and 18 m grass buffers reduced losses of atrazine by 43% and 99.9%, respectively, even under conditions of intense rainfall (Patty et al. 1995). Rhode et al. (1980) found that the share of pesticide retained by buffer strips depends on the initial water content of the soil: trifluralin losses decreased by 96% in dry buffer strips, but only by 86% in prewetted buffer strips.

Very few field experiments have been conducted which examine the effect of unsprayed field margins, which are planted under the same crop as the rest of the field and simply not treated with pesticides. One such study (de Snoo 1999) looked at 3 m-wide and 6 m-wide unsprayed margins in winter wheat, sugar beet, and potato fields in the Netherlands, where the primary chemical used was glyphosate. It was found that a 3 m-wide unsprayed strip reduced spray drift to ditches on the edge of the fields by 95%, at a wind-speed 4.5 m/s, while 6 m-wide strips prevented all herbicide drift into the ditches. Yield losses in the unsprayed portions of the field were 30% in sugar beet, 13% in winter wheat, and 2% in potatoes. An additional study of unsprayed field margins, conducted in the UK, is Longley et al. (1997). That study tested drift of the pesticide deltamethrin from winter wheat fields when a 6 m margin was left unsprayed compared to when the entire field was sprayed. Tests were conducted under a variety of different wind speeds and spray heights. Results showed that the amount of pesticide drift with the unsprayed margins ranged from 0% to 0.9%. This was significantly lower than the 5%-75% pesticide drift that occurred when the entire field was sprayed.

Similarly, the existing literature does not focus on the properties of buffer strips planted with an alternative economic crop. One exception is Hall et al. (1983), who examined atrazine losses from corn fields planted with oat strip crops. Loss of atrazine without the strip crop was 3.5%, while with the strip crop it was only 0.33%, a 91% decrease in losses.

2.3.2 Buffer Strip Research in California

Most buffer strip research has been done in the Eastern US, though a few studies have taken place in California or other Mediterranean climates. Prichard et al. (2010), which is a manual of field recommendations targeted at California winegrape growers, says that hardy, tall perennial grasses are the best vegetation to plant in a buffer strip. The manual also says that the required buffer width to remove pesticides depends on the slope of the field: slope less than 1% should be at least 25 ft, while 10% slopes require at least a 50 ft wide buffer strip. That report cites Grismer (2006) and Watanabe and Grismer (2001), which both found that the most important phase for removal of pesticides by buffer strips is at infiltration. Once the pesticide infiltrates the soil it can be trapped by soil constituents and organic matter, and subsequently degraded.

However, the extent to which this is the case depends on the characteristics of the pesticide in question. Watanabe and Grismer (2001), in a controlled laboratory test of vegetative filter strips, found that 73% of applied diazinon was detected in runoff water; this is due to the fact that diazinon, due to its high water solubility, has lower rates of infiltration in the buffer strip.

Rein (1999) reports that both perennial and annual grass species can be effective for use in buffer strips. Commonly used annual grasses in California include *Lolium multiflorum, Hordeum vulgare, Festuca species* and common California native perennial grasses, such as *Bromus Carinatus, Elymus glaucus, and hordeum brachyantherum*. The study involved an economic cost-benefit analysis of buffer strips along strawberry fields in Elkhorn Slough, Monterey Bay, with runoff-reduction benefits estimated using the existing scientific literature rather than an actual on-site field experiment. The paper states that vegetative buffer strips can capture 40-80% of pesticide run-off, depending on the topography and soil characteristics of the particular field; however, the study does not specify a particular type of pesticide and is determined from studies conducted in other states. Specific widths of the buffer strips are also not specified, though, the study reports that 1 acre of buffers was planted for every 35 acres of strawberries.

Rein et al. (1998) tested 5 m, 10 m, 20 m and 40 m buffer strips under three different “treatments”: native perennial grasses (a mix of *Nassella pulchra*, *Bromus carinatus* and *Deschampsia caespitosa*), non-native annual barley grass (*Hordeum vulgare*), and an unseeded treatment consisting of volunteer weedy vegetation. The experiment was also completed in Elkhorn Slough, but it tested non-point source N and P fertilizer runoff instead of pesticide runoff, and found that the annual barley grass treatment was the most effective in reducing that kind of runoff.

Truong (2000) investigated the potential for using vetiver grass (*Vetiveria zizanioides)* in vegetative buffers in Yolo County, California. It explains why the climate and soil should be compatible for this type of grass, and outlines its benefits in various regions where it has been tested. Tests have shown that vetiver grass buffers trap 48% of diuron runoff, 67% of chlorpyrifos runoff, and 86% of endosulfan runoff. However, the study did not test vetiver buffers in California itself.

Moore et al. (2008) conducted studies on vegetative ditches in Yolo Country, California. 113 m long and 1.8 m top wide ditches were dug at the end of agricultural fields and planted with *Hordeum vulgare* (barley) and *Lolium multiflorum* (annual ryegrass); the invasive weed Lamb’s quarter (*Chenopodium album*) was also present in high quantities. Rainfall events were simulated with heavy irrigation. That study found that vegetation was more effective at removing the pyrethroid permethrin than the organophosphate diazinon, though including vegetation in the ditches had significant effect on reducing both kinds of pesticide runoff. The distance needed to reduce diazinon concentration by 50% was 1155 m for a ditch without vegetation, but only 55 m for a ditch with vegetation. The distance needed to reduce permethrin concentration by 50% was 347 m in a ditch without vegetation and 22 m in a ditch with vegetation.

Anderson et al. (2008) found similar results when comparing chlorpyrifos, a highly soluble OP, with permethrin at four sites in the Salinas Valley in California. In this study, runoff was passed through 300 m long, 3.25 m wide vegetative ditches planted with rushes, pennywort, wild rye and red rescue. The concentration of several pyrethroids, including permethrin, in the runoff was reduced by 100%, but chlorpyrifos was only reduced by 35%. While the study also found that diazinon concentrations were reduced between 10% and 55%, the remainder of the diazinon could be removed if the water was treated with an enzyme, Languard-OP A.

2.3.3 Organophosphate Runoff in California

Organophosphate runoff has been an important policy concern in California. The use of organophosphates (OPs) in the US decreased by 14% from 1992 to 2000, but still accounted for 40% of the total amount of pesticides used in 2000 (Epstein & Bassein 2003). In California alone, 85 million kg of OP pesticides were applied in 2000. Dormant season OP pesticide use in California almond and stone fruit orchards reached its high point in 1992-1994, and has since declined. Conversely, pyrethroid use has increased, as it has been used to substitute for OPs, which are more toxic. Brady et al (2006) compare runoff from California orchards of diazinon, an OP, and esfenvalerate, a pyrethroid. It is shown that diazinon has substantially higher runoff and toxicity for the water flea in nearby streams.

In California almond orchards, OPs sprayed during the dormant season are viewed as the most effective way to deal with a number of arthropod pests, including peach twig borer (PTB), San Jose scale (SJS), European red mite, and brown mite (Zhang et al 2004). They are traditionally applied with a narrow-range oil that increases the effectiveness of the OP pesticide. However, high levels of several OPs, including diazinon, chlorpyrifos, and methidathion, have been found in dangerous concentrations in the Sacramento and San Joaquin river basins, which led to DPR regulations on OP applications. Zhang et al (2004) found that OP use in California almond orchards has decreased substantially since regulations were first put into place. Dormant-season OP sprays used to be used in 40-50% of orchards in the state, but by 2000 this had decreased to only 9% of orchards. Logically, substitute methods of pest control have increased in this same time period: Bt use increased from 6% to 27% of acreage; pyrethroid use increased from 2% to 16%, and application of dormant oils alone increased from 2% to 7%. The alternatives seem to be working, as evidenced by the continued high almond yields during the same time period. However, none of the substitutes is perfect. Bt controls only PTB, not the full range of almond pests, and pyrethroids can be toxic to bees and flat head minnows.

A number of studies have been conducted over the past decade to continually assess the levels of OPs in the Sacramento and San Joaquin river basins, how those levels are affected by rainfall and pesticide use, and whether the DPR regulations have had any impact. Deleanis et al. (2002) attempted to determine the geographical sources of OP pollution in the waterways, but did not have adequate data to accomplish this task. Guo et al. (2003) developed an empirical model that could be used to predict OP levels in the rivers based on rainfall data and levels of pesticide application. Zhang and Zhang (2011) developed a model to analyze the effectiveness of the various regulations and best management practices, including use of buffer strips, on reduction in OP runoff into California waterways. That study found that the effectiveness of vegetative buffer strips depends on their composition and size, and that the combination of vegetated ditches, buffer strips and use reduction decreased diazinon and chlorpyrifos load by over 94%.

2.3.4 Economic Analyses

A few past studies have looked at the economic impact of pesticide regulations, including requirements for buffer strips.

2.3.4.a Buffer strips

Brodt et al. (2009) examined the costs and benefits of hedgerows, windbreaks, and grassed edges in farmers' fields. The researchers conducted interviews with 22 growers in Yolo County, California, in order to determine the extent to which such features are currently used and the reasons why they have not been more widely adopted. They found that only one third of the farmers in the study had installed grassed edges and hedgerows, with a total of 10% of land taken out of production for these purposes, despite government incentive programs. The primary reasons identified by growers were high costs and loss of revenue. Some growers were also concerned about the spread of invasive weeds and fire risk. Thus, many of them preferred to use herbicides and disking and scraping along the edges of their fields.

A study by Qui and Prato (1998) sought to evaluate the economic value of riparian buffer strips in reducing agricultural non-point source pollution. The effect of riparian buffers on reducing sediment, nitrate, and atrazine runoff into the Goodwater creek watershed in Missouri was calculated, and then a Cost and Return Estimator (CARE) model was used to determine the economic impact of the riparian buffers. The total watershed net return (TWNR) was calculated, using indirect valuation methods to assign an economic value to the improved water quality caused by buffers, and taking into account direct costs of establishing the buffers, plus the opportunity costs of reduced crop acreage. The study found that the net economic value of buffers that would reduce atrazine concentration in the water from 45 to 24 ppb was $612,117. They also found that the value and cost of buffers varied dramatically across the different sub-basins in the watershed, though there was still a net positive value in all but two of the sub-basins.

A report conducted in the UK by Agra CEAS Consulting (2005) also focused on the economic impact of buffer zones. The authors examined 5 m, 6 m, and 8 m wide field margins, both cropped and uncropped, and used partial budgeting to determine the change in gross margin and fixed costs likely for a farmer who introduces buffer strips to reduce pesticide loss. Using organic yields as a proxy for the yields in cropped field margins and zero yields for uncropped field margins, the study calculated the change in profit margins for 38 different crops, including strawberry and broccoli. They found the highest costs for strawberries with uncropped field margins, with losses of £0.90 per m length for the 5 m wide buffers, £1.08 per m length for the 6 m buffers, and £1.44 per m length for the 8 m buffers.

Rein (1999) sought to estimate the total costs and benefits of establishing vegetative buffer strips along strawberry fields in the Elkhorn Slough watershed in Monterey Bay, California. Costs of installing buffer strips as well as foregone crop revenue were taken into account, while the benefits estimated included a reduction in pesticide costs and a reduction in farm damage from soil erosion. The author determined that in the first year after buffer strips are established, farmers will have a net economic benefit of $1,488, and those benefits will increase to $6,171 over five years.

Carter et al. (2005) estimate the cost to the California strawberry industry of the state 2001 use regulations for methyl bromide designed to reduce human exposure to methyl bromide emissions. One component of these regulations was the requirement of minimum distances, or buffers, from homes and schools and other sensitive sites. Total estimated costs were over $26 million.

2.3.4.b Other pesticide and runoff regulations

Lichtenberg, Parker, and Zilberman (1988) used information on price, quantity, elasticity of supply and demand, and estimates of cost and yield effects provided by scientists to estimate the net social welfare costs of pesticide regulations. The model developed in that study was used to estimate the costs of banning the insecticide ethyl parathion, an OP, on California plums, prunes, and almonds. Changes in equilibrium price and quantity due to the regulation were calculated for each crop in each region, then consumer and producer surplus were estimated both for those directly and indirectly affected.

Sunding (1996) created a general model to calculate the impact of environmental regulations on a regional basis, determining the dead weight loss to society by using regional crop output and changes in regional production due to regulation. The model was then applied to determine the marginal welfare cost of banning mevinphos, an insecticide-acaricide, in four California vegetable crops: broccoli, cauliflower, head lettuce, and leaf lettuce. The study determined the expected yield loss for switching from mevinphos to an alternative insecticide (diazinon or dimethoate) by conducting telephone interviews with 56 growers. The analysis was disaggregated by crop, region, and month. The results suggested estimated welfare losses are reduced when heterogeneity across regions and months is taken into account.

Pimentel et al. (1991) estimated the potential agricultural and environmental costs and benefits of reducing pesticide use in the US by 50%, using data on current pesticide use patterns in 40 crops and estimates of yield losses when pesticides are not used. The study determined that the direct cost of reducing pesticide use by half would be $1 billion, while the social and environmental costs of pesticide use currently are $2.2 billion per year. The study also concluded that reducing pesticide use by half would increase the price of food by only 0.6%.

Taylor et al. (1992) used an interesting methodology to evaluate the economic impacts of nitrogen and phosphorus runoff from fertilizer and five different regulations that sought to reduce such pollution. Though not directly about pesticide runoff, the model used is similar to that in the current paper. The researchers used a biophysical simulator, the Erosion-Productivity Impact Calculator to simulate crops yields, erosion, and nutrient pollution based on soil characteristics and levels of farm inputs. These output levels were then substituted into the General Algebraic Modeling System model in order to identify growers' profit-maximizing responses to regulations. The system was used to test the effects of several regulations, including taxes on nitrogen fertilizer and nitrate runoff, per acre effluent standards, and a ban on fall fertilizer application.

Chapter Two Appendix
Comparison of Draft Regulations and 3 CCR § 6960

"Dormant Insecticide Contamination" *(existing)*	**"Restrictions to Address Pesticide Drift and Runoff to Protect Surface Water"** *(proposed)*
• Cannot make an application if field moisture is at capacity and a storm event is predicted within 48 hours, or o A storm event likely to produce runoff from the treated area is forecasted by the National Weather Service	• Cannot make an application if field moisture is at capacity and a storm event is predicted within 48 hours, or o A storm event likely to produce runoff from the treated area is forecasted by the National Weather Service ▪ Apply pesticide only if application is followed by the use of a technology or product that rapidly degrades or reduces offsite movement of the pesticide so that it will not adversely affect water quality. The technology or product shall be approved and publicly noticed by the director on the DPR's website, after consultation with the State Water Resources Control Board, and approval shall be based on scientific data demonstrating the effectiveness in rapidly degrading or reducing offsite movement of the pesticide to surface water, or comply with subparagraphs (B) and (C)
o Divert any runoff with an on-farm recirculating system and/or,	• Sub Paragraph (B)I o For four weeks after application, divert any rain

o Contain and hold any runoff for 72 hours before releasing into a sensitive aquatic site.
 	
• **<u>Exemption</u>** to only applying a dormant oil, or applying to a hydrologically isolates site, or diverting any runoff with on-farm recirculating system/ containing and holding any runoff for 72 hours before releasing into a sensitive site.
  o The operator of the property to be treated shall obtain a written recommendation from a licensed pest control advisor prior to the application; and
    ▪ The application shall not be
	runoff with an on-site recirculating system and/or
	  o Contain and hold any rain runoff for 72 hours before releasing into a sensitive aquatic site.
	  o If there are sequential storms that would result in a holding period longer than 72 hours,
	    ▪ The operator may release proportional amounts of runoff consistent with the estimated amount of runoff from, the 72-hour holding time for, each storm
	  o Sub Paragraph (B)II
	    ▪ If using in ground water protection areas during period October 1 through March 31, comply with appropriate management practice in 3CCR section 6487.4
	    ▪ If using in ground water protection areas during period April 1 through September 30,
	      • Comply with subparagraph (C)
	  o Subparagraph (C)
	    ▪ Same as (B)I
	
	• **<u>Exemption</u>** to not applying when field is at moisture capacity and a storm is predicted within 48 hours, or a storm event likely to produce runoff is predicted, or the use of a technology that rapidly degrades or reduces runoff.
	  o At the time of the application, the operator of the property obtains and follows a written recommendation from a

made within 100ft of any sensitive aquatic site; and ▪ Wind speed shall be 3-10 miles per hour at the perimeter of the application site as measured by an anemometer on the upwind side	licensed pest control adviser for the pesticide application. o Criteria determining need of treatment, required to be specified in a written recommendation by 3CCR section 6556(d), shall include ▪ A description of the economic threshold, or ▪ Other benchmark(s) used to guide decision-making, ▪ Along with pest scouting records ▪ Degree-days, or ▪ Other modeling reports, or ▪ Other information that was used to justify the recommended treatment, **and** ▪ At the time of application, the operator of the property possesses and is implementing a surface water quality management plan, defined in Attachment II
• Noted in exemption above: o Application shall not be made within 100 ft of any sensitive aquatic site	• Ground applications shall not be made within 25 feet of any sensitive aquatic site
• Aerial application of dormant insecticides shall only be allowed if; o Soil conditions do not allow field entry, or approaching	• Airblast, high-pressure (>60 psi) wand, or hand gun applications shall not be made within 100 ft of any sensitive aquatic site

bloom conditions necessitate aerial application; and
o Operator receives written recommendation from licensed pest control advisor and, application is not within 100 feet of a sensitive aquatic site and wind speed is between 3-10 mph.
	• Aerial applications shall not be made within 150 feet of any sensitive aquatic site, or
	  o In the case of forestry applications, the distance specified by the local regional water quality control board if greater than 150 feet
	• Aerial applications to deciduous plants during the dormant season shall only be allowed if soil conditions do not allow field entry, or
	  o Approaching bloom conditions necessitate aerial application, and
	  o If the operator of the property obtains a written recommendation from a licensed pest control adviser.

Chapter 2 References

Agra CEAS Consulting. 2005. "Potential Economic and Financial Impact of Buffer Zones." Centre for European Agricultural Studies, Imperial College at Wye. Kent, UK.

Anderson, B.S., B.M. Phillips, J.W. Hunt, B. Largay, and R. Shihadeh. 2008. "Pesticide and Toxicity Reduction Using Vegetated Treatment Systems and Landguard OP-A." Data Summary and Final Report. Central Coast Regional Water Quality Control Board, San Luis Obispo, California.

Arora, K., S.K. Michelson, and J.L. Baker, J.L. 2003. "Effectiveness of Vegetated Buffer Strips in Reducing Pesticide Transport in Simulated Runoff." *Transactions of the ASABE* 46(3): 635–644.

Brady, J., W. Wallender, I. Werner, B.M. Fard, F. Zalom, M. Oliver, M. Mata, J. Henderson, L. Deanovic, and S. Upadhaya. 2006. "Pesticide Runoff from Orchard Floors in Davis, California, USA: A Comparative Analysis of Diazinon and Esfenvalerate." *Agriculture, Ecosystems & Environment* 115(1-4): 56-68.

Brodt, S., K. Klonsky, L. Jackson, S. Brush, and S. Smukler. 2009. "Factors Affecting Adoption of Hedgerows and Other Biodiversity-enhancing Features on Farms in California, USA." *Agroforestry Systems* 76(1): 195-206.

Buttle, J.M. 1990. "Metolachlor Transport in Surface Runoff." *Journal of Environmental Quality* 19: 531-538.

[CDPR 2010A] California Department of Pesticide Regulation. 2010. "Comments Received by DPR and DPR Responses." February.
http://www.cdpr.ca.gov/docs/emon/surfwtr/regs/comments_2010.pdf.

[CDPR 2010B] California Department of Pesticide Regulation. 2010. "Responses to Second Set of Comments Received by DPR." March.
http://www.cdpr.ca.gov/docs/emon/surfwtr/regs/comments_03-2010.pdf

Carter, C.A., J.A. Chalfant, R.E. Goodhue and G.J. McKee. 2005. "Costs of 2001 Methyl Bromide Rules Estimated for California Strawberry Industry." *California Agriculture* 59(1):41-46.

Demars, C., and M. Zhang. 2011. **DRAFT** report to OPCA, CDFA.

de Snoo, G.R. 1999. "Unsprayed Field Margins: Effects on Environment, Biodiversity and Agricultural Practice." *Landscape and Urban Planning* 46: 151-160.

Dileanis, P.D., K.P. Bennett, and J.L. Domagalski. 2002. "Occurrence and Transport of Diazinon in the Sacramento River, California, and Selected Tributaries During Three Winter Storms, January-February 2000." WRIR - 02-4101. USGS, Sacramento, CA. 2002.

Dow AgroSciences n.d. http://www.cdms.net/ldat/ld02A011.pdf "Specimen Label Lorsban-4E Insecticide."

Epstein, L., and S. Bassein. 2003. "Patterns of Pesticide Use in California and the Implications for Strategies for Reduction of Pesticides." *Annual Review of Phytopathology* 41:351-375.

Ganzelmeier, H. 1993. *Criteria for assessment of plant protection products in the registration procedure.* BBA Braunschweig, Germany.

Gril, J.J., B. Real, L. Patty, M. Fagot, and I. Perret. 1997. "Grassed Buffer Zones to Limit Contamination of Surface Waters by Pesticides: Research and Action in France." In *Buffer Zones: Their Process and Potential in Water Protection.* N. Haycock, T. Burt, Keith Goulding, Gilles Pinay, Editors. Quest Environmental: Hertfordshire, UK.

Grismer, M.E., T. O'Geen, and D. Lewis. 2006. *Vegetative Filter Strips for Non-point Pollution Control in Agriculture*. University of California ANR Publication 8195.

Guo, L., C. Nordmark, F. Spurlock, B. Johnson, L. Li, M. Lee, and K. Goh. 2003. "Semi-empirical Prediction of Pesticide Loading in the Sacramento and San Joaquin Rivers during Winter Storm Seasons." California EPA/Department of Pesticide Regulation, Environmental Hazards Assessment Program. Sacramento, CA. July, 2003.

Hall, J. K., N. L. Hartwig, and L. K. Hoffman. 1983. "Application Mode and Alterative Cropping Effects on Atrazine Losses from a Hillside." *Journal of Environmental Quality* 12:336-340.

Harris, G.L., and A. Forster. 1997. "Pesticide Contamination of Surface Waters-- the Potential Role of Buffer Zones." In *Buffer Zones: Their Process and Potential in Water Protection.* N. Haycock, T. Burt, Keith Goulding, Gilles Pinay, Editors. Quest Environmental: Hertfordshire, UK.

Harris, G.L, P.H. Nicholls, S.W. Bailey, K.R. Howse, and D.J. Mason. 1994. "Factors Influencing the Loss of Pesticides in Drainage from a Cracking Clay Soil." *Journal of Hydrology* 159:235-253.

Jones, R.L., G.L. Harris, J.A. Catt, R.H. Bromilow, D.J. Mason, and D.J. Arnold. 1995. "Management Practices for Reducing Movement of Pesticides to Surface Water in Cracking Clay Soils." *BCPC Brighton Crop Protection Conferences, Weeds* 2: 489-498.

Lichtenberg, E., D. Parker, and D. Zilberman. 1988. "Marginal Analysis of Welfare Costs of Environmental Policies: The Case of Pesticide Regulation." *American Journal of Agricultural Economics* 70(4): 867-874.

Lloyd, G.A. and G.J. Bell. 1993. *Hydraulic nozzles: Comparative spray drift study.* Report of a study carried out in 1983 in association with the BAA.

Longley, M., T. Çilgi, P.C. Jepson, and N.W. Sotherton. 1997. "Measurements of Pesticide Spray Drift Deposition into Field Boundaries and Hedgerows. I. Summer Applications." *Environ. Toxicol. Chem.* 16:165–172.

Mickelson, S.K., and J.L. Baker. 1993. "Buffer Strips for Controlling Runoff Losses." *ASAE/CSAE Meeting Presentation Paper No. 93-2048.* Spokane Centre, Spokane, Washington, 20-23 June.

Moore, M.T., D.L. Denton, C.M. Cooper, J. Wrysinski, J.L. Miller, K. Reece, D. Crane, and P. Robins. 2008. "Mitigation Assessment of Vegetated Drainage Ditches for Collecting Irrigation Runoff." *Journal of Environmental Quality* 37:486-493.

Patty, L., J. Gril, B. Real, and C. Guyot. 1995. "Grass Buffer Strips to Reduce Herbicide Concentration in Runoff: Preliminary Study in Western France." Symposium at the University of Warwick, Conventry, 3-5 April. *BCPC Monograph No. 62: Pesticide movement in water*, 397-406.

Payne, N.J., B.V. Helson, K.M.S. Sundaram, and R.A. Flemming. 1988. "Estimating Buffer Zone Width for Pesticide Application." *Pesticide Science* 24:147–161.

Pimentel, D., L. McLaughlin, A. Zepp, B. Lakitan, T. Kraus, P. Kleinman, F. Vancini, J. Roach, E. Graap, W. Keeton, and G. Selig. 1991. "Environmental and Economic Effects of Reducing Pesticide Use." *BioScience* 41(6): 402-409.

Prichard, T., P. Verdegaal, L. Schwankl, and R. Smith. 2010. "Controlling Offsite Movement of Agricultural Chemical Residues: Winegrapes." California Department of Pesticide Regulation--Pesticide Management Alliance Grant in Cooperation with the San Joaquin County and Delta Water Quality Coalition.

Qiu, Z., and T. Parto. 1998. "Economic Evaluation of Riparian Buffers in an Agricultural Watershed." *Journal of the American Water Resources Association* 34(4): 877-890.

Rein, F.A. 1999. "An Economic Analysis of Vegetative Buffer Strip Implementation. Case Study: Elkhorn Slough, Monterey Bay, California." *Coastal Management* 27(4):377 — 390.

Rein, F., M. Los Huertos, R. Curry, and M. Fitzsimmons. 1998. "Effects of Perennial Grass Buffer Strips on Movement of NPS Pollutants from Cropland to Wetland." Technical Completion Reports, University of California Water Resources Center, UC Berkeley.

Rhode, W. A., L. E. Assmussen, E. W. Hauser, R. D. Wauchope, and H. D. Allison. 1980. "Trifluralin Movement in Runoff from a Small Agricultural Watershed." *Journal of Environmental Quality* 9:37-42.

Syngenta Crop Protection Inc. n.d. “Specimen label: Warrior II with Zeon.” http://www.cdms.net/LDat/ld8JD040.pdf.

Taylor, M., R. Adams, and S. Miller. 1992. “Farm-level Response to Agricultural Effluent Control Strategies: The Case of the Willamette Valley.” *Journal of Agricultural and Resource Economics* 17(1): 173-185.

Truong, P. 2000. “Vetiver Grass System: Potential Applications for Soil and Water Conservation in Northern California.” Paper presented at the Stiff Grass Technology Seminar, Woodland: 9 May 2000.

Sunding, D. 1996. “Measuring the Marginal Cost of Nonuniform Environmental Regulations.” *American Journal of Agricultural Economics* 78(4): 1098-1107.

Watanabe, H., and M.E. Grismer. 2001. “Diazinon Transport through Inter-row Vegetative Filter Strips: Micro-ecosystem Modeling.” *Journal of Hydrology* 247:183-199.

Wauchope, R.D. 1978. “The Pesticide Content of Surface Water Draining from Agricultural Fields.” *Journal of Environmental Quality* 7:459-472.

Williams, R.J., D.N. Brook, P.J. Glendinning, P. Mattheissen, M.J. Mills, and A. Turnbull. 1991. “Movement and Modeling of Pesticide Residues at Rosemaund Farm.” *BCPC Brighton Crop Protection Conference, Weeds* 2: 507-514.

Zhang, M., L. Wilhoit, and C. Geiger. 2004) “Dormant Season Organophosphate Use in California Almonds.” PM04-01. Pest Management and Licensing, Department of Pesticide Regulation. Sacramento, CA.

Zhang, X., and M. Zhang. 2011. “Modeling Effectiveness of Agricultural BMPs to Reduce Sediment Load and Organophosphate Pesticides in Surface Runoff.” *Science of the Total Environment* 409(10): 1949-1958.

Chapter 3
Methodology and Selected Case Studies

This chapter describes the partial equilibrium approach used for the analysis (section 3.1), the case study counties (section 3.2) and the case study crops (section 3.3).

3.1 Partial Equilibrium Analysis

Section 3.1.1 addresses the basics of partial equilibrium analysis. Section 3.1.2 discusses the various sources from which information for this analysis was obtained. Section 3.1.3 discusses technical and practical caveats regarding the analysis and its findings.

3.1.1 Approach

A partial equilibrium analysis considers a single market. In this instance, we consider the market for a specific commodity from a specific county in each case study. In the absence of county-specific information regarding acreage allocations across crops, we assume that acreage allocated for the production of an individual crop is fixed. In order to identify the effects of the proposed draft regulations on revenues and costs, we consider the effects on supply and cost of production of the commodity. Cost per acre, yield per acre, and output quality are allowed to respond to the draft regulations. Changes in costs will affect growers' net revenues. Changes in yield due to the draft regulations will affect the total quantity supplied, total revenues, costs and net revenues. Reductions in output quality may prevent growers from obtaining price premiums for quality that they currently obtain, or may make some share of output unmarketable. Land in buffers is specified in the draft regulations as a function of the application method used. Land in buffers may affect the total quantity supplied, total revenues, total costs, and net revenues.

In order to complete the analysis, we must consider the extent to which the price of a commodity changes in response to a change in the quantity produced in a particular county. Economists call such changes "price flexibilities" and estimate them using statistical techniques.[1] The county-crop case study approach makes it particularly challenging to represent the price flexibility because production of a specific commodity in a specific county is generally not distinguishable from production elsewhere in California in any substantive way. We consider three cases. While individually each case has its drawbacks, as a group they provide a sense of the potential impacts. In the first case, only the case study county is affected by the draft regulations. While there is a non-zero price flexibility, so that price changes with quantity, the change in production is relatively small for most of the case studies we evaluate, so the change in price is small as well. This measure does provide a sense of how the county's

[1] A crop's price flexibility is the inverse of its own-price elasticity of demand. The own price elasticity of demand is a measure of how sensitive the demand for a crop is to a change in its price, and is defined as the percentage change in the quantity demanded of that crop for a one percent increase in the crop's price. Elasticities greater than one are considered elastic (responsive to price changes) and less than one are inelastic (not responsive to price changes). Demand is perfectly inelastic when the own price elasticity of demand is equal to zero; a change in price will have no effect on demand. Demand is perfectly elastic when the own price elasticity of demand approaches negative infinity; any increase in price will result in zero demand.

share of California production influences the price response. In the second case, all of California is assumed to be affected by the regulations in exactly the same manner as the case study county is. Thus, there is a larger increase in price if the quantity produced decreases and vice versa. Of course, there will be variations across counties; this case is intended to provide an approximate indication of how the impact on the case study county-crop pair is affected by the regulations applying to all California production. The third case assumes that the price flexibility is zero; price does not change with a change in the quantity produced in the case study county or in California as a whole. This could be due to growers in other states increasing production, or to growers in other countries increasing production, or some combination of the two.

We report two impact measures for each price response case: changes in total revenues and changes in net revenues. Total revenues are the value of the crop: the price multiplied by the quantity sold. Net revenues are the difference between total revenues and total operating costs per acre. Total operating costs are computed using the cost of the pesticide treatment(s) used currently and the cost of the treatment(s) specified to be used if the draft regulations are implemented, as well as all other operating costs included in the University of California Cooperative Extension cost and return studies.

3.1.2 Information Sources

The analysis combines information from a number of sources. Own-price elasticities of demand (the inverse of price flexibilities) were obtained from the economic literature. Base yields and prices were obtained from county agricultural commissioners' reports. Conversations with University of California Cooperative Extension Farm Advisors and Specialists were used as the basis for identifying one or two particularly critical impacts for the case study crops in terms of specific affected active ingredients or specific pests. The scientific literature was used to identify yield and cost effects of these identified impacts when relevant studies were available. University of California Cooperative Extension cost studies were used as the basis for computing changes in net revenues (http://coststudies.ucdavis.edu/current.php). Cultural practices are an important part of integrated pest management programs. The analysis assumes that growers already use such practices. List prices were obtained for specific pesticide products used in the analysis.[2]

Total acreage and acreage in buffers were obtained from Demars and Zhang (2011) for each crop-county case study.[3] Table 3.2.1 the acreage in buffers, the share of total acreage in buffers, the number of fields affected, and the share of all fields affected by buffer width summarizes for each crop-county case study pair. It also includes information on the average acreage in buffers for affected fields.

[2] The use of specific products for the computation of cost and net revenue effects is not an endorsement. Products were chosen in order to be able to compare costs; information regarding the average cost of an active ingredient is not publicly available.

[3] Demars and Zhang (2011) is an in-progress draft report for CDFA that was made available to this project team for purposes of preparing this draft report for CDFA. It is not available for general circulation.

Table 3.2.1. Acres in Buffers and Fields with Buffers under Draft Regulations by County, Crop, and Buffer Width

County	Crop Name	Total Acres	Total number of fields	Average field size	25' Buffer: Acres affected	25' Buffer: Percent of acres affected	25' Buffer: Number of fields affected	25' Buffer: Percent of fields affected	25' Buffer: Average acres by fields affected by buffer	25' Buffer: Average percent of fields affected by buffer	100' Buffer: Acres affected	100' Buffer: Percent of acres affected	100' Buffer: Number of fields affected	100' Buffer: Percent of fields affected	100' Buffer: Average acres by fields affected by buffer	100' Buffer: Average percent of fields affected by buffer	150' Buffer: Acres affected	150' Buffer: Percent of acres affected	150' Buffer: Number of fields affected	150' Buffer: Percent of fields affected	150' Buffer: Average acres by fields affected by buffer	150' Buffer: Average percent of fields affected by buffer
Butte	Rice	103,197	1,850	56	639	0.6	1,538	83	0.4	1	10,656	10.3	1,726	93	6	15	17,608	17.1	1,743	94	10	23
	Walnut	31,601	1,380	23	101	0.3	360	26	0.3	4	1,024	3.2	562	41	2	16	1,772	5.6	602	44	3	24
	Almond	40,410	1,344	30	480	1.2	442	33	1.1	3	2,408	6.0	625	47	4	12	3,859	9.5	668	50	6	18
Colusa	Rice	147,603	3,097	48	1,453	1.0	2,767	89	0.5	2	18,395	12.5	3,026	98	6	17	30,018	20.3	3,034	98	10	27
	Almond	30,832	984	31	99	0.3	286	29	0.3	1	1,144	3.7	441	45	3	10	2,014	6.5	456	46	4	16
	Tomato	18,954	332	57	128	0.7	234	70	0.5	1	1,511	8.0	302	91	5	10	2,527	13.3	306	92	8	17
Fresno	Grape	258,380	6,114	42	2,982	1.2	1,839	30	1.6	5	11,818	4.6	2,154	35	5	17	17,612	6.8	2,256	37	8	24
	Tomato	114,625	797	144	1,378	1.2	368	46	3.7	3	5,262	4.6	396	50	13	12	7,704	6.7	405	51	19	18
	Alfalfa	98,942	988	100	1,814	1.8	515	52	3.5	4	6,976	7.1	569	58	12	14	10,199	10.3	579	59	18	20
	Almond	88,922	1,325	67	1,327	1.5	520	39	2.6	5	5,161	5.8	594	45	9	16	7,582	8.5	621	47	12	22
Monterey	Grape	42,426	354	120	583	1.4	178	50	3.3	3	2,316	5.5	191	54	12	12	3,485	8.2	199	56	18	17
	Lettuce	42,115	1,998	21	448	1.1	497	25	0.9	5	1,788	4.2	567	28	3	16	2,684	6.4	605	30	4	22
	Strawberry	11,484	251	46	140	1.2	86	34	1.6	4	566	4.9	98	39	6	14	855	7.4	107	43	8	19
Santa Barbara	Grape	26,445	186	142	206	0.8	44	24	4.7	4	765	2.9	46	25	17	14	1,083	4.1	47	25	23	19
	Lettuce	7,724	296	26	39	0.5	44	15	0.9	4	147	1.9	51	17	3	14	214	2.8	53	18	4	19
	Strawberry	6,159	110	56	29	0.5	20	18	1.4	3	113	1.8	20	18	6	13	168	2.7	20	18	8	20
Stanislaus	Almond	101,760	4,169	24	1,732	1.7	1,401	34	1.2	5	6,640	6.5	1,564	38	4	17	9,712	9.5	1,622	39	6	23
	Alfalfa	33,227	1,018	33	526	1.6	381	37	1.4	4	2,062	6.2	431	42	5	14	3,050	9.2	460	45	7	19
	Walnut	27,118	1,429	19	555	2.0	536	38	1.0	6	2,105	7.8	597	42	4	19	3,074	11.3	620	43	5	27
	Tomato	13,747	218	63	214	1.6	106	49	2.0	4	854	6.2	124	57	7	13	1,244	9.0	130	60	10	18

Source: Demars and Zhang, 2011

3.1.3 Caveats

As with any analysis of this sort, there are a number of technical caveats. First, the price response is dependent on the own-price elasticity of demand, which we have drawn from estimates in the existing literature. We bound the implications of this for our analysis by considering the case where price does not change in response to a change in quantity.[4] Second, list prices for pesticide products do not necessarily reflect the prices paid by individual growers. If percentage differences vary across products then the change in cost between the base treatment and the treatment that would be utilized under the draft regulations will be distorted. Third, related to the previous point, only one base treatment and one treatment under the draft regulations are considered in each case study. In practice, growers use a variety of treatment programs. Fourth, the identification of selected impacts was based in part on the extent of use of a specific active ingredient on a case study crop in a case study county. Critical active ingredients that are used on only a small share of acreage in any given year but have few or no substitutes for the management of one or more pests are not included in the analysis. Fifth, operating costs from cost studies are used to compute net revenues. To the extent that actual operating costs vary systematically from those reported in the crop studies, changes in net revenue will be distorted in absolute terms.

There are also a number of practical caveats. First, very new chemistries are not considered in the analysis. New chemistries may offer better alternatives than the ones considered in the case studies. Second, the draft regulations would eliminate the listed active ingredients for future use against new invasive pests in buffers adjacent to sensitive aquatic sites. This could increase short-term losses from these pests considerably if no efficacious unlisted active ingredient was identified quickly. Third, the analysis does not incorporate compliance costs and the cost of potentially administering two management programs: one for land in buffers and one for other land. Section 5.1 discusses this issue in more detail. Fourth, in many instances scientific information regarding yield effects of weeds and cost effects other than pesticide material costs is unavailable. To the extent that competition from weeds reduces yields and weed growth complicates management and repair of irrigation systems, the cost effects presented here will underestimate the cost of the draft regulations to growers. The same problem holds for other specific pests. Fifth, we do not address resistant varieties explicitly. Related to this, in some instances information from the scientific literature regarding yield effects is not current; changes in varieties since then may have altered the impacts.

Finally, the analysis is very aggregated, and does not reflect variability in effects. As noted in 3.1.1, the case where the entire state is assumed to face the same effects for a given crop as the case study county does is clearly a rough approximation. Differences across counties exist, so the reported impacts are approximations. Because the case study crops are examined for at least two counties (see section 3.2 below), one can get some sense of how the effects will differ across the state. Differences in pest pressure are one driver of these differences. For example, comparing two case studies, almonds produced in Fresno County face greater pest pressure

[4] In general theoretical terms, the other bound would be for demand to be perfectly inelastic, so that the quantity demanded does not change regardless of the price. This is not an interesting case in the current context.

than those produced in Stanislaus County. Variations in the share of land in buffers next to sensitive aquatic sites will also differ. The differences in the counties examined for a specific crop provide some information regarding the importance of this variation.

3.2 Case Study Counties

Six counties representing four production regions are included in the analysis. Butte and Colusa represent the Sacramento Valley. Fresno represents the southern San Joaquin Valley, Monterey and Santa Barbara represent the Central Coast, and Stanislaus represents the northern San Joaquin Valley. Table 3.2.1 summarizes the case studies by county and crop. At least three crops are considered for each county and at least two counties are considered for each crop.

Table 3.2.1 County and Crop Case Studies

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus
Alfalfa			X			X
Almond	X	X	X			X
Grapes (all)			X	X	X	
Lettuce				X	X	
Tomatoes (processing)		X	X			X
Rice	X	X				
Strawberries (fresh)				X	X	
Walnut	X					X

3.2.1 Butte County

Butte County is located in the Sacramento Valley, bordering Tehama County on the north, Glenn and Colusa counties on the west and Sutter and Yuba counties on the south. Plumas County, in the Northeast Mountain region, borders Butte on the east. The total population in Butte was 220,000 in 2010, and the land area was 1,639 square miles, leading to a population density of 134.2 people per square mile (U.S. Census Bureau, 2010). The primary industries in the county in 2006, in terms of employment, were health care, retail, accommodation and food services, and construction. Agriculture, forestry, and fishing made up only 5% of total employment, though crop production and agriculture and forestry support activities ranked as the top two most competitive industries in terms of value (CEDP, 2006).

Butte County was the eighteenth largest agricultural county in California in terms of value produced in 2009, with $540 million of total production. It was one of the top producers in California of blueberries, kiwifruit, olives, clingstone peaches, dried plums, walnuts, oats, and rice (NASS, 2010). In decreasing order of value, the leading agricultural commodities are rice, walnuts, almonds, dried plums, and nursery stock. The total value of agricultural production in the county decreased by 6% from 2008 to 2009, though it increased by 72% over the 10-year average from 1999-2009.

This report examines selected potential impacts of the draft regulations for three crops in Butte County: almonds, rice, and walnuts.

3.2.2 Colusa County

Colusa County is located in the Sacramento Valley region of California, and is bordered to the south by Yolo County, to the north by Glenn County and to the East by Sutter County, all part of the Sacramento Valley region. To the west, Colusa is bordered by Lake County. The population of Colusa was 21,419 people in 2010 and total land area was 1,151 square miles, for a population density of 18.6 people per square mile (U.S. Census Bureau, 2010). The primary industries in Colusa in 2009 were crop production, agriculture and forestry support services, food manufacturing, truck transportation, and animal production (CEDP, 2006).

Colusa County was the seventeenth largest agricultural county in California in 2009 in terms of value, at $599 million, and it is the leading producer of rice in the state. The top commodities in the county are, in decreasing order: rice, almond meats, processing tomatoes, rice seed, and wheat (NASS, 2010).

This report examines selected potential impacts of the draft regulations for three crops in Colusa County: almonds, processing tomatoes, and rice.

3.2.3 Fresno County

Fresno County is located in the southern San Joaquin Valley. It borders Kings and Tulare counties to the south and Madera and Merced counties to the north, all part of the San Joaquin Valley. It also borders San Benito and Monterey to the west, part of the Central Coast region, and Mono and Inyo counties to the east, part of the Sierra Nevada region. The population of Fresno County was 930,450 in 2010 and the total land area was 5,963 square miles, leading to a population density of 156 people per square mile (U.S. Census Bureau). The primary industries in Fresno are agricultural and forestry services, crop production, animal production, and food and beverage manufacturing (CEDP, 2006).

Fresno has the highest value of agricultural production in California, with a total value of $5.37 billion in 2009 (NASS, 2010). In decreasing order by value, the leading agricultural commodities in the county are grapes, tomatoes, almonds, poultry, and cattle and calves. Fresno is also one of the top producers in California of asparagus, fresh market beans, broccoli, carrots, sweet corn, cucumbers, garlic, lettuce, melons, mushrooms, onions, chili peppers, squash, tomatoes, almonds, almonds, apples, apricots, cherries, dates, figs, grapes (especially raisin grapes), kiwifruit, nectarines, oranges, peaches, pears, pecans, plums, barley, dry beans, cotton lint, cottonseed, alfalfa, oats, sugar beets, wheat, cattle, poultry, hogs, sheep, turkeys and honey (NASS, 2010). From 2008 to 2009 there was an overall decrease in the value of agricultural production in Fresno of 4.5%, though this trend varied by sector. There was an increase of 19.7% in vegetable crop value, a 34.9% increase in nursery crops, and an 8% increase in apiary products. On the other hand, there was a 4.7% decrease in fruit and nut crops, a 34% decrease in livestock and poultry products, and a 33.4% decrease in field crop production (Fresno County, 2010).

This report examines selected potential impacts of the draft regulations for four crops in Fresno County: alfalfa, almonds, processing tomatoes, and grapes.

3.2.4 Monterey County

Monterey County is located in the Central Coast region of California and is bordered by Santa Cruz to the north, San Benito, Fresno and Kings to the east, and San Luis Obispo to the south. The population of Monterey County was 415,057 in 2010 and total land area was 3,322 square miles, leading to a population density of 124.9 people per square mile (U.S. Census Bureau, 2010). The leading industries in the county are agriculture and forestry support activities, crop production, hunting and fishing, and accommodation and food services (CEDP, 2006).

Monterey is the third largest agricultural county in California in terms of value, with a total of $4.03 billion of production in 2009 (NASS, 2010). In decreasing order by value, the top agricultural commodities in Monterey are lettuce, strawberries, nursery products, broccoli, and grapes. Monterey is also one of the leading producers in California of artichokes, asparagus, broccoli, cabbage, carrots, cauliflower, celery, lettuce, mushrooms, spinach, squash, raspberry, strawberries, grapes (especially wine grapes), barley, nursery products, and flowers and foliage (NASS, 2010). The county had one of the largest increases in total production value in the state from 2008 to 2009: 5.4%. The growth trends varied by crop, however: the value of leaf lettuce increased by 13%, but head lettuce value decreased by 5%, a trend that has lasted several years; and strawberry value increased by 22% (Monterey County, 2010).

This report examines selected potential impacts of the draft regulations for three crops in Monterey County: grapes, lettuce, and strawberries.

3.2.5 Santa Barbara County

Santa Barbara is located in the South Coast region of California, just north of Ventura County. It is also bordered by San Luis Obispo, in the Central Coast region, to the north. The population of Santa Barbara was 423,895 in 2010 and the total land area was 2,737 square miles, leading to a population density of 154.9 people per square mile (U.S. Census Bureau, 2010). The leading industries in the county are agriculture and forestry support activities, crop production, beverage manufacturing, and museums and historical sites (CEDP, 2006).

Santa Barbara was the twelfth largest agricultural county in terms of value in California in 2009, at $1.24 billion. It is one of the leading producers in California of broccoli, cabbage, cauliflower, celery, lettuce, squash, avocados, strawberries, and flowers and foliage (NASS, 2010). In decreasing order by value, the top commodities in Santa Barbara are strawberries, broccoli, wine grapes, lettuce and cauliflower. The county saw a 9.1% increase in the value of total agricultural production from 2008 to 2009, though there was a slight decrease in acreage (0.7%) (Santa Barbara County, 2010).

This report examines selected potential impacts of the draft regulations for three crops in Santa Barbara County: grapes, lettuce, and strawberries.

3.2.6 Stanislaus County

Stanislaus County is located in the northern San Joaquin Valley. It is bordered by San Joaquin County to the north and Merced County to the south. Santa Clara County, which is part of the Central Coast region, borders Stanislaus on the west, and Calaveras and Tuolumne, both in the Sierra Nevada region, border it to the east. The population of Stanislaus was 514,453 in 2010 and total land area was 1,494 square miles, leading to a population density of 344.4 people per square mile (US Census Bureau, 2010). The primary industries in the county are food and beverage processing, other manufacturing, retail, healthcare and social services, and agriculture (CEDP, 2006).

Stanislaus is the sixth largest agricultural county in California by value produced, with $2.3 billion of total output in 2009. It is one of the top five producers in California of almonds, apricots, cherries, cantaloupe, fresh market beans, honeydew, pumpkins, squash, peaches, tomatoes (both fresh market and processing), walnuts, and sweet potatoes (NASS, 2010). The top ten agricultural commodities in Stanislaus in terms of value are, in decreasing order by value: milk, almonds, chickens, cattle and cows, tomatoes, walnuts, silage, peaches, deciduous fruits and nuts grown in a nursery, and turkeys. There was a 7% decrease in the value of total agricultural commodities from 2008 to 2009, mostly due to declining milk prices. The value of chickens and tomatoes both saw notable increases of 23% and 104%, respectively (Stanislaus County, 2010).

This report examines selected potential impacts of the draft regulations for four crops in Stanislaus County: alfalfa, almonds, processing tomatoes, and walnuts.

3.2 References

[Butte County, 2010]. Butte County 2009 Agricultural Crop Report. (29 June 2010). Available at http://www.buttecounty.net/Agricultural%20Commissioner/~/media/County%20Files/Agriculture/Public%20Internet/2009%20Crop%20Report.ashx Accessed July 2011.

[CCAC, 2010] County Agricultural Commissioner's Data 2009. December 2010. USDA National Agricultural Statistics Service, California Field Office. Available at http://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/200910cactb00.pdf Accessed July, 2011.

[CEDP, 2006]. California Facts. California Economic Development Partnership, November 2006. Available at http://www.labor.ca.gov/cedp/pdf/[CountyX].pdf Accessed July 2011.

[Fresno County, 2010] Fresno Department of Agriculture. 2009 Annual Agricultural Crop and Livestock Report. Available at www.co.fresno.ca.us/ViewDocument.aspx?id=44077 Accessed July, 2011.

[Monterey County, 2010]. Monterey County Crop Report 2009. Monterey County Commissioner's Office. Available at http://ag.co.monterey.ca.us/assets/resources/assets/18/CropReport2009.pdf?1296154928 Accessed July 2011.

[NASS 2010a] California Agricultural Statistics: Crop Year 2009. USDA National Agricultural Statistics Service. Dec. 2010. Available at

http://www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/Reports/2009cas-all.pdf Accessed July 2011.

[Santa Barbara County, 2010] Agricultural Production Report: Santa Barbara County, 2009. Agricultural Commissioner's Office, County of Santa Barbara. April 2010. Available at http://www.countyofsb.org/uploadedFiles/agcomm/crops/2009CR2.pdf Accessed July 2011.

[Stanislaus County, 2010] Stanislaus County Agricultural Crop Report 2009. June 2010. Available at http://www.stanag.org/ag/croprpts/croppdf/2009-crop-report.pdf Accessed July, 2011.

U.S. Census Bureau. (2010). State and County Quick Facts. Available at http://quickfacts.census.gov/qfd/states/06/06099.html Accessed July 2011.

3.3 Case Study Crops

Each crop's economic role in the case study counties and California is discussed below, followed by a discussion of one or two key impacts it would potentially sustain if the draft regulations are implemented.

3.3.1 Alfalfa

3.3.1.a Economic profile

In 2009, California was the top producer of alfalfa hay in the US, accounting for 10.7% of total U.S. alfalfa, a drop from 2007, when California's share was 14%. Alfalfa was the eleventh most important crop grown in California in 2009 in terms of value, down from the sixth most important in 2008. (NASS, 2010a) California alfalfa production was 7.7 million tons in 2009 for a total nominal value of $875 million (CCAC, 2010). The total acreage of alfalfa planted in California in 2009 was 1,081,879 acres. Yields were 7.24 tons per acre. The nominal price per ton of alfalfa in California overall in 2009 was $113.38, equivalent to $809.53 per acre. The total nominal value in the state was $875,494,000. These values were compared to numbers from the 1999 crop year (CCAC, 2000) to determine the changes across the last decade. It was found that acreage decreased by 1.8%, yields decreased by 1.4%, production decreased by 3.2%, nominal price increased by 26% and nominal total value increased by 22.6%.

The top California counties in terms of alfalfa hay production were Imperial, Kern, Tulare, Fresno, and Merced counties (NASS, 2010a). The two counties included in our case studies which produce alfalfa hay are Fresno and Stanislaus. In 2009 Fresno produced a total of 651,000 tons of alfalfa hay (a 5.2% increase since 1999) on 87,100 acres (a 7% increase). Yields per acre were 7.47 tons/acre (a 1.7% decrease), and the price per acre in the county was $124 (an increase in nominal dollars of 38%). The total value of alfalfa in Fresno was $80,724,000, a 45.8% increase since 1999 (CCAC 2010). This accounted for 8.4% of California's alfalfa hay production, or 0.9% of total US production. Alfalfa accounted for 1.5% of the total value of crop sales in Fresno (Fresno County, 2010). In 2009 Stanislaus produced a total of 301,000 tons of alfalfa (a 3.4% decrease since 1999) on 41,810 acres (a 6.7% increase), with per acre yields of 7.20 (a 9.4% decrease). The price of alfalfa per acre in the county was $121 per ton (a 20% increase in nominal terms), resulting in a total value of $36,421,000, a 15% increase (CCAC, 2000; CCAC, 2010). Stanislaus accounted for 3.9% of California alfalfa production, or 0.4% of total US production. Alfalfa was 1.6% of the value of all crops produced in Stanislaus in 2009 (Stanislaus County, 2010).

Table 3.3.1 Value of Annual Production, Imports and Exports: Alfalfa Hay, 2005-2009
(1000s of nominal US $)

Value of Production	2005	2007	2009
California	964,172	1,198,075	714,375
Fresno County	86,067	93,292	55,710
Stanislaus County	43,953	39,248	31,618
US Overall	6,366,064	7,810,619	6,676,402
Imports	2,430	6,800	3,848
Exports	165,087	171,249	354,253

Sources: CCAC 2005-2009; FAS 2011.

The United States is a net exporter of alfalfa hay, although trade is a trivial share of production. The value of alfalfa hay imports is approximately one-tenth of one percent of domestic production, while the U.S. exports approximately 2% of domestic production. The primary sources of U.S. alfalfa hay imports are Canada and Mexico. Japan, South Korea, and Taiwan are the three largest importers of U.S. alfalfa hay (NASS, 2010b).

Although alfalfa hay has a relatively low sales value per acre, it is more valuable when the values of soil services are included. Alfalfa is often grown in rotation with other crops partially because it adds nitrogen to soil through a process called nitrogen fixation. It also improves soil structure (CAFA, 2004). Partially as a consequence of its non-revenue benefits, alfalfa hay was the fifth most planted crop in Fresno County in 2007.

Alfalfa hay is an intermediate good. It is not directly consumed by humans, but rather is utilized as an input in the production of red meat, milk and live animals. Alfalfa demand is driven by demand for these final goods. The domestic per capita consumption of red meat (beef, lamb, pork, and veal) and dairy products (fluid milk and cream, butter, cheese, frozen dairy products, evaporated and condensed milk, dried milks, and dried whey) decreased over the last decade. Comparing the three-year average for 2005-2007 to the one for 1995-1997, the average per capita availability of red meat decreased 1% (ERS, 2009b). This decline was driven by a 2% decrease in the average per capita availability of beef, which accounted for 58% of red meat consumption in 2007. The decline in beef demand continues today: beef demand dropped by 8.6% between 2007 and 2010. The average per capita availability of dairy production decreased 5% over the same comparison period. This decline was driven by a 7% decrease in the average per capita availability of fluid milk and cream, which accounted for 58% of dairy product consumption in 2007 (ERS, 2009b). As a result of these declines in domestic red meat and dairy consumption, the domestic demand curve for alfalfa may have shifted in over the last decade.

Over the last decade, the nominal value of alfalfa hay, dairy product, and red meat exports and imports increased. Comparing the three-year average for 2005-2007 to the one for 1995-1997, the average nominal value of alfalfa exports increased by 101%, and the average nominal value of alfalfa imports increased by 46% (FAS 2011). The alfalfa trade surplus expanded over the last decade. The United States shifted from being a net exporter to a net importer of red meats over the last decade, while simultaneously shifting from being a net importer to a net exporter of dairy products. The average nominal value of dairy product exports increased by 165%, the average nominal value of livestock exports increased by 21%, and average nominal value of red meat exports increased by 9%. The average nominal value of dairy product imports increased by 114%, the average nominal value of livestock imports increased by 54%, and the average nominal value of red meat imports increased by 137% (FAS, 2011). The trends described above imply an expansion of foreign consumption of U.S. alfalfa directly and indirectly through other products, an expansion of the indirect domestic consumption of foreign produced feed inputs through imported meats, livestock, and dairy products, and an ambiguous change in the indirect domestic consumption of domestic alfalfa due to the possible re-importation of domestic alfalfa through foreign livestock and meat. The net effect of these trends on the demand for U.S. alfalfa over the last decade is difficult to determine.

Domestic demand for California alfalfa is inelastic. Konya and Knapp (1988) estimate an own-price elasticity of demand for California alfalfa of -0.17, which is similar to the estimate of -0.107 found by Russo et al. (2008). Konya and Knapp (1988) estimated elasticities of domestic demand for California alfalfa with respect to the number of cattle and an index of beef and milk prices, which they found to be 0.78 and 0.11, respectively.

The supply of California alfalfa is inelastic. Konya and Knapp (1988) estimated an own-price elasticity of supply for California alfalfa of 0.13, while Russo et al. (2008) estimated one of 0.133. This is consistent with an important production characteristic of alfalfa: It is a perennial crop, so planting alfalfa is a multi-year decision (CAFA, 2004).

3.3.1.b Key potential impacts of draft regulations

Alfalfa growers will not leave buffers unplanted or untreated when an alternative treatment is available. Due to differences in cost and efficacy, growers are most likely to treat buffers with alternative materials and continue to use regulated materials on the remainder of the field, although some growers may choose to move to alternative materials.

The most important active ingredients for alfalfa production that will be prohibited for use in buffers are chlorpyrifos (Lorsban 4EC), used for control of various aphid species and alfalfa weevil; and pendimethalin (Prowl H20) and Trifluralin (Treflan TR-20), used for pre-emergent weed control on established alfalfa.

<u>Alternatives to chlorpyrifos in alfalfa production</u>. The current label for Lorsban 4E specifies a buffer of 25 feet for ground boom applications and 150 feet for aerial applications adjacent to "permanent bodies of water such as rivers, natural ponds, lakes, streams, reservoirs, marshes,

estuaries, and commercial fish ponds" (Dow AgroSciences n.d.) Lorsban Advanced, registered in California in 2010, has the same buffer indoxacarb (Steward) as a treatment for alfalfa weevil. Some growers use indoxacarb for the first two aerial applications in their pest management program and use chlorpyrifos in later applications. Others have moved to using only indoxacarb. However, indoxacarb does not provide as consistent control of alfalfa weevil as chlorpyrifos does. In the Delta, several growers have experimented with aerial spraying chlorpyrifos up to a buffer, and then landing and reloading the plane and spraying the buffer with indoxacarb. Application costs were increased considerably, although the pest control was good. Material costs per acre are also higher.

Lambda-cyhalothrin (Warrior II with Zeon), a pyrethroid, is another alternative for alfalfa weevil control. However, it is listed in the draft regulations as a regulated active ingredient. It may be possible to utilize other pyrethroids that are not listed in the proposed regulations.

Aphids are another important economic past of alfalfa. Parasites and predators may provide some/adequate control, but not for high levels of pest pressure. Chlorpyrifos is used to treat aphids**.** UC IPM guidelines list Lorsban 4EC and Dimethoate 2.67 EC (dimethoate) as treatments for cowpea aphid, spotted alfalfa aphid, blue alfalfa aphid and pea aphid (UC IPM A 2008). Dimethoate is also on the draft regulations list of regulated active ingredients. There are no buffer zone requirements on the Dimethoate 2.67 EC label, so the draft regulations would have an incremental effect owing to changes in the treatable area as well as the definition of sensitive aquatic site.

<u>Alternative approaches for weed control.</u> Most active ingredients recommended by the UC IPM guidelines for pre-emergent use on established alfalfa are listed in the draft regulations: pendimethalin (Prowl H20), trifluralin (Treflan TR-20), diuron (Karmex DF, Direc 4L), norflurazon (Solicam DF), hexazinone (Velpar), and metributzin (Sencor) (UC IPM A-H 2009). Only EPTC (Eptam) and flumioxazin (Chateau) are not on the list of regulated active ingredients. Pendimethalin is a very important pre-emergent herbicide for alfalfa. Prowl is a liquid, and can be applied in a tank mix with other materials. Trifluralin, in contrast, is granular and requires a separate application.

The draft regulations do not appear to limit post-emergence herbicide alternatives for weed management in established alfalfa to the same extent. Consequently, there is the potential that if the draft regulations are implemented for growers to utilize more post-emergence herbicides. If this occurs there may be unanticipated economic and environmental effects. The economic implications of such a shift are outside the scope of this analysis.

<u>Other factors affecting the potential costs of the draft regulations.</u> Some alfalfa growers in the Delta are transitioning from aerial applications to ground applications in order to manage pesticide drift. Making the transition is costly, because it requires new equipment, and it requires more labor (and machine time) on an ongoing basis. Some growers have obtained better control after transitioning. Altering the application method reduces the size of the

applicable buffer in the draft regulation from 150 ft. to 25 ft. It is also not extremely expensive to reload with a different material for buffer treatment.

To the extent that use of the listed active ingredients occurs during the dormant season, the incremental effect of the draft regulations will be negligible due to the effects of existing regulations regarding dormant pesticide applications. This statement does not imply that there are no economic costs of the existing regulations; it simply means that growers incur those costs already.

3.3.1.c Analyzed impacts

Three potential impacts are evaluated jointly in the partial equilibrium analysis: the effect of using indoxacarb instead of chlorpyrifos to control alfalfa weevil, the loss of chlorpyrifos as a means of controlling aphids, and the effect of using a non-regulated active ingredient for pre-emergence weed control.

Alfalfa weevil control. We assume that Lorsban 4E (chlorpyrifos) is used except in the buffers, where Steward (indoxicarb) is used. Both are applied aerially, so the 150-ft. buffer applies. Alfalfa yields are reduced by 12% in the buffer (Godfrey and Putnam 2002).[5] The per acre cost of the pesticide material is 60% higher on acreage treated with indoxacarb.

Aphid control. We assume that Lorsban 4E (chlorpyrifos) is used except in the buffers. Because the UC IPM guidelines do not recommend any pesticides with active ingredients that are not listed in the draft regulations, the buffer is assumed to be untreated. Alfalfa yields are reduced by 60% in the buffer (Sharma and Stern 1976).[6] Due to this dramatic yield loss, it is assumed that growers will transition to ground spraying in order to reduce the buffer size to 25 ft. Because the buffer is untreated, the per acre cost of the pesticide material decreases by 100%.

Pre-emergence weed control. We assume that Prowl H20 (pendimethalin) is used except in buffers, where Chateau (flumioxazin) is used. These active ingredients were chosen because they had the largest acreage in their comparison groups (listed and not listed in the draft regulations, respectively). We specify a 150 foot buffer because the base treatment is an aerial application. In the absence of data regarding changes in yield or quality, only a change in the cost of treatment is considered. The same application method is used, so only the change in the

[5] Comparison of yields from Lorsban (1.5 pints per acre) and Steward SC (4.6 oz. per acre) in Godfrey and Putnam (2002). One important caveat regarding the use of this yield effect id that Steward SC has been replaced by Steward EC, so that the effects on yields may differ even if the application rate is the same. The label rate for treatment of alfalfa weevil is 6.7 to 11.3 fluid ounces per acre. Another caveat is that the trials used a backpack sprayer rather than an aerial application.

[6] This comparison of yields is based on one of Penncap M (methyl parathion, air-applied, 6 oz. per acre) and untreated acreage in Sharma and Stern (1976). Important caveats regarding the use of this yield effect in the analysis include that the tested active ingredient is a different organophosphate no longer registered for use in alfalfa, results from two untreated controls were averaged to compute the percentage yield loss, and changes in alfalfa varieties and management practices over time may have altered the effects of not treating for aphids.

cost of the material itself is evaluated. The treatment cost per acre increases by 59% for acreage treated with flumioxazin instead of pendimethalin.

3.3.2 Almond

3.3.2.a Economic profile

In 2009, almonds were the fourth highest value crop grown in California, earning a total value of $2.365 billion, or 6.8% of the total value of California production. California remained the only state that grew almonds commercially in the country, accounting for 99% of the U.S. almond production (NASS, 2010a). 773,029 acres were planted in almonds in California in 2009, a 49% increase from 1999 (CCAC 2000, 2010). Yields were 0.96 tons per acre, an 8% increase since 1999. Production was 741,825 tons, a 62% increase. The most important factor was improved management techniques that allowed for a greater number of trees per acre and a smoothing of the cyclical nature of nut tree yields (ERS, 2008). The price per ton of almonds in California was $3,189, an 88% increase since 1999 (CCAC 2000, 2010). Because both production and price of almonds increased substantially over the past decade, there was a very dramatic increase in the total value of California almond production: 204%.

Counties in our case studies which produce almonds include Fresno, Stanislaus, Colusa, and Butte. All of these counties saw increases in almond acreage, nominal price, yields, production, and total nominal value from 1999-2009. Some of the increases were very substantial (NASS 2010a).

Fresno is the top almond producing county in California, with 121,000 acres of almonds in 2009. At yields of 1.16 tons/acre, the highest productivity in the state, total production in 2009 was 140,000 tons. The price per ton in Fresno was $3,376, leading to a total value of production of $474 million. Almond prices in Fresno have increased 86% since 1999, in nominal terms. Harvested acreage increased by 112%, yields increased by 7.4%, and total production increased by 127%. The total nominal value of almond production increased by 320% (CCAC 2000, 2010). Almonds were the fourth most important crop in Fresno County in 2009, accounting for 8.8% of the total value of all crops (Fresno County, 2010).

Stanislaus is another important county for California almond production. In 2009 there were 134,003 acres of almonds, a 51% increase from 1999. Yields were 1.00 tons/acre, the same as a decade earlier, and total production was 134,000 tons, a 53% increase. The price per ton was $3,400 per ton, an increase in nominal dollars of 116% from 1999 and the highest price of all the counties studied. Total value of the almond crop in Stanislaus increased by 231% in nominal terms, to $456 million (CCAC 2000, 2010). Almonds were the second most important crop in Stanislaus County in terms of value, accounting for 19.7% of the total value of all crops (Stanislaus County, 2010).

Butte and Colusa have lower almond production than Fresno and Stanislaus, though production and value are on the rise in both counties. Butte had 38,548 acres of almonds in 2009, a 3.6% increase since 1999, yields of 0.76 tons/acre (a 24.6% increase), and total production of 29,296 tons (a 29% increase). The price per ton of almonds was $3,100 (an increase in nominal dollars of 88% since 1999), and total value of the almond crop in Butte County was $90.8 million (a 143% increase). Almonds were the third most important crop in Butte in terms of value, contributing 17% of the total value of all crops (Butte County, 2010). Colusa had 36,050 acres of almonds in 2009 (a 75% increase since 1999), yields of 1.05 (a 78% increase), and total production of 37,853 tons (a 212% increase). The price per ton was the same as in Stanislaus, at $3,400, leading to a total value of $129 million, an increase in nominal value of 524% since 1999 (CCAC 2000, 2010). Almonds were the second most important crop in Colusa in terms of value.

Worldwide, the U.S. is the largest producer of almonds followed by Spain, Australia, and Turkey. Virtually all almond production occurs in California's Central Valley. Fresno produces approximately 20% of California's almonds, Stanislaus produces 19%, Butte produces 4% and Colusa produces 5.5% (CCAC 2010). The United States imports few almonds, while California exports approximately two-thirds of its production. Spain, Germany, and India are the largest importers of California almonds (Boriss and Brunke, 2009b).

Table 3.3.2 Value of Annual Production, Imports and Exports: Almonds, 2005-2009

(1,000s of nominal U.S. $)

Value of Production	**2005**	**2007**	**2009**
Fresno County	453,720	477,540	472,640
Stanislaus County	473,043	465,800	455,600
Butte County	187,391	133,170	90,817
Colusa County	121,968	122,677	128,699
California	2,415,432	2,161,583	2,365,834
Other U.S.	--	--	--
Imports	6,854	17,592	5,994
Exports	1,471,441	1,524,139	1,422,644

Sources: CCAC 2005-2009, FAS 2011.

Almond yields are highly variable (Russo et al., 2008). California almond producers are partially protected against low production years in two ways. First, yield per tree (nuts per tree) is inversely related to kernel size (as measured in weight). When the average number of nuts per tree is below average, average kernel size is larger than average; larger nuts fetch a premium in the market. The inverse is also true. When the average number of nuts per tree is higher, almond kernel size tends to be smaller. This results in a lower average price per nut (ERS, 2008; ERS, 2007b; ERS, 2005a). Second, demand for almonds is inelastic. This implies that as supply decreases, prices will increase by an amount sufficient to compensate for this loss of sales.

There are two major market institutions in the California almond industry: Blue Diamond and the Almond Board of California. Blue Diamond is a grower cooperative that is owned by two-thirds of California growers. It markets one-third of all California almonds. The Almond Board of California is the federal almond marketing order. The Almond Board imposes a check off in order to fund research and market promotion. The Board also has the authority to regulate quality and volume. To this end, the Board administers an almond reserve. The large increase in production discussed above has resulted in large almond stocks in recent years, which will exert downward pressure on future almond prices in the absence of outward shifts in the demand for almonds (ERS 2008).

The domestic consumption of almonds has increased in recent years, and U.S. almond exports have also expanded. U.S. per capita availability more than doubled from 0.56 lbs./person in 1997 to a record high of 1.24 lbs./person in 2007 (ERS, 2009a).[7,8] Comparing the three-year average for 2005-2007 to the three-year average for 1995-1997, the average annual per capita domestic availability of almonds increased 76.6%. This is at least partially the result of a shift outward in the domestic demand curve for California almonds. This shift has been driven by the increased popularity of international dishes, the marketing of the health benefits of almonds by the Almond Board of California, and an increase in government procurements (ERS, 2008; Boriss and Brunke 2009b).

Worldwide demand for U.S. almonds has shifted out in recent years (ERS 2007b). Again, comparing the three-year average for 2005-2007 to the three-year average for 1995-1997, the average annual value of U.S. almond exports increased 121%. This trend is expected to continue as per capita incomes rise in developing nations (ERS 2007b).

As mentioned earlier, the demand for almonds is inelastic. Green (1999) estimated a world own-price elasticity of demand for California almonds of -0.83, while Alston et al. (1995) estimated one of -1.05. A more recent study estimated a domestic own-price elasticity of demand of between -0.35 and -0.48 (Russo et al. 2008).

The supply of California almonds is also inelastic, due to a number of characteristics of almond production. Russo et al. (2008) estimated a short-run domestic own-price elasticity of supply of 0.12. This estimate supports economic theory that implies that the supply of California almonds is likely inelastic. Almonds are a perennial with a productive life of twenty to twenty-five years, so planting almond orchards is a long-run investment. There are multiple years between planting an orchard and the initial commercial harvest, so it takes three to four years for new production to enter the market place. Furthermore, if a perennial crop must be removed prior to planting the orchard, the removal of trees or vines is an added expense.

Recent years have been marked by record harvests due to acreage expansion. Demand will need to continue to shift outward in order to maintain the total value and the value per acre of California almond production. Otherwise, a significant decrease in price may occur. In the short run, a slowing or reversal of demand expansion below the currently expected rates would

---

[7] Food availability is an estimate of domestic consumption per capita. Food availability, which is measured at the farm level, is the amount of a commodity in terms of tonnage that is used up in the United States on a per capita basis. This estimate is equal to the total value of domestic production plus the value of net exporters divided by the U.S. population.

[4] The United States is the largest consumer of California almonds; the majority of which is consumed through processed foods.

reduce the price of almonds. Orchard acreage is relatively fixed in the short-run, so the price of almonds must decline in the short-run to equate supply and demand. In the long run, growers will respond to lower prices by removing acreage from almond production. As a consequence, the price of almonds will increase until a new equilibrium is reached.

Two recent increases in almond production costs may influence growers' planting decisions. First, the California almond industry implemented a mandatory pasteurizing rule for raw almonds in 2007. Second, the recent outbreak of colony collapse disorder doubled the cost of renting hives for honeybee pollination (Boriss and Brunke, 2009b). These cost increases would shift in the California almond supply curve in the medium and long-run, all else equal. If other cost-saving measures are not found, or if demand does not shift out sufficiently, these cost increases may result in a decline in California almond production in the medium and long-run.

3.3.2.b Key potential impacts of draft regulations

Growers will not leave buffers untreated. They may move to alternatives for buffer areas only, or for the entire orchard. Their choices regarding whether to use different management approaches for buffers and remaining acreage will vary depending on the primary pest management concern, previous pest pressure, the alternative chosen, the irrigation system, and other pesticide use regulations, among other considerations. There are regional differences in pest pressure; the southern San Joaquin Valley faces greater pressure than the northern San Joaquin Valley and the Sacramento Valley. Current patterns of pesticide use and differences in treatment costs suggest, however, that growers will use alternatives only in the buffers.

This discussion focuses on two effects of the draft regulations: weed control and the loss of esfenvalerate for peach twig borer and navel orangeworm and lamba-cyhalothrin for peach twig borer management. Cultural practices are an important part of integrated pest management for almonds. This discussion assumes that growers engage in recommended cultural practices.

Weed control. Weeds compete with young almonds. Once an orchard is in full production, weeds continue to compete for water, although this is less important. Weeds disrupt sprinkler spray, and can interfere with irrigation equipment (UC IPM-A-IWM 2009). Many growers use a pre-emergence application of oxyfluorfen (Goal) and oryzalin (Surflan) as part of a weed control program. Glyphosate, which is not listed in the draft regulations, is used for post-emergence spot treatments of weeds, and may be applied prior to harvest to the entire orchard. The use of alternative pre-emergence treatments may increase the need for later spot treatments.

Peach Twig Border and Navel Orangeworm control: esfenvalerate and lamba-cyhalothrin. Esfenvalerate and lambda-cyhalothrin are pyrethroids that were introduced as substitutes for organophosphates. Chemical controls are only part of a management program for these pests. Field sanitation is particularly important for navel orangeworm control; chemical treatments alone provide only about 50% control, and untreated orchards have exhibited damage of up to 30% (Pickel 2002). In addition to direct damage, the navel orangeworm has been linked to fungi responsible for aflatoxins (Heintz 2000), a serious food safety risk. A single aflatoxin contamination event could have significant adverse effects on the demand for California almonds. Peach twig borer is a major almond pest and may contribute to problems with navel orangeworm as well (Pickel 2002). Yield losses of more than 30% have been observed in untreated orchards (Pickel 2002).

Esfenvalerate and lambda-cyhalothrin are dormant season treatments for peach twig borer. The UC IPM Pest Management Guidelines offer a number of alternative dormant season treatments. Spinosad (Entrust or Success), spinetoram (Delegate), and narrow range oil plus diflubenzuron (Dimilin) are not listed in the draft regulations. In addition to esfenvalerate and lambda-cyhalothrin, bifenthirn (Brigade), permethrin (Ambush), and cyfluthrin (Baythroid) are listed in the draft regulations (UC IPM A-PTB 2009). The insecticide use patterns in all four counties suggest that growers prefer the listed active ingredients to the alternatives provided in the UC IPM Guidelines (DPR 2009).This trend was more pronounced in the southern counties, i.e., growers their preferred to use insecticides flagged in DPR's draft regulations.

Esfenvalerate is listed as a hull split spray for navel orangeworm. The UC IPM Guidelines for navel orangeworm management list several alternatives. Azinphosmethyl[9] (Guthion) and chlorpyrifos (Lorsban) are also listed in the draft regulations. Methoxyfenozide (Intrepid), spinetoram (Delegate), Bt, phosmet (Imidan), and spinosad (Success, Entrust) are not listed in the draft regulations. As was the case for peach twig borer, growers treat substantially more acres with the active ingredients listed in the draft regulations than with the other active ingredients, according to 2009 PUR data.[10] Fresno growers used a greater proportion of active ingredients listed in the draft regulations than growers in the other counties which is consistent with the greater pest pressure faced by almond growers in the southern San Joaquin Valley. Goodhue, Klonsky, and Mohapatra (2010) find that production region is a statistically significant determinant of growers' use of organophosphates, and that growers in the southern San Joaquin Valley were more likely to use organophosphates and to apply them to a greater share of their almond acreage when they do use them.

Another factor to consider when examining information regarding treated acreage is that an application in one season may suppress populations in the following season. Thus, considering treated acreage in one year may understate the importance of chemical treatments- and specific active ingredients- to integrated pest management programs.

3.3.2.c Analyzed impacts

Two potential impacts are considered in the partial equilibrium analysis: the effect on weed management and the effect on navel orangeworm and peach twig borer management. Growers use a wide variety of weed management programs; we consider only one, simple

[9] A negligible amount of this active ingredient was applied in Butte County in 2009. None was applied in Colusa or Fresno Counties.

[10] While these comparisons provide a measure of the relative importance of the active ingredients in the three counties, it is important to keep in mind that the active ingredients are used to treat other pests as well as navel orangeworm.

possibility. As noted above, pest pressure is recognized to vary across regions. Here we limit attention to scenarios where growers use alternative treatments only in the buffers.

Weed control. We consider only effects on orchards in full production. This understates the cumulative effects over the life of the orchard because competition from weeds is more important for young trees. No data regarding future implications for vigor and production were available to guide choices of impacts, so the effects from competition during orchard establishment years were not considered.

We specify that Goal is ground-applied pre-emergence in the base treatment, and that it is replaced by Matrix under the draft regulations. This replacement increases the cost of spot treatments with glyphosate later in the season. The 25-ft. buffer applies. The net effect on pesticide material costs is a 19% decline in pesticide material costs. Owing to lack of data, we do not consider how greater weed pressure could increase labor and material costs for management and repair of irrigation systems. Yields remain unchanged.

Peach twig borer and navel orangeworm control. We consider only effects on orchards in full production. Based on pesticide use reporting data, in the base scenario Warrior II with Zeon (lambda-cyhalothrin) and Asana XL (esfenvalerate) are applied in Stanislaus County, esfenvalerate is applied in Butte and Colusa Counties, and Asana XL and Intrepid 2F (methoxyfenozide) (not listed in the draft regulations) are applied in Fresno County. The 100-ft. buffer applies. Under the draft regulations, all counties would treat with spinosad. Two scenarios are considered: yields are unchanged and yields decline by 15%.[11] Insecticide material costs increase by 236% in Stanislaus County and 449% in Butte and Colusa Counties. The cost of replacing esfenvalerate with spinosad in Fresno County increases the cost of including a second active ingredient in the pest management program by 449%. These dramatic percentage increases are driven by the relatively high cost of the spinosad treatment.

[11] The 15% yield decrease scenario is based on statements in Pickel (2002) regarding yields in untreated, infested orchards (30%) and the extent to which chemicals can provide control (50%); the 15% yield loss used here is not specified directly.

3.3.3 Grapes

3.3.3.a Economic Profile

California has the highest production of table, raisin and wine grapes of all the states in the U.S. It accounts for over 90% of production of all grapes, and over 99% of commercial production of raisin and table grapes (NASS, 2010a). Grapes, aggregated, was the second most valuable agricultural commodity in California in 2009, after milk and cream, accounting for 9.4% of the total value of agricultural production. The value of grapes production in California can be broken down as follows: 12.5% raisin grapes, 28.5% table grapes, and 59% wine grapes (CCAC, 2010).

There was a 12% increase in the value of all grapes between 2008 and 2009, and a 23% increase in the value of wine grapes (NASS, 2010a). Overall, acreage of raisin grapes has been increasing in California over the past decade, though yields have declined significantly and thus production has declined. Acreage for table grapes has also declined, but yields have increased. The net effect is that production has decreased slightly. Wine grape acreage overall in California has also declined by a small margin, though there have been increases in acreage in some counties. Yields and production have both increased over the past decade. Nominal prices of all three types of grapes increased in California from 1999-2009. The total nominal value of raisin grapes declined over that time period, but total nominal value of the other two types increased, with wine grapes experiencing the biggest growth in value.

In 2009 there were 150,316 acres of raisin grapes in California (a 17% increase since 1999), yields were 2.13 tons/acre (a 77% decrease), production was 407,715 tons (a 73% decrease), the price was $946 per ton (a 223% increase in nominal terms), and total value was $385,701,300 (a 13% decrease in nominal terms) (CCAC 2000, 2010). That same year there were 90,837 acres of table grapes in California (a 22.5% decrease since 1999), yields were 8.9 tons/acre (a 16% increase), production was 810,977 tons (a 9.4% decrease), the price was $1,590 per ton (an increase in nominal dollars of 37%) and total value was $1,289,726,000 (a 25% increase) (CCAC 2000, 2010). Wine grape acreage was 554,931 in 2009 (a 2.2% decrease from 1999), yields were 7.2 tons/acre (an 18.5% increase), production was 4,010,037 tons (a 19.5% increase), the nominal price was $667 on average (a 25% increase) and total nominal value of wine grapes was $1,896,278,500 (a 41% increase) (CCAC 2000, 2010).

The primary raisin grape producing counties in California are Fresno, Madera, Tulare, Kern and Kings. Of these, Fresno is our only case study; it accounts for 71% of total raisin production value in the state (Fresno County, 2010). There were 112,620 acres of raisin grapes in Fresno in 2009 (a 50% increase since 1999), yields were 2.1 tons/acre (an 85% decrease), production was 240,000 tons (a 78% decrease), the nominal price was $1,136 per ton (a 290% increase), and total nominal value was $272,640,000 (a 13% decrease) (CCAC 2000, 2010). Grapes as a whole are the most valuable crop in Fresno County, accounting for 12.4% of the total value of its agricultural production. Raisin grapes account for 41% of that total, table grapes for 29%, and wine grapes for 30% (CCAC 2010).

The major table grape-producing counties in California are Kern, Tulare, Fresno, Riverside, and Madera. Fresno is our only case study. It contributes 14.9% of California table grape production value. In 2009 there were 15,099 acres of table grapes in Fresno (a 39% decrease from 1999), yields were 9.1 ton/acre (a 73% increase), production was 137,000 tons (a 5.6% increase), the nominal price was $1,398 per ton (a 42.5% increase) and total nominal value was $127,218,000 (a 50% increase) (CCAC 2000, 2010).

The top wine grape producing counties in California are Napa, Sonoma, San Joaquin, Monterey, and Fresno. Our case studies include Monterey and Fresno, plus Santa Barbara. Although Santa Barbara is not among the most important grape-producing counties for the state, production is an important component of its total agricultural revenue. Monterey accounts for 9% of wine grape production value in California, Fresno for 7.6%, and Santa Barbara for 5.2% (NASS, 2010a).

Grapes are the fifth most valuable agricultural commodity in Monterey, accounting for 6% of total production value in the county; essentially all of the grapes grown in Monterey are wine grapes (NASS, 2010a). In 2009 there were 41,114 acres of wine grapes in Monterey (a 20% increase since 1999), yields were 5 tons/acre (a 43% increase), production was 205,000 tons (a 15.8% increase), the nominal price was $1,161 per ton (a 12.4% decrease) and the total nominal value was $238,082,000 (a 51% increase) (CCAC 2000, 2010).

Fresno had 67,376 acres of wine grapes in 2009 (a 48% decrease since 1999), yields of 12.5 tons/acre (a 131.5% increase), production of 803,560 tons (a 15.8% increase), a price of $253 per ton (a 6.8% increase) and total value of $203,428,000 (a 23.5% increase) (CCAC 2000, 2010).

Wine grapes were the third most valuable agricultural commodity in Santa Barbara in 2009, accounting for 11% of total value (NASS, 2010a). There were 22,050 acres of wine grapes (a 57% increase from 1999), yields of 4.5 tons/acre (a 50% increase), production of 99,225 tons (a 136% increase), a price of $1,385 per ton (a 3% decrease), and total value of $137,426,600 (a 129% increase) (CCAC 2000, 2010).

U.S. per person consumption of table grapes has increased over the last three decades from 2.9 pounds per capita in 1970 to 7.5 pounds in 2003. Since 1985, per capita consumption has remained around 7-8 pounds per person. U.S. table grapes are marketed mainly from May through December with Southern California accounting for much of the early season crop and Central California accounting for the later supply (Boriss and Brunke, 2006a). U.S per capita consumption of raisins has remained relatively unchanged since 1999, at 7 pounds per capita on a fresh weight basis. This is a 2.8 pound decrease from the height of consumption in 1988 at 10.8 pounds per capita (Boriss and Brunke, 2006b).

China is the leading producer of fresh-market grapes worldwide, followed by Italy, Chile, and then the US. Historically, just over one-third of U.S. domestic production of fresh grapes is exported. The value of U.S. fresh grapes exports totaled $588 million in 2009. The primary destinations for US exports are Canada and China (Boriss and Brunke, 2006a). The US is a net exporter of raisins, with only $28 million worth of raisin imports in 2009 and $286 million in raisin exports. The U.S. was the second largest exporter of raisin in the world in 2004, after Turkey. The primary destinations for U.S. raisin exports are the EU (especially the UK), Japan, and Canada (Boriss and Brunke, 2006b).

The U.S. is a net importer of fresh grapes, importing roughly $1.05 billion worth of table grapes in 2009. The value of U.S. exports has increased substantially over the past several decades, but the value of imports has increased at a greater rate. The primary sources of US grape imports are Chile, which supplies about 70% of fresh grape imports, and Mexico, which supplies 28% (Boriss and Brunke, 2006a). Most fresh grapes are imported during the off-season months of California production.

Table 3.3.3 Value of Annual Production, Imports and Exports: Raisin Grapes, 2005-2009
(1,000s of nominal U.S. $)

Value of Production	**2005**	**2007**	**2009**
Fresno County	219,816	341,061	272,640
California	340,887	448,083	567,894
Other U.S.	--	--	--
Imports- Raisins	33,367	37,545	28,000
Exports- Raisins	210,332	212,815	285,926

Sources: CCAC, 2005-2009; FAS, 2011.

Table 3.3.4 Value of Annual Production, Imports and Exports: Table Grapes, 2005-2009
(1,000s of nominal US $)

Value of Production	**2005**	**2007**	**2009**
Fresno County	138,573	117,707	191,570
California	1,034,350	1,180,684	1,289,726
Other US	--	--	--
Imports- Fresh Grapes	944,452	959,616	1,048,294
Exports- Fresh Grapes	539,582	552,040	588,461

Sources: CCAC, 2005-2009; FAS, 2011.

Table 3.3.5 Value of Annual Production, Imports and Exports: Wine Grapes, 2005-2009
(1,000s of nominal US $)

Value of Production	2005	2007	2009
Santa Barbara County	160,365	99,919	137,427
Monterey County	254,615	251,604	238,082
Fresno County	196,162	154,942	203,428
California	2,722,371	2,331,152	2,676,113
Total US	3,129,162	2,619,272	3,006,868

Source: CCAC, 2005-2009

Henneberry et al. (1999) used a linear AIDS model to estimate a demand equation for several types of fruits and vegetables in the US as a whole. They estimated that the Marshallian own-price elasticity of demand of table grapes for the US as a whole is elastic, at -2.092. Nuckton (1978) estimated the own-price elasticity of demand for both raisin and wine grapes in California and found -0.27 for raisin grapes and -0.16 for wine grapes, both inelastic. Lave (1963) estimated that the own-price elasticity of supply for raisin grapes in the U.S. as a whole was inelastic, at 0.23. Volpe et al. (2008) estimated the own-price elasticity of supply for several varieties of California wine grapes and found inelastic values for all cases. There was a range of values between 0.29 and 0.85, depending on the variety. No studies were found in the literature which estimated the price elasticity of supply for table grapes.

3.3.3.b Key potential impacts of draft regulations

Growers will not leave buffers untreated. They may move to alternatives for buffer areas only, or for the entire vineyard. Their choices regarding whether to use different management approaches for buffers and remaining acreage will vary depending on the primary pest management concern, previous pest pressure, the alternative chosen, the irrigation system, and other pesticide use regulations, among other considerations. Current patterns of pesticide use and differences in treatment costs suggest, however, that growers will use alternatives only in the buffers. Within Fresno County, the relative importance of specific active ingredients listed in the draft regulations is different for wine grapes and other grapes, according to 2009 Pesticide Use Reports data.

This discussion focuses on two effects of the draft regulations: weed control and the loss of imidacloprid (Provado) for control of insects including leafhoppers, mealybugs, grapeleaf skeletonizer, and sharpshooters.[12] Cultural practices are an important part of integrated pest management for grapes. This discussion assumes that growers engage in recommended cultural practices.

[12] Mites are an economically important pest of California grapes; potential impacts on mite management are not discussed here.

Weed control. Weeds compete with young vines for resources. Here the focus is on established vineyards (UC IPM G-IWM 2008). Even when a vineyard is established, weed control improves growth and yield, particularly when growth is limited. Weeds can also affect the efficacy of irrigation by distorting water distribution patterns, and can promote other pests, including insects, mites, nematodes and small mammals, as well as disease (UC IPM G-IWM 2008). Weed management programs vary across regions, and even across vineyards due to a variety of factors disease (UC IPM G-IWM 2008).

This analysis focuses on pre-emergence chemical treatments for weed control. Based on recommended treatments under the UC IPM Guidelines, this is the category of treatments with the largest number (and share) of active ingredients listed in the draft regulations. Oryzalin, oxyflourfen, diuron, simazine, and pendimethalin are listed. Napropamide, flumioxazin, isoxaben (for non-bearing vines only), and rimsulfuron are not listed (UC IPM G-HTT 2010).

Herbicide use patterns vary considerably across the three study counties, according to 2009 PUR data. In Santa Barbara County, rimsulfuron accounts for a substantial share of herbicide-treated acreage. Acreage treated with any of the listed active ingredients in Santa Barbara County is equivalent to a smaller share of harvested acreage than in the other two case study counties.[13] This suggests that the impacts of the draft regulations would be smaller. Monterey County uses substantially more herbicides, and active ingredients listed in the draft regulations are much more important, particularly oxyflourfen, which is listed as a treatment for established weeds. Active ingredients listed in the draft regulations are a substantial share of herbicide treatments in Fresno County for wine grapes and other grapes. Oxyflourfen is particularly important for wine grapes and simazine is particularly important for other grapes.

Loss of imidacloprid for insect control. Imidacloprid (Provado 1.6) is registered for mealybugs and other grape pests, including leafhoppers, sharpshooters, and grapeleaf skeletonizer. Its label mandates buffers of 25 feet for ground application methods and 150 feet for aerial application as the draft regulations; consequently, the effect of the draft regulations on its use will depend on the definition of sensitive aquatic site as well as on the 75-foot difference in the mandated buffer width for air-blast applications. The label definition is "lakes; reservoirs; rivers; permanent streams, marshes or natural ponds; estuaries and commercial fish farm ponds" (Bayer CropScience n.d.).

There are four species of mealybug: grape, obscure, longtailed, and vine. Vine mealybug is a relatively recent invader. The importance of individual species varies by region (Daane et al. 2005). All species cause damage by excreting honeydew, which promotes black sooty mold, and by transmitting grape viruses (UC IPM 2008 G-MB; UC IPM 2008 G-VMB).

[13] Treated acres described here are not necessarily unique acres. That is, two treated acres may be two acres, each treated once or one acre, treated twice. Hence, we cannot state what percentage of harvested acres literally were given a specific treatment. We can only report treated acres as a percentage of harvested acres.

Most of the active ingredients suggested for mealybug management in the UC IPM Guidelines are listed in the draft regulations. Grape, obscure, and long-tailed mealybugs are addressed in the same set of recommendations. Buprofezin (Applaud) is the only recommended active ingredient not listed in the draft regulations. Imidacloprid, methomyl, and diomethoate are all listed (UC IPM 2008 G-MB). For vine mealybugs, buprofezin and acetamiprid (Assail) are recommended options that are not listed in the draft regulations. Chlorpyrifos, imidacloprid, methomyl, and diomethoate are all listed (UC IPM 2008 G-VMB). Clothianindin (Clutch 50 WDG), dinotefuran (Venom), and spirotetramat (Movento) are additional alternatives used currently but not included in the 2008 Guidelines.

Acreage equivalent to about a third of harvested acreage of non-wine grapes in Fresno County was treated with listed active ingredients, primarily imidacloprid. Acreage equivalent to about a fifth of harvested acreage of non-wine grapes was treated with active ingredients not listed in the draft regulations.

Wine grape use patterns vary considerably by region. Active ingredients listed in the draft regulations were used on a large percentage of harvested acres for our three counties, 37%, 45%, and 58% for Santa Barbara, Fresno, and Monterey, respectively. Imidacloprid was the most important of the listed active ingredients. There was relatively little use of non-listed active ingredients in Fresno and Monterey, 6% and 15% of harvested acres respectively, but potential alternatives were more important in Santa Barbara (45%). Dinotefuran and buprofezin were the main non-listed AIs for these counties.

3.3.3.c Analyzed impacts

Two potential impacts are considered in the partial equilibrium analysis: the effect on weed management and the effect on insecticide control when imidacloprid is no longer available for use in the buffer. Growers use a wide variety of pest management programs; we consider only one possibility per target pest.

<u>Weed control</u>. Only effects on established vineyards are considered. This understates the cumulative effects over the life of the vineyard because competition from weeds is more important for young vines. No data regarding future implications for vigor and production were available to guide choices of impacts, so the effects of competition during vineyard establishment years were not considered.

We consider two scenarios, chosen to bound the potential effects on costs and yields. The first scenario assumes that the entire field is treated with the alternative, and sustains a 5% yield loss. The second assumes that only the buffer is treated with the alternative, and sustains no yield loss. Intermediate scenarios where the entire vineyard is treated with the alternative and does not face a yield loss and where only the buffer is treated with an alternative and sustains a 5% yield loss are not reported. The 25-foot buffer applies.

The base and regulation treatments differ for wine grapes and other grapes. For wine grapes, we specify that oxyflourfen (Goal 2XL) is replaced by Matrix under the draft regulations.

flumioxazin (Chateau). We assume that growers choose to use the alternative rather than immediately incorporating Goal 2XL into the soil. There is a 35% decline in herbicide material costs for the pre-emergence treatment. Increased labor and material costs regarding any need for greater management and repair of irrigation systems due to greater weed pressure are not considered owing to a lack of data. For other grapes (Fresno only), we specify that simazine (Simazine 90) is replaced by flumioxazin (Chateau). We assume that growers choose to use the alternative rather than immediately incorporating Simazine 90 into the soil. There is a 24% increase in herbicide material costs for the pre-emergence treatment.

Loss of imidacloprid for insect control. Only effects on established vineyards are considered. We consider two scenarios, chosen to bound the potential effects on cost and yield. In the first scenario only the buffer is treated with the alternative, and does not sustain a yield loss. In the second scenario the entire field is treated with the alternative. Wine grapes sustain a 10% yield loss and other grapes sustain a 20% yield loss, owing to the greater damage caused by mealybugs to table grapes.[14] The 100-ft. buffer applies.

Treatments that would be used under the draft regulations differ for wine grapes and other grapes based on 2009 use patterns, although the base treatment is the same. In the base treatment imidacloprid (Provado) is applied. Buprofezin (Applaud), an insect growth regulator, is applied in the regulation treatment for wine grapes. Insecticide material costs for the application increase by 55%. Spirotetramat (Movento) is applied in the regulation treatment for other grapes. Insecticide material costs for the application increase by 260%. All treatments include two applications.

[14] Untreated infestations of mealybug can lead to complete losses (Daane et al. 2005). Central Coast Vineyard Team (2008) found no significant difference in damage between an untreated control and Applaud; however, populations were low (likely due to previous treatments using Lorsban), which reduces the likelihood of finding a statistically significant difference, all else equal. In the absence of more data these fairly conservative numbers were selected. Rather than being interpreted as annual losses on all vineyards, they can be interpreted as larger losses on some vineyards in any particular year.

3.3.4 Lettuce
3.3.4.a Economic profile
California is the largest producer of both leaf lettuce and head lettuce in the U.S. The state grows 79% of U.S. head lettuce and 85% of leaf lettuce (NASS, 2010a). Together, all lettuces (head, leaf and romaine) constituted the fifth most valuable crop in California in 2009, accounting for 5% of the total value of all crops in the state. Individually, leaf lettuce accounted for 1.6% of total value and head lettuce for 2.3% (CCAC, 2010). Acreage and production of head lettuce have declined in California over the past decade (CCAC 2000, 2010). In 2009 there were 100,952 acres of head lettuce in California (a 24% decrease from 1999), yields were 20.2 tons/acre (an 8.8% increase), production was 2,043,372 tons (an 18% decrease), the price of head lettuce was $390 per ton (an increase in nominal dollars of 58%), and total value was $796,716,300 (a 28.7% increase). Leaf lettuce, by contrast, saw a slight increase in acreage and production over the past decade, though there was a notable 10% drop in production between 2008 and 2009 (NASS 2010). Between those two years there was also an increase in romaine lettuce production by 16%, suggesting a shift in the relative attractiveness of these two crops for growers. However, this report will not address romaine lettuce specifically. In 2009 there were 73,461 acres under leaf lettuce production in California (a 1.2% increase from 1999), yields were 11.15 tons/acre (an increase of 27%), production was 805,285 tons (a 30.5% increase), the price was $502 per ton (a 6% increase) and total value was 410,690,900 tons (a 36% increase) (CCAC 2000, 2010).

The top lettuce-producing counties in California are Monterey, Imperial, Fresno, Santa Barbara, and San Luis Obispo (NASS, 2010a). Our analysis includes Monterey and Santa Barbara. Monterey accounted for 54.7% of the value of head lettuce production and 44% of the value of leaf lettuce production in California in 2009. Lettuce is the most valuable crop in Monterey, if leaf and head lettuce are aggregated. If they are counted separately, then strawberries are the most valuable crop, followed by head lettuce (10.9% of total production value), and leaf lettuce (6.2% of total production value). In 2009 there were 48,691 acres of head lettuce in Monterey (an 18.3% decrease since 1999), yields were 23.2 tons/acre (a 3% increase), production was 1,129,625 tons (a 16% decrease), the price was $386 per ton (a 64% increase) and total value was $435,952,000 (a 38% increase) (CCAC 2000, 2010). As for leaf lettuce, in 2009 there were 41,175 acres in Monterey (a 4% decrease from 1999), yields were 13.9 tons/acre (a 29% increase), production was 574,773 tons (a 23% increase), the price was $430 per ton (a 25% decrease) and total value was $247,243,000 (an 8% decrease) (CCAC 2000, 2010).

Santa Barbara is the fourth biggest producer of lettuce in California, contributing 7.8% of the total value of head lettuce production and 5.1% of leaf lettuce production value in 2009. If aggregated, lettuce is the fourth most valuable crop in Santa Barbara. Head lettuce alone is the fifth most valuable crop, accounting for 5% of the total value of agricultural production in the county, and leaf lettuce is the eighth most valuable, accounting for 2.3% of total value (NASS, 2010a). In 2009 there were 10,215 acres of head lettuce in Santa Barbara (a 22% decrease from 1999), yields were 16.4 tons/acre (a 9.5% increase), production was 167,702 tons (a 14.5% decrease), the price was $370/ton (a 76% increase) and total value was $62,049,800 (a 50.7%

increase) (CCAC 2000, 2010). By contrast, the value and acreage of leaf lettuce in Santa Barbara increased, though not as much as in Fresno. There were 4,074 acres of leaf lettuce in the county in 2009 (a 65% increase), yields were 9.75 tons/acre (an 8.8% decrease; this was the only region we studied which had a decrease in yields), production was 39,734 tons (a 50.4% increase), the price of leaf lettuce was $722/ton (a 102% increase) and total value was $28,687,700 (a 203% increase) (CCAC 2000, 2010).

Table 3.3.6 Value of Annual Production, Imports and Exports: Lettuce, 2005-2009
(1,000s of nominal U.S. $)

Value of Production- Head Lettuce	**2005**	**2007**	**2009**
Santa Barbara County	59,191	87,846	66,250
Monterey County	311,813	508,599	435,952
California	621,361	838,049	796,716
Total U.S.	1,011,976	1,247,941	1,155,468
Value of Production- Leaf Lettuce			
Santa Barbara County	23,976	25,705	28,688
Monterey County	176,258	196,662	247,243
California	449,934	472,172	559,010
Total U.S.	463,995	502,310	657,659
Imports- All Lettuce	20,047	33,314	52,577
Exports- All Lettuce	120,483	134,075	104,872

Source: CCAC, 2005-2009; FAS, 2011.

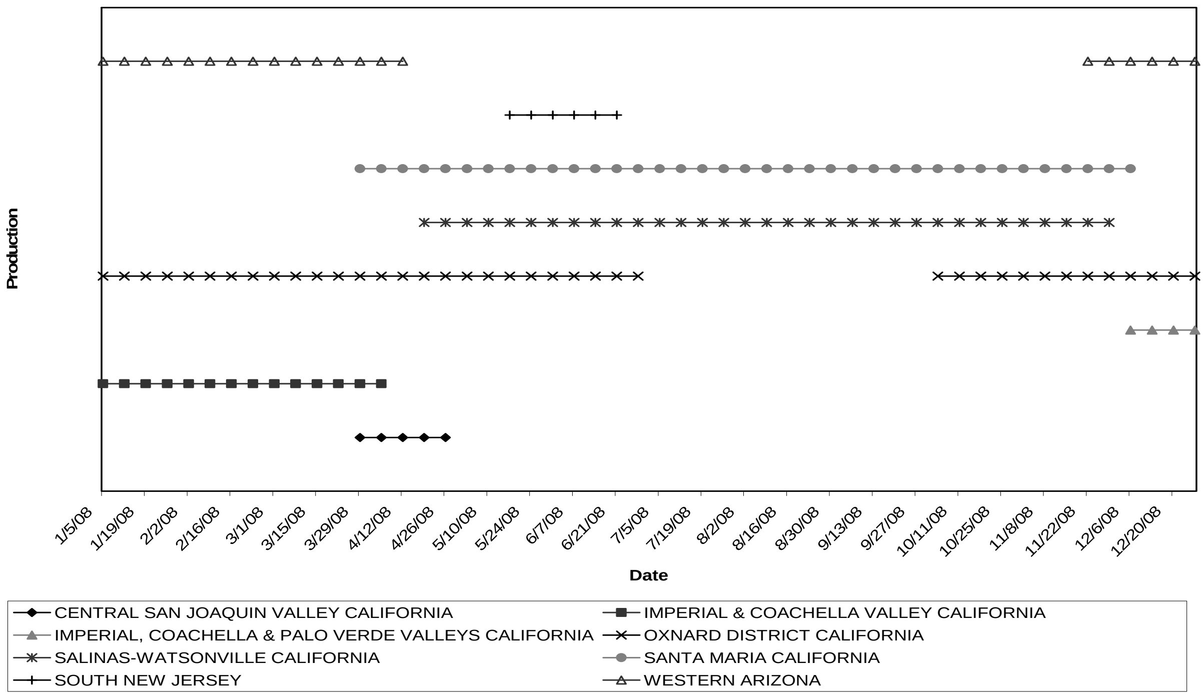
Leaf Lettuce- Domestic Demand, Exports and Imports

There are several types of lettuce: head lettuce (the most popular type of which is iceberg lettuce), romaine, butterhead lettuce (including Boston and Bibb) and loose leaf lettuce (green leaf, red leaf, and oak leaf). California County Agricultural Commissioners' Data (CCAC) reports four categories: lettuce head, lettuce leaf, romaine lettuce, and lettuce bulk salad products. Our report will only focus on the head and loose leaf lettuce categories.

The U.S. is a net exporter of leaf lettuce. Imports of leaf lettuce are approximately 3% as large as domestic leaf lettuce production, while U.S. exports are approximately 25% of domestic leaf lettuce production. Worldwide, the U.S. was the second largest producer of lettuce in terms of tonnage (approximately 19%) in 2007 after China (52%). Spain was third with 5% of production (Boriss and Brunke, 2009a). The U.S. was the second largest exporter of lettuce in terms of value (approximately 22%) in 2006 after Spain (35%). Exports of fresh lettuce from the U.S. in 2009 were worth $104.9 million (FAS, 2011). Canada, Mexico and Taiwan are the top three markets for U.S. leaf lettuce. U.S. imports of lettuce were worth $52.6 million. Mexico, Canada, and Israel are the three largest exporters of leaf lettuce to the United States (Boriss and Brunke, 2009a).

California produces leaf lettuce year round; different counties dominate the market at different periods throughout the year, as shown in the figure below. The areas around Santa Maria (in Santa Barbara County and Salinas-Watsonville in Monterey County are the main domestic suppliers of lettuce from July through September.

Figure 3.3.1 Seasonal Pattern of Leaf Lettuce Production: California, Arizona, and New Jersey



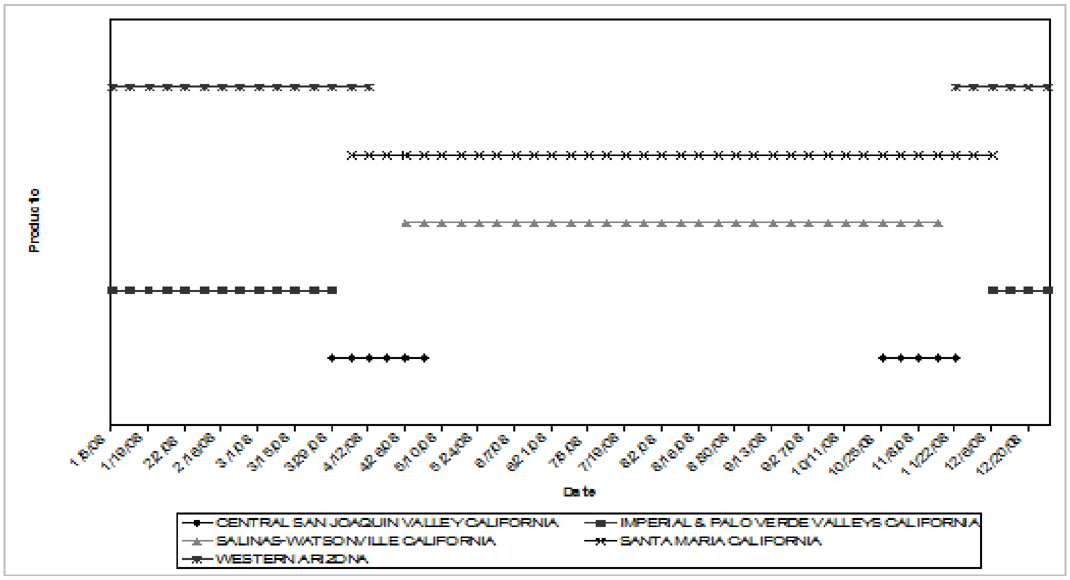
Source: ERS, 20010c.

Domestic consumption of leaf lettuce, including romaine, increased rapidly in recent years. From 1997 to 2007, the per capita domestic availability of romaine lettuce leaf increased 76% from 6.6 lbs./person in 1997 to 11.6 lbs./person in 2007 (Boriss and Brunke, 2009a). This continues a fairly consistent upward trend in per capita domestic availability over the past twenty-five years. Since 1986, per capita domestic availability increased over 450%. From 1994 to 2004, per capita use of romaine lettuce increased 199%, while lettuce leaf (red, green, and oak leaf) increased 31% (ERS, 2010c). The increase in leaf lettuce and romaine lettuce consumption is at least partially the result of the demand curve for these products shifting out. This demand shift was primarily due to increased popularity of Caesar salads, salad bars, and packaged salads (Lucier and Jerardo, 2005; Boriss and Brunke, 2009a). Other reasons for this shift are the increased use of romaine lettuce in the food service industry and nutrition; romaine lettuce is a low calorie source of vitamin A, vitamin C, and foliate (Lucier and Jerardo, 2005). The increased consumption of leaf lettuce, including romaine, resulted in increased total lettuce consumption even as consumption of iceberg lettuce declined. Not only has domestic demand soared for U.S. Leaf lettuce, exports and imports of leaf lettuce increased over the last decade. Based on a comparison of the three-year average for 2005-2007 to the three-year average for 1995-1997, the average value of U.S. leaf lettuce exports grew 283%. The average nominal value of U.S. lettuce leaf imports grew 467%. Even though imports rose rapidly over the last decade, imports are still small relative to domestic production. The average gap between the value of U.S. leaf lettuce exports and imports expanded over the last decade by over 250% (FAS 2011, Boriss and Brunke, 2009a).

Head Lettuce- Domestic Demand, Exports and Imports

Though iceberg lettuce is the most popular type of lettuce within the U.S., accounting for approximately two-thirds of all domestic lettuce consumption (Lucier and Jerardo, 2006; ERS, 2005b), domestic consumption of head lettuce declined in recent years. From 1997 to 2007, the per capita domestic availability of head lettuce declined 23% from 23.9 lbs. /person in 1997 to 18.4 lbs. /person in 2007. This follows a downward trend in per capita domestic availability that began in 1989 when per capita domestic availability of head lettuce peaked at 28.69 lbs. /person. Per capita domestic availability has declined 36% since then. The 2006 and 2007 levels match those seen in the early 1960s (ERS, 2010b). The figure below displays the seasonal location of iceberg lettuce production in 2008. California produces iceberg lettuce year round. The San Joaquin Valley produces iceberg lettuce twice a year: late-March to late-April and late-October to late-November. California has the domestic market to itself from mid-April to mid-November when iceberg lettuce is not in season in Arizona. The San Joaquin Valley never has the domestic market to itself. Other California regions' market windows overlap with the San Joaquin Valley's market windows.

Figure 3.3.2 Seasonal Pattern of Iceberg Lettuce Production: California and Arizona



Source: ERS, 2010b.

Though U.S. lettuce head exports exceeded imports, imports have grown and exports have shrunk over the last decade. Based on a comparison of the three-year average for 2005-2007 to the three-year average for 1995-1997, the average value of U.S. lettuce head exports grew 43% (FAS, 2011). However, between 2008 and 2009 total lettuce US exports declined by 22%; this is largely due to a contraction in head lettuce exports. The average value of U.S. lettuce head imports grew 347% from 1995 to 2005. This growth in imports has been accompanied by a recent shift towards year-round lettuce head imports. These changes are the result of lettuce shippers diversifying their sources in order to avoid weather-related disruptions of their supply (Lucier and Jerardo, 2006). Even though imports rose rapidly over the last decade, imports are still small relative to domestic production. Furthermore, the average gap between the value of U.S. lettuce head exports and imports expanded over the last decade.

The own-price elasticity of domestic demand for lettuce is inelastic. You, Epperson, and Huang (1996) estimated an own-price elasticity of domestic demand of -0.0139 at the retail level. Huang (1986) found an own-price elasticity of demand for lettuce of -0.1371, providing further support for the claim that the domestic demand for lettuce is inelastic. The domestic and world demand curves for California lettuce are likely more elastic. However, the elasticity of domestic demand for California lettuce is likely close to these estimates because California is the primary supplier of lettuce to the domestic market and the sole supplier for much of the year. Sexton and Zhang (1999) estimated an elasticity of demand for California iceberg lettuce of -0.16 using farm-level data from Imperial Valley and the Salinas-Watsonville area. A more recent study estimated a domestic own-price elasticity of demand for California lettuce of -0.71 at the retail level (Russo et al., 2008). Hammig and Mittlehammer (1980) estimated a US own-price elasticity of supply for lettuce of 0.52.

3.3.4.b Key potential impacts of draft regulations

Growers will not leave buffers unplanted. Their choices regarding management approaches for buffers and remaining acreage will vary depending on the primary pest management concern, previous pest pressure, the alternative chosen, and other regulations.

One important active ingredient for lettuce production is pronamide (Kerb 50W), used for pre-emergence grass and broadleaf weed control. Other active ingredients listed in the draft regulations may play key roles in lettuce pest management; only pronamide and weed control are considered here.

<u>Alternatives to pronamide for weed management.</u> Pronamide was the most widely used herbicide on head and leaf lettuce in Monterey and Santa Barbara Counties in 2009. Other pre-emergence herbicides include benefin (Balan), which is listed in the draft regulations, and bensulide (Prefar 4-E), which is not. Pronamide provides control or partial control of a broader spectrum of weed species than these alternatives do. According to the Weed Research and Information Center, University of California Cooperative Extension, bensulide does not control many weeds that pronamide controls, including, chickweed, henbit, malva, mustards, black nightshade, hairy nightshade, wild oat, London rocket, shepherd's-purse, and volunteer cereals (WRIC-UCCE, 2009).

Weed control is a critical issue for lettuce production. Lettuce is very sensitive to competition from weeds particularly during the seedling stage (UC IPM L-IWM 2007). Lanini and Le Strange (1991) found that untreated lettuce control plots had zero yields. Growers use a combination of herbicides, cultivation, and hand weeding to manage weeds (Fennimore et al. 2010). Reduced herbicide efficacy increases hand weeding expenses and makes thinning more costly. Haar and Fennimore (2003) found that overall weed control expenses were higher when bensulide was used for pre-emergence weed control for head lettuce than when pronamide was used. The cost difference was statistically significant. Yields were also lower, although the difference was not statistically significant. The untreated control also had statistically significant higher weed control expenses than the pronamide-treated plot and lower yields with a statistically insignificant difference. Haar and Fennimore (2003) conclude that the increased labor spent thinning and hoeing compensated for the lack of chemical control. Due to increased labor costs, weed management costs were 50% higher on the control plot. This results were from a single-season experiment. Because pronamide provides control for important weed species that bensulide does not, there is the potential for a weed seed bank to increase over time unless hand hoeing provides equivalent control. Crop rotation is one means of managing this possibility. If crop rotation is not effective, then increased weed pressure may increase thinning and hand weeding costs further and reduce yields.

<u>Other factors affecting the potential costs of the draft regulations.</u> Pronamide is not suitable for use on all lettuce crops. Its long pre-harvest interval prohibits its use for machine-harvested pre-cut green salad mixes (Shem-Tov, Fennimore, and Lanini 2006). However, these crops may benefit from pronamide applications indirectly if planted in ground previously treated with

pronamide, which would reduce the pre-existing seed bank. On the other hand, if lettuce is rotated with crops that are sensitive to pronamide, the draft regulations will not affect growers' pest control options.

Growers have the option of using shallow mechanical ground incorporation immediately after applying Kerb. In this case, the pronamide product is not subject to the draft regulations. If the appropriate type of irrigation system and water application rate is used for incorporation, then the pronamide product is not subject to the draft regulations.

In addition to the lack of alternatives registered currently, there is little pesticide industry interest in developing new herbicides for small-acreage specialty crops. Contributing factors include limited market size for specialty crops (leading to insufficient returns on research and development), increased costs of research and development, increased regulatory compliance costs (primarily due to re-registration requirements), industry consolidation, and liability risk that is disproportionate to returns given other opportunities to invest in product research and development (Gast 2008). These factors have contributed to the limited number of current alternatives. Most active ingredients registered for use in lettuce and specialty crops were registered originally around thirty years ago; new use regulations for and re-review of these long-registered products increasingly limit their use (Fennimore and Doohan 2008).

3.3.4.c Analyzed impacts

The potential impact on weed management of removing pronamide from pre-emergence applications is considered in the partial equilibrium analysis.

Weed control. We specify that in the base treatment pronamide is applied to all acreage. (As is standard practice, applications are banded, so that approximately 25% of field acreage is treated; we evaluate planted acreage, not treated acreage). We assume that it is not immediately incorporated into the soil, so that the 25-foot buffer applies. Under the regulation we consider two scenarios: bensulide is applied to the entire field, and bensulide is applied to only the buffer zone We consider two sets of changes in yield, pesticide material costs, thinning costs, and hand hoeing costs for each scenario, both drawn from results reported in Haar and Fennimore (2003).[15] In the first scenario, yield decreases by 3%. Pesticide material costs still decrease by 46%. Because the pesticide is applied at the time of planting, application costs are not addressed. Thinning costs increase by 72% and hoeing costs increase by 37%. In the second scenario, yield increases by 4% and thinning and weeding costs increase by 50% and 20%, respectively.

[15] Haar and Fennimore (2003) incorporated the treatments into the soil within 24 hours of application using about 20 mm of water from an overhead sprinkler system.

3.3.5 Processing Tomatoes

3.3.5.a Economic profile

California is the number one producer of processing tomatoes in the U.S., supplying 95% of the total value in the country in 2009. Processing tomatoes are the second most important vegetable crop in California in terms of value, after lettuce, and the eighth most valuable agricultural crop (NASS, 2010a). Data from 2009 and 1999 crop years were compared to determine the current levels and changes over time for production, price, etc. (CCAC 2000, 2010). There were 316,118 acres of processing tomatoes planted in California in 2009, with yields of 45.14 tons per acre and total production of 14,270,611 tons. This represented an 8.8% decrease in acreage since 1999, but a 19.6% increase in yields and a 9.5% increase in production. Processing tomatoes were one of five crops with the largest increase in production (13%) compared with the previous year (NASS, 2010a). The price of processing tomatoes in California was $80.96 per ton in 2009 (an increase in nominal dollars of 40% since 1999), and the total value of production was $1.16 billion (a 52% increase in terms).

The counties in California with the highest levels of processing tomato production are Fresno, Stanislaus, San Joaquin, Yolo, and Kings (NASS, 2010a). The counties with sizeable production that are in our study are Fresno, Stanislaus, and Colusa.

Fresno County is the biggest producer of processing tomatoes in California, accounting for 40% of total value. There were 115,000 acres of processing tomatoes in Fresno in 2009, yields were 48 tons per acre, and total production was 5,520,000 tons. The price of tomatoes was $83 per ton, and the total value was $458 million. Acreage in Fresno remained constant from 1999-2009. Yields, and therefore production, increased by 15.7%. The nominal price of processing tomatoes in Fresno increased by 45.6% over the same time period, and total nominal value increased by 68.4% (CCAC 2000, 2010). Tomatoes are the second highest value crop in Fresno county, contributing 8.5% of the total value of all crops in 2009 (Fresno County, 2010).

Stanislaus County is the second biggest producer of processing tomatoes in the state, accounting for 7% of California's total value. It had 24,237 acres of processing tomatoes in 2009, yields of 40.56 tons per acre, and total production of 983,000 tons. The price in Stanislaus was $82 per ton, and the total value of the crop was $80.6 million (CCAC, 2010). This represented 3.4% of the total value of crops in Stanislaus. The processing tomato industry has grown significantly in Stanislaus: tomatoes rose from the tenth most valuable crop in the county in 2008 to the fifth most valuable in 2009 (Stanislaus County, 2010). Processing tomatoes account for 3.9% of the total value of crops in Stanislaus. Acreage increased by 11.2% since 1999, yields increased by 7.3%, and production increased by 19.3%. The nominal price also increased, by 36.7%, and total nominal value went up by 63.2% (CCAC 2000, 2010).

Colusa County has a much smaller, and declining, level of production of processing tomatoes. However, processing tomatoes are still the county’s third most valuable crop, accounting for 12% of total value in 2009. There were 18,440 acres in the county in 2009, a 39.5% decrease from a decade before. Yields increased by 35.6% to 48.4 tons per acre, the highest among the counties in our study, but production still declined by 18% to 892,496 tons. The price for processing tomatoes in Colusa was $81.45 in 2009, a 35.8% increase since 1999, and total value was $72.7 million, a 10.4% increase since 1999 (CCAC 2000, 2010).

U.S. exports of processing tomatoes amounted to 180,019 metric tons (valued at $139.0 million) in 2007. Canada, Mexico, Japan, Korea and Italy were the leading US export markets for processing tomatoes. In 2007 U.S. imports of processing tomatoes totaled 49,993 metric tons, valued at $37.7 million. Mexico, China, Canada, Israel, and Chile were the leading sources of imported processed tomatoes by value in 2007 (USITC, 2008). Imports of processed tomatoes increased between 2003–2007, and exports remained stable. U.S. processing tomato exports decreased and imports increased in recent years (ERS, 2010e). Again, comparing the three-year average for 2005-2007 to the three-year average for 1995-1997, the average annual nominal value of U.S. processing tomato exports decreased 45% and imports increased 20%, respectively. Over this time period, exports increased to Canada, Mexico, and South Korea by 12%, 844%, and 27% respectively, while exports decreased by 10% to Japan and 45% to Italy (FAS, 2011). Together, these five countries purchase a little less than 80% of U.S. processing tomato exports in terms of value. While China went from a non-exporter to the second largest exporter of processing tomatoes to the United States in the last decade, the average nominal value of Mexico, Canada, Israel, and Italy processing tomato imports decreased 20%, 6%, 42%, and 54%, respectively. Together, all five countries account for approximately 80% of the value of processing tomato imports into the United States (USITC, 2008).

U.S. per capita consumption of processing tomatoes, as measured by per capita availability, decreased over the last decade. Based on a comparison of the three-year average for 2005-2007 to the three-year average for 1995-1997, per capita domestic availability of processing tomatoes decreased 5.92% over the last decade (ERS, 2010e). In 2007, per capita domestic availability of processing tomatoes was 68.8 lbs. /person. Per capita domestic availability of processing tomatoes reached its high of 77.1 lbs. /person in 1991 and since then has been on an erratic, but general trend downwards. This reverses the general upwards trend in the 1980s resulting from the growth of meals away from home in ethnic restaurants, specifically those serving Italian and Mexican food, and the promotion of tomatoes for their nutritional properties: antioxidant lycopene, vitamin A and vitamin C (Boriss and Brunke, 2005b; California Tomato Commission).

Table 3.3.7 Value of Annual Production, Imports and Exports: Processing Tomatoes 2005-2009
(1,000s of nominal U.S. $)

Value of Production	**2005**	**2007**	**2009**
Fresno County	246,177	345,340	458,160
Stanislaus County	23,473	44,421	80,606
Colusa County	42,818	45,634	72,694
California	588,388	858,513	1,155,299
Total U.S.	620,987	901,761	1,218,912
Imports	21,510	37,691	
Exports	127,046	139,045	

Source: CCAC, 2005-2009; FAS, 2011.

Processing tomatoes are used in a variety of food items and condiments, and estimates of demand elasticity typically focus on the demand for tomatoes products, instead of processing tomatoes in general. George and King (1971) estimated own-price elasticities of demand for canned tomatoes of -0.178 and -0.176 at the retail and farm-gate levels, respectively. Chern (1976) and Chern and Just (1978) used data from 1967-1975 and estimated an own-price elasticity of demand for processing tomatoes of -0.40. Huang (1985) estimated an own-price elasticity of demand for canned tomatoes at the retail level of -0.38. In a more recent study, Russo et al. (2008) used U.S. retail sales data for the period 1993-2004 to estimate an own-price elasticity of demand of tomatoes products of -0.26 at the consumer level, which suggests that demand is highly inelastic. At the farm-gate level, they used prices for the period 1982-2002 to estimate an own-price elasticity of demand of -0.18. In both cases, the results are statistically significant. The same study estimated the own-price elasticity of supply and finds that it is also inelastic, at 0.41 in the short run and 0.69 in the long run.

3.3.5.b Key potential impacts of draft regulations

Growers' management choices regarding whether to use different management approaches for buffers and remaining acreage or even whether to plant the buffer will vary depending on the primary pest management concern, the layout of the field relative to the position of the sensitive aquatic site, previous pest pressure, the alternative chosen, and other regulations.

Growers maintain a roughly 20-ft. area at the ends of fields for equipment turning. If a 25-ft. buffer already includes that turning area, it is likely that they will simply plant one or two fewer rows of tomatoes in order to meet the 25-ft. requirement.

<u>Weed control</u>. To comply with the draft regulations, many growers would simply extend the 20-ft. turnaround area to 25 feet. However, this will not always be the case. Given the importance of the active ingredients listed in the draft regulations for weed control in

processing tomatoes, growers may choose not to plant the buffer rather than use a less effective spray program. We focus on this alternative in the partial equilibrium analysis.

Worms. Though many active ingredients used for worm management in processing tomatoes are listed in the draft regulations, alternatives such as spinosad and methoxyfenozide are available. These products tend to be more expensive. Because we consider a scenario where growers do not plant buffer acreage, we do not review specific alternatives or compare changes in costs here.

Stink Bug Management. All but four of the treatment programs recommended for stink bug in tomatoes in the UC IPM Guidelines include at least one active ingredient listed in the draft regulations (UC IPM T-SB 2008). Of those remaining, the use of kaolin clay requires washing the tomatoes, which limits its use; insecticidal soap has limited efficacy, methamidophos is only available with a Special Local Needs permit, and endosulfan is not available for use as an alternative in buffer zones due to use restrictions. The set of sites defined as unacceptable for endosulfan applications on the Thionex 3EC label include "fields draining directly into surface waters such as streams, rivers, lakes, ponds, marshes, bays, estuaries, or the ocean" and "fields draining into surface drainage ditches or canals that flow directly into surface waters such as streams, rivers, lakes, ponds, marshes, bays, estuaries, or the ocean" as well as sites in two specific drainage systems (Makhteshim Agan of North America, Inc. n.d.). Effectively, growers have the option of either sustaining the losses due to stink bug or of not planting the buffers.

The UC IPM Guidelines for stink bug management in tomatoes state that treatment decisions regarding stink bug are a function of the final use of the tomatoes, owing to the nature of damage. It is unlikely that treatment would be recommended for processing tomatoes used for paste or juice. Treatment is more likely to be recommended for processing fields intended for solid-pack or dice canning (UC IPM T-SB 2008). Consequently, the total economic impacts of the draft regulations are limited by the final use allocation of California processing tomatoes production between tomatos paste and other products. The effects will be borne by growers and processors involved in the production of whole or diced canning tomatoes. Cullen and Zalom (2007) observed damage on untreated field plots of over 50%, so losses could be substantial for growers producing tomatoes for these markets.

3.3.5.c Analyzed impacts

Because growers may respond to difficulties in implementing an efficacious weed management program under the draft regulation by simply not planting, we limit attention to this impact. We examine the effects of growers not planting in the buffer zone. Because some area defined as being within a buffer may be part of a turnaround area and hence not planted, we consider two scenarios that bound the number of acres affected. In the first scenario, none of the buffer area was already included in a turnaround area, so that all acreage within 25 feet of a sensitive aquatic site would be left unplanted as a result of the draft regulations. In the second scenario, all acreage within 20 feet of a sensitive aquatic site was already part of a turnaround area. Hence, the net acreage loss includes the remaining 5 feet between the existing turnaround area and the required buffer width.

3.3.6 Rice

3.3.6.a Economic profile

California's rice crop is the second largest in the U.S., accounting for 22% of the value of national rice production. Rice is the tenth most valuable crop grown in California, contributing 2.8% to the total value of production in 2009 (NASS, 2010a). In 2009 there were 563,974 acres of rice in California, a 6.6% increase from 1999. Yields were 4.38 tons/acre (a 19% increase), production was 2,472,614 tons (a 27% increase), the price of rice was $390 per ton (an increase in nominal dollars of 37%) and total value was $963,526,000 (a 74% increase) (CCAC 2000, 2010).

The top rice-producing counties in California by value are Colusa, Sutter, Butte, Glenn, and Yuba counties. Colusa and Butte are included in our case studies. Rice is the most valuable crop in both counties (NASS, 2010a). It accounts for 40.7% of total crop value in Colusa and 33.9% of total crop value in Butte. Colusa is the top rice producing county in the state, accounting for 25% of the value of all California rice (CCAC, 2010). In 2009 there were 152,400 acres of rice in Colusa (an 8.2% increase from 1999), yields were 4.5 tons/acre (a 20% increase), production was 685,800 tons (a 29.8% increase), the price was $355/ton (a 21.2% increase) and total value was $243,459,000 (a 57.2% increase) (CCAC 2000, 2010). Butte accounts for 19% of the total value of rice production in California. In 2009 there were 103,416 acres of rice in Butte (a 7.2% increase), yields were 4.7 tons/acre (a 27.4% increase), total production was 486,055 tons (a 36.5% increase), the price of rice was $379 (a 30.7% increase) and total value of production was $103,265,000 (a 78.4% increase) (CCAC 2000, 2010).

The U.S. is currently the fourth biggest rice exporter in the world, despite the fact that it only accounts for 2% of the world's total rice production. Historically, over half of all U.S. rice has been exported, though in the past decade domestic consumption has grown substantially, reducing the proportion of exports (FAS, 2011). Per capita consumption of rice in the U.S. has more than doubled in the last ten years and is currently about 20 lbs./capita, though this is still very low compared to nations in which rice is the primary staple (200-300 lb./capita) (Sage Foods, 2011). Of the rice going to the domestic market, roughly 60% goes to table rice, about 25% to the industrial market and processed food, and about 15% to beer. U.S. exports of rice were worth $2.18 billion in 2009. The primary destinations of U.S. rice exports are in Latin America: Mexico, Central America, and Brazil when the rice crop in Uruguay and Argentina fails. US imports of rice in 2009 totaled $608 million and were primarily aromatic and fragrant varieties: jasmine from Thailand and basmati from India and Pakistan (Sage Foods, 2011).

Table 3.3.8 Value of Annual Production, Imports and Exports: Rice, 2005-2009
(1,000s of nominal U.S. $)

Value of Production	2005	2007	2009
Butte County	86,085	129,822	184,214
Colusa County	124,963	188,027	243,459
California	467,625	664,538	963,526
Total U.S.	1,738,598	2,600,871	3,209,236
Imports	224,934	395,473	608,315
Exports	1,277,238	1,392,405	2,175,899

Source: CCAC, 2005-2009; FAS, 2011.

Russo et al (2008) estimated that the demand for California rice is inelastic, with a value of -0.36. They found that supply was also inelastic, with values of 0.45 in the short run and 0.72 in the long run.

3.3.6.b Key potential impacts of draft regulations

Rice growers will not leave buffers unplanted. Their choices regarding whether to use different management approaches for buffers and remaining acreage will vary depending on the primary pest management concern, previous pest pressure, the alternative chosen, and other regulations.

The most important active ingredients for rice production that will be prohibited for use in buffers are propanil (Stam 4SC, Super Wham) which is used as a cleanup herbicide for weed control, and lambda-cyhalothrinin (Warrior II with Zeon), a pyrethroid which is used to control rice water weevil and tadpole shrimp.

<u>Alternatives to propanil for weed management.</u> Propanil is the most widely used herbicide in rice. It is a relatively cheap material. Resistance to propanil has not been detected in watergrass species, unlike other available grass herbicides: molinate, thiobencarb and fenoxaprop-ethyl (Fischer et al. 2000). Thus, growers are able to use it as a “clean-up” herbicide post-planting, following a pre-plant application of one or more other active ingredients.[16] Most propanil in Butte and Colusa Counties is ground-applied, so there is relatively little scope for growers to reduce the impact of the draft regulations by changing from aerial to ground applications.

Because of widespread herbicide resistance among common weed species in rice fields, it is difficult to identify post-planting alternatives to propanil as part of an effective weed

[16] Stam 4SC is labeled for selective control of annual sedges, barnyard grass, crabgrass species, early and late watergrass, junglerice, ricefield bulrush, rice flatsedge, and smallflower umbrella plant (United Phosphorus, Inc. n.d.).

management program. At the present time, there are no established alternative active ingredients without some resistance in the weed population. Though chemical alternatives may exist, their cost and efficacy must be evaluated. There are some alternatives with both chemical and cultural components that could aid in weed management.

One cultural alternative may be to increase the depth of water in order to drown weeds. This "deep water" approach has the disadvantages of stressing the rice plants and requiring more water use. It also isn't available as an alternative for all growers because levees must be tall and strong enough to hold the increased amount of water. Deep water can be paired with herbicides to increase the efficacy of the overall weed management program and improve yields relative to the use of deep water alone (Williams et al. 1990). If growers choose to use deep water as an alternative management technique, then its use may or may not be required for the entire field, depending on the field's design and levee orientation relative to the sensitive aquatic site in question.

Linquist et al. (2008) report results from an experiment with a minimum tillage system for rice that includes only fall tillage, and then the preparation of a "stale seedbed" and the use of pre-plant flooding to germinate weeds. Once the weeds have emerged they are treated with glyphosate, an active ingredient not listed in the draft regulations. Target weed species had not developed resistance to glyphosate. This approach can reduce the need for post-plant herbicide treatments.

Another alternative is to simply treat the buffer with herbicides that are not listed in the draft regulations. This approach could lead to the development of a seed bank of weeds resistant to the active ingredients applied. An untreated buffer would lead to the development of a weed seed bank including both resistant and susceptible seeds. Higher weed populations and increased competition for rice plants would result in the buffer, and could increase infestations in the interior of the field as well. Competition with weeds reduces rice yields. Perez de Vida et al. (2006) found that competition with late watergrass reduced rice yields between 32% and 48% for an untreated control. These results can be interpreted as bounding the losses that would occur if other active ingredients were applied to the buffer; susceptible weeds would die, reducing competition.

Alternatives to lambda-cyhalothrin for rice water weevil management. Warrior II with Zeon has label restrictions with mandated buffer widths as a function of application method that are identical to those in the draft regulations. The label restrictions regard buffer zones for "aquatic habitats (such as, but not limited to, lakes; reservoirs, rivers; permanent streams; marshes; natural ponds; estuaries; and commercial fish ponds)" (Syngenta Crop Protection Inc. n.d.). Thus, the effect of the draft regulations would depend on the implemented definition of sensitive aquatic site and its difference from the Warrior II with Zeon label definition.

The UC IPM Guidelines for rice water weevil management in rice list two alternative chemical controls: (s)-cypermethrin (Mustang), another pyrethroid listed in the draft regulations, and diflubenzuron (Dimilin 2L), an insect growth regulator, which is not listed. However, diflubenzuron is not available as an alternative buffer treatment for all land that would be included in buffers. The Dimilin 2L label prohibits ground applications within 25 feet and aerial applications within 150 feet of "bodies of water such as lakes, reservoirs, rivers, permanent streams, natural ponds, marshes or estuaries." (Chemtura Corporation n.d.). In addition, the label requires that the buffer include a 25-foot vegetative buffer strip to reduce runoff. The extent to which the proposed regulation would limit the use of Dimilin 2L depends on the difference between the label's definition of bodies of water and the draft regulations' definition of sensitive aquatic site.

Buffer zone requirements are particularly problematic for rice water weevil management, due to its life cycle and movement. It overwinters outside rice fields in grassy areas and areas with weed debris, often ones associated with sensitive aquatic sites such as sloughs, and levee banks. The rice water weevil has a limited range of movement and does not tend to migrate very far into rice fields. The heaviest damage tends to be within 15-20 feet of field edges, although moderate damage can occur as far as 35 feet from field edges (UC IPM R-RWW 2009). Insecticide treatments within 30-50 feet of levees usually provide acceptable control (UC IPM R-RWW 2009).

In 2009, all applications of lambda-cyhalothrin in Butte and Colusa were made by air, according to CDPR PUR data. This is driven by the timing of post-planting applications; rice fields are treated with lambda-cyhalothrin when the rice plants are about an inch high. At this stage of development, water movement caused by the equipment used for ground applications can uproot rice plants and, hence, lower yields. Thus, the timing of the application must be changed in order to change the application method.

Research findings indicate that pre-flood applications of lambda-cyhalothrin can be effective against the rice water weevil (Godfrey et al. 2007; Godfrey et al. 2008; Godfrey and Goldman 2010). Prior to flooding, growers do not know if rice water weevil is present, so a pre-flood application is a preventative treatment, not one in response to a level of infestation that exceeds an economic threshold for treatment. If buffer zones are implemented, growers who have sustained yield losses due to rice water weevil in the past will likely use pre-flood applications. Other growers may choose to monitor fields rather than treat them pre-flood.

Alternatives to lambda-cyhalothrin for tadpole shrimp management. One challenge in analyzing the potential effects of the draft regulations is that growers may use a single application of a pesticide to manage multiple pest species. In addition to being used to control rice water weevil, lambda-cyhalothrin and other pyrethroids are used to manage tadpole shrimp, which have been increasing in importance as a rice pest in the Sacramento Valley over the past several years.

Commonly tadpole shrimp affect part of a field, not necessarily the entire field. The UC IPM Guidelines list three options for tadpole shrimp control. The first is a cultural practice: flood the field, hold the water for a sufficient period to induce tadpole shrimp hatching, and then drain it completely before seeding. Drawbacks to this approach include that it may affect other aspects of pest management, particularly weed management (encouragement of weeds and reduction of herbicide efficacy), and any pesticide holding requirements (UC IPM 2009). It also increases water use. In order to address the increase in weed pressure an additional application of herbicide may be required, increasing costs. The second option, carbaryl, is listed in the draft regulations. Copper sulfate is the remaining option. There are recent concerns about its efficacy when there is a large amount of rice straw in the field. Copper binds to the straw. It is also relatively expensive. Growers may apply copper to the entire field because it is also a treatment for algae.

Other factors affecting the potential costs of the draft regulations. Virtually all rice fields in Butte and Colusa Counties will be affected by the draft regulations. A fifth of Colusa rice acreage is within 150 feet of a sensitive aquatic site, as is 17% of Butte rice acreage. Most rice acreage is in a continuous rice rotation. The combination of reduced pest control alternatives, particularly for grasses, and the large share of acreage affected suggest that over time the draft regulations could lead to increased pest pressure and higher pest control costs even in acreage outside buffers.

3.3.6.c Analyzed impacts

Two potential impacts are considered in the partial equilibrium analysis: the effect on weed management of omitting propanil as a cleanup spray from the spray program and the effect of moving from a post-planting aerial application of lambda-cyhalothrin to a pre-flood ground application for management of rice water weevil, and the effect of moving from a post-planting aerial application of lambda-cyhalothrin. Due to data limitations the implications for tadpole shrimp management are not addressed here. Following Mutters et al. (2007) all treatments are made by custom applicators.

Weed control. We specify that propanil is used as a cleanup spray except in the 25 ft. buffer, where no cleanup application is made. Following Mutters et al. (2007), we assume that 50% of the eligible acreage requires a cleanup spray. Rice yields are reduced by 40% in the buffer, averaging the extremes of the range reported by Perez de Vida et al. (2006) for an untreated control. This assumption is likely to overstate potential short-term yield losses under the draft regulations because growers may choose to apply an available herbicide anyway. We do not consider this alternative because of a lack of data regarding the overall weed management plan and herbicide rotations in such cases. On the other hand, this assumption may understate long-run yield losses due to increased resistance to remaining herbicides and the creation of an increased weed seed bank. The per-acre cost of treatment declines by 100% in the buffer because no cleanup spray is applied.

Rice water weevil control. We specify that lambda-cyhalothrin is applied aerially post-plant in the current (base) treatment, and is ground-applied pre-flood under the draft regulations. Because it is usually applied to field edges for rice water weevil management, in order to proxy the implications of reducing the acreage that can be treated, we assume that the land included in the 100-ft. buffer represents, roughly, the land that is treated currently. We assume that the label restrictions are not currently binding. We assume that under the draft regulations lambda-cyhalothrin is ground-applied on eligible acreage within 100 ft. of the field edge, and that nothing is applied in the 25-ft. buffer. The acreage that is eligible for ground treatment does not sustain a yield loss. Based on the available data, we consider two yield losses within the buffers. Under the first scenario, within the 25-ft. buffer yields decline by 11% and yields decline by 13% on acreage with a ground-applied treatment.[17] Under the second scenario yields decline by 23% in the buffer and by 15% on acreage with a ground-applied treatment.

[17] Godfrey et al. (2008), Godfrey and Goldman (2009) and Godfrey and Goldman (2010) report yields from trials including a number of established and potential rice water weevil control treatments. This percentage averages the percentage change in yields between the Warrior (2008, 2009) or Warrior II (2010) treatment and the untreated control across the three years. Results vary in magnitude and statistical significance across years- only the 2008 trial showed a statistically significant difference in yields. These trials use introduced, rather than natural, rice water weevil populations. In 2009 the pattern of differences in yields did not correspond to the pattern of differences in direct measures of treatment efficacy (Godfrey and Goldman 2009). The untreated control had a yield that was 15% higher than the yield of the Warrior treatment. Averaging only the 2008 and 2010 outcomes results in a 23% yield loss. However, it is important to keep in mind that statistical significance is partially a function of sample size; relatively small samples are less likely to provide significantly significant results, all else equal.

3.3.7 Strawberries

3.3.7.a Economic profile

California is the largest producer of strawberries in the U.S., accounting for 89% of the total value of the strawberries crop in 2009. There are three categories of strawberries reported in California production statistics, depending on the county: fresh market, processing, and unspecified. Fresh market strawberries accounted for 82% of total California strawberry value in 2009, processing strawberries was 6%, and unspecified strawberries were 12% (NASS, 2010a). If aggregated, strawberries were the sixth most valuable crop grown in California in 2009, up from the eighth most valuable in 2008. Over the decade from 1999-2009 there were dramatic increases in acreage, production and value of fresh strawberries in California despite only a modest increase in price (CCAC 2000, 2010). In 2009 there were 37,925 total acres of all types of strawberries in California, total production was 1,242,067 tons, and total value of production was $193,756,044. This represented a 55% increase in acreage, an 87% increase in production, and an increase in nominal value of 265% since 1999 (CCAC 2000, 2010). Changes in yields and prices varied by type of strawberries. Processing strawberries had yields of 32.4 tons/acre (an 11% increase since 1999) and the price was $598 per ton (an increase in nominal dollars of 1%), while unspecified strawberries had yields of 29.4 tons/acre (a 6% increase) and the price was $1575 per ton (a 44.5% increase) (CCAC 2000, 2010). Fresh strawberries yields were 32.7 tons/acre (a 24% increase) and the price was $1760 per ton (a 20.5% increase). There were 27,472 acres of fresh market strawberries in California in 2009, total production was 897,635 tons, and the total value of the crop was $1,579,784,400. Over that time period acreage increased by 144%, production increased 203%, and total value increased by 265% in nominal terms (CCAC 2000, 2010).

The major strawberry-producing counties in California are Monterey, Ventura, Santa Barbara, San Luis Obispo, and Sacramento counties. Monterey and Santa Barbara are included in our case studies. Monterey has the highest strawberry production in California in terms of value: 47% of the total. Santa Barbara County produces 19% of the total (NASS, 2010a).

Strawberries are the second most valuable crop grown in Monterey, and strawberry production accounts for 18.6% of total crop value in the county. Fresh strawberries accounted for 99% of total strawberry value in Monterey in 2009, therefore we will not include processing strawberries in our analysis. In 2009 there were 11,247 acres of fresh strawberries in Monterey (a 103% increase from 1999), yields were 33.96 tons/acre (a 51% increase), production was 382,000 tons (a 206% increase), the price of strawberries was $1,953 (a 20% increase) and total value of production was $746,061,000 (a 267% increase) (CCAC 2000, 2010).

In Santa Barbara, strawberries are the most valuable crop and accounted for 24% of total crop value in 2009. Of that total, 87% of the value came from fresh strawberries and 13% from processing strawberries (CCAC, 2010). In 2009, fresh strawberry production was 43,839 tons and the total value of production was $299,442,100 (a 539% increase) (CCAC 2000, 2010). Processed strawberry production was 71,725 tons (a 28% increase) and the total value of production was $45,172,400 (a 36% increase in nominal terms) (CCAC 2000, 2010). Notably, the value of production increased by a much larger margin for Santa Barbara County than for California overall. This may be driven by changes in the harvest “windows” due to changes in planting time made by growers in order to benefit from higher prices.

U.S. strawberry imports were valued at less than 10% of total U.S. production in the 2004-2006 time period. In 2009 strawberries imports into the U.S. were worth $153 million (FAS, 2011). Mexico, China and Canada were the largest foreign suppliers of fresh strawberries to the U.S. Strawberries exports were even smaller from 2004-2006, valued at 5% of total U.S. production. Exports rose by 2009, to $325 million (FAS, 2011). Canada, Mexico and Japan were the largest importers of U.S. fresh strawberries. Domestic per capita consumption of fresh strawberries in the U.S. was 5.82 pounds per person in 2005, a 20% increase since 2000 (ERS, 2007b). The average real retail price per pound of fresh strawberries has increased, suggesting an outward shift in the demand for fresh strawberries.

Table 3.3.9 Value of Annual Production, Imports and Exports: Fresh Strawberries, 2005-2009
(1,000s of nominal U.S. $)

Value of Production	**2005**	**2007**	**2009**
Santa Barbara County	170,672	592,557	299,442
Monterey County	385,731	272,517	746,061
California	872,830	1,216,581	1,579,784
Total U.S.	1,396,400	1,751,100	2,123,700
Imports	91,985	131,870	153,087
Exports	223,863	277,248	324,839

Source: CCAC, 2005-2009; FAS, 2011.

Estimates of the own-price elasticity of demand for strawberries vary. Within a demand system for major fruits, Henneberry et al. (1999) actually estimated a positive value, which implies that the quantity of strawberries demanded increases with the price of strawberries and contradicts economic theory. This counter-intuitive finding may be due in part to their use of annual data and their choice of products to include in the demand system. Price and Mittelhammer (1979) estimated an own-price farmgate elasticity of demand of -1.96. You, Epperson and Huang (1996) estimated a retail own-price elasticity of -0.28.[18] Incorporating seasonality considerations, Carter et al. (2005) provided harvest “stage” estimates that generate a volume-weighted own-price elasticity of demand for California strawberries at -1.9, a highly elastic demand. No supply elasticity for California or for the U.S. was found in the economic literature. Askari et al. (1977) estimated the price elasticity of supply for strawberries in the U.K. as 0.3 in the short run and 1.03 in the long run. However, this result is unlikely to apply to California strawberries due to differences in competitive and agronomic conditions.

[18] Retail data do not take food service sales into account.

3.3.7.b Key potential impacts of draft regulations

Strawberry growers will not leave buffers unplanted. Growers may choose to use alternative chemical and/or cultural controls on the buffers. Options for alternative chemical control programs may be limited due to regulations intended to mitigate resistance in the target pest population.

If the draft regulations are implemented, the most important problem for strawberry production would be lygus bug management. Most chemical alternatives are listed in the draft regulations and would not be available for growers to use in buffer zones. Cultural controls, such as winter weed management and regular monitoring, should be included in IPM programs regardless of whether chemical controls are used. The following discussion of alternatives begins with that assumption.

Lygus bug management in strawberry production: chemical control. Malathion is perhaps the most important active ingredient used for lygus bug. Naled and bifenthrin are also used extensively, and fenpropathrin is also used to a lesser extent. All of these active ingredients are listed in the draft regulations. Thiamethoxam, acetamiprid, and novularon are three active ingredients that are not listed. Growers use a variety of active ingredients in their lygus bug management programs, and rotate them in order to manage the development of resistance. Depending on pest pressure, up to eight applications per season may be used for lygus bug control. The pest management program used in the most recent University of California cost study for the production of fresh strawberries on the Central Coast includes two applications of malathion, one of naled, and one of fenpropathrin, four applications in total (Bolda et al. 2010).[19] Owing to restrictions on the number of applications of individual non-listed alternatives per season, label requirements to rotate active ingredients, and an aquatic sites buffer label requirement for novaluron, under the draft regulations it may be difficult for strawberry growers to implement an efficacious lygus bug management program.

Novaluron (Rimon) is not yet included in the UC IPM Pest Management Guidelines for lygus bug management in strawberries. It is an insect growth regulator that can provide effective control, but only for early instars of lygus bug. The Rimon specimen label restricts applications to three per season, and requires that it be rotated with other active ingredients. The specimen label prohibits it from being ground-applied within "75 feet of bodies of water such as lakes, reservoirs, rivers, permanent streams, natural pounds, marshes, or estuaries" (Chemtura Corporation, n.d.). The label also specifies that 25 feet of this buffer should be a vegetative strip in order to reduce runoff. Potential use of novaluron will depend on the difference between the label definition of bodies of water for the buffer requirement and the definition of sensitive aquatic site used in the implementation of the draft regulations.

Acetamiprid (Assail) and thiamethoxam (Actara), neonicotinoids, kill lygus bugs. However, they also kill important beneficials that are in the same order as lygus. Assail applications are limited

[19] The most recent cost study for Santa Barbara County is from 2006. While it assumes two applications in its lygus bug treatment program, current practices tend to involve more treatments.

to two per season on the label, plus the requirement to rotate to a different class of active ingredient after two applications of neonicotinoids. There is no buffer requirement for this product (United Phosphorus, Inc. n.d.). Actara limits applications to three per season. In addition, there is a season maximum on all thiamethoxam products. Rather than specifying a rotation requirement to manage pest resistance to the active ingredient class, it recommends that the class be changed for each "treatment window" defined by the population's stage(s) of development and other considerations. Its surface water advisory indicated that it should not be applied within 48 hours of a forecast rain event. The label specifies a 25 foot buffer for an "aquatic area" in order to allow the growth of a vegetative buffer strip. Given that these treatments are subject to the 100 foot buffer in the draft regulations, this requirement will affect the value of this alternative but may not eliminate it.

The UC IPM Guidelines also list insecticidal soap (e.g. M-Pede) as an alternative. Its efficacy is limited, and the guidelines recommend limiting applications to two per season and no more than one per month due to the possibility of phytotoxicity (UC IPM ST-LB 2010).

<u>Lygus bug management in strawberry production: cultural control.</u> Two cultural control practices are included in the UC IPM Guidelines: growing flowering plants in or near strawberry fields in order to attract adult lygus bugs away from the strawberries, and vacuuming lygus bugs from the plants mechanically.

The use of flowering plants requires extensive monitoring of the population development of the lygus bug population. The adults are attracted to the plants and the females lay eggs there rather than on the strawberry plants. However, the infested flowering plants should be removed prior to the development of the emerging nymphs into adults that could then infest the strawberries. Alternatives that do not involve plant removal require ongoing monitoring and management (UC IPM ST-LB 2010).

Bug vacuums that suction lygus bugs from the field are used currently by many organic growers and even some conventional growers. Pickel et al. (1994) found no statistically significant difference in the share of damaged fruit between a treatment involving weekly vacuuming beginning at the time of lygus detection and continuing for the rest of the season and a treatment including two applications of malathion. Damage was significantly lower for a treatment including two applications of bifenthrin. The UC IPM Pest Management Guidelines note that the efficacy of control provided by vacuuming depends on pest pressure; damage is not reduced to acceptable levels by vacuuming when populations are moderate to heavy. Other cautions included in the guidelines are that vacuuming can spread disease throughout the field (powdery mildew and gray mold) and that it can eliminate generalist predators (UC IPM ST-LB 2010). Using the same data as Pickel et al. (1994), Pickel et al. (1995) found that vacuuming weekly was slightly over twice as costly as applying malathion twice. The cost of vacuuming did not include any cost for the vacuum itself, only labor and fuel costs for the tractor and vacuum.

A third cultural alternative combines the use of vacuuming with the use of flowering plants, including alfalfa. Swezey, Nieto, and Bryer (2007) compared the efficacy and cost of interplanting a row of alfalfa as a lygus bug trap within strawberry fields and vacuuming only the traps or traps and nearby strawberry rows with the cost of vacuuming an entire planting of only strawberries. An economic analysis of one year of the experiment found that taking vacuuming cost differences and the cost of reduced yields owing to dedicating land to traps found that net revenues for an organic grower increased by 13%. The applicability of these results to conventional production is unclear, given differences in prices, differences in yields, and interactions with other components of pest management programs. Another possible management approach would be to couple vacuuming with chemical controls. One grower reported that this approach allowed him to reduce chemical inputs by up to two-thirds (Burfield 2009).

<u>Other factors affecting the potential costs of the draft regulations.</u> As mentioned above, resistance management is an important consideration in lygus bug management. The draft regulations would eliminate active ingredients in important chemical classes. Eliminating these options reduces growers' ability to rotate classes and hence hasten the development of resistance. Indeed, the two options that can be used in the proposed buffer zones are both neonicotinoids.

3.3.7.c Analyzed Impacts

The partial equilibrium analysis addresses the potential economic impacts of vacuuming as an alternative to the use of malathion and other listed active ingredients in lygus bug management. Due to limitations on the use of non-listed active ingredients aimed at resistance management, and given the buffer requirement for novaluron, growers may have trouble implementing a lygus bug management program involving four sprays in a buffer.[20] Thus we consider the effects of substituting vacuuming for all chemical controls. Of course, another alternative would be to combine chemical applications with vacuuming in affected areas; we do not evaluate that possibility here. We consider only fresh market strawberries, due to the nature of the damage caused by lygus bug.

<u>Vacuum:</u> We specify that growers vacuum only in the buffer. The four-spray management program included in the UC cost study is the base treatment used in the rest of the field. The high-pressure sprays mean that the 100-ft. buffer applies. We assume that the lygus bug population is sufficiently low that the vacuum provides control equivalent to the spray program, and so there is no difference in damage, implying no difference in yield. Because the insecticides are applied in a tank mix, there is no reduction in application costs when vacuuming replaces insecticides.[21] Based on the information available, only the cost of tractor operation and operator time are considered; no separate cost of operating the vacuum is

[20] Naled and fenpropathrin, one of the listed active ingredients, has a 25-foot buffer specified for ground applications. The extent to which the draft regulations would have an incremental effect depends on the specific definition of sensitive aquatic site.

[21] This distinction leads to a larger percentage cost difference than that reported by Pickel et al. (1995).

considered. Similarly, due to a lack of information regarding the hours of use for a vacuum each season no capital cost is considered. Even given these considerations, the cost of vacuuming is almost five times as high as the four-spray management program.

In order to consider the possibility that vacuuming may reduce yields relative to malathion, particularly when there is substantial pest pressure, we include an additional two scenarios. They match the previous two scenarios except that they include a 5% yield loss on all vacuumed land. This yield loss is chosen arbitrarily in order to illustrate the potential increase in losses when yield is affected. Comparing the scenarios with and without yield loss provides some sense of its importance. Because strawberries have a very high value per acre harvested, any yield loss will increase the effects of the draft regulations substantially.

3.3.8 Walnut

3.3.8.a Economic profile

California accounts for nearly all U.S. production of black and English walnuts (over 99%). The numbers in this summary refer only to English walnuts.[22] Production in 2009 was a record 488,769 tons, and value was over $813 million. Walnuts were one of nine crops noted in the 2009 California crop report for substantial increases in total value compared with the previous year, at 32% growth in value (NASS, 2010a). Over the decade 1999-2009, the nominal value of California walnuts grew by 177%, while production increased by 58% to 488,769 tons. Acreage of walnuts in California in 2009 was 262,279, a 25% increase from 1999, and yields were 1.87 tons/acre, a 26% increase from 1999. The price of walnuts was $1,660 per ton, an increase in nominal dollars of 76% (CCAC 2000, 2010).

The counties with the highest value of walnut production are San Joaquin, Stanislaus, Butte, Tulare, and Tehama. Stanislaus and Butte are included in our study (NASS, 2010a). Butte is the second largest producer of walnuts in California, accounting for 14.3% of total value in 2009 (CCAC, 2010). Walnuts were the second most valuable crop in Butte, making up 21.5% of total agricultural value in the county. In 2009, there were 32,022 acres of walnuts in Butte, yields were 2.25 tons/acre, and production was 72,050 tons. The price of walnuts in the county was $1,620 per ton and total value was $116,721,000. There were sizable increases in all variables: nominal price in the county increased by 99.5%, acreage increased by 74%, yields increased by 27%, and production increased by 121%. As a result, the nominal value of walnut production in Butte increased by 341% (CCAC 2000, 2010).

Stanislaus has the third largest walnut production in California, accounting for 14% of total walnut value in the state in 2009 (NASS, 2010a). That year, walnuts were the sixth most valuable crop in Stanislaus, accounting for 5% of the county's total crop value. There were 29,628 acres of walnuts in Stanislaus in 2009, yields were 2.04 tons/acre, total production was 60,400 tons, the price per ton was $1,890, and total value was $114,156,000. All of these variables had increased since 1999, though not as much as in Butte County. Stanislaus acreage had increased 10%, yields increased 58%, production increased 58%, nominal price increased 76%, and total value increased by 177% (CCAC 2000, 2010).

The U.S. is the world's largest walnut exporter and supplies approximately 33% of the world's walnuts. The value of U.S. walnut exports in 2009 was over $345 million (FAS, 2011). The primary destinations of U.S. walnut exports are Spain, Italy, Germany and Japan. Walnut imports into the U.S., valued at $2.7 million in 2009, come mainly from China, Brazil and the Ukraine.

[22] In 2009 the value of black walnuts in California was $355,200, only 4% of the total value of walnuts, and no Black walnut acreage was recorded in the counties in our case study.

Table 3.3.10 Value of Annual Production, Imports and Exports: Walnuts, 2005-2009
(1000s of nominal U.S. $)

Value of Production	**2005**	**2007**	**2009**
Butte County	76,691	105,029	116,721
Stanislaus County	80,309	119,065	114,156
California	610,415	824,804	813669
Other U.S.	--	--	--
Imports	621	3,212	2,782
Exports	201,242	314,073	345,590

Sources: CCAC, 2005-2009; FAS, 2011.

According to Russo et al. (2008), the demand for California walnuts is inelastic: with an estimated own-price elasticity of -0.48. Supply is also inelastic, with estimated values of 0.15 in the short run and 0.19 in the long run.

3.3.8.b Key potential impacts of draft regulations

Walnut growers will not pull out trees in response to the draft regulations, nor plant a different crop. These are not economically desirable options. They will not leave the buffer untreated because it would become a pest reservoir. Growers will either treat buffers with an alternative pesticide or treat the entire orchard with an alternative pesticide. This decision will vary across growers for a number of reasons, such as pest pressure and the ease of using a different treatment on the buffer given the direction of the orchard rows.

The most important active ingredient for walnut production that will be prohibited in buffers is chlorpyrifos (Lorsban 4E) for control of codling moth. Although some growers have already transitioned to alternatives, it is still an important pest management tool. Weed control is another important concern that is not addressed in this analysis. Though walnut husk fly and mites are important pests, non-listed alternatives are available, especially for the latter.

<u>Alternatives to chlorpyrifos for codling moth control.</u> The current label for Lorsban 4E specifies a buffer of 25 feet for ground boom applications and 150 feet for aerial applications adjacent to "permanent bodies of water such as rivers, natural ponds, lakes, streams, reservoirs, marshes, estuaries, and commercial fish ponds" (Dow AgroSciences n.d.) Lorsban Advanced, registered in California in 2010, has the same buffer requirements. If there is an incremental effect of the draft regulations, it will depend on whether the definition of sensitive aquatic site is broader than the label definition of permanent bodies of water, and the resulting affected acreage.

The viability of alternatives depends on the degree of pest pressure. The UC IPM guidelines for codling moth control in walnuts separate treatments by the intensity of infestation. Some alternatives to chlorpyrifos for moderate to heavy codling moth infestations are also listed in the draft regulations, including lambda-cyhalothrin, bifenthrin, and methyl parathion.

Chlorantraniliprole (Altacor), a larvicide, is included as a treatment for moderate to heavy infestations and is not listed in the draft regulations. Spinetoram (Delegate) is an alternative to chlorpyrifos that is being increasingly used by growers. Van Steenwyk, Kiss, and Evers (2009) found that Altacor 35WG applied at 3 oz. per acre and Delegate 25 WG applied at 3.2, 4.8, or 6.4 oz. per acre did not have a significantly different share of infested walnuts at harvest than Lorsban 4E applied at 4 pints per acre.

There are two considerations besides cost and yield that can influence the performance of spinetoram as an alternative to chlorpyrifos. First, the number of applications required for a codling moth management program depends on the number of codling moth generations. Two to four applications are made per season. The Delegate 25 WG label restricts its use to no more than three consecutive applications in a given season. Growers requiring a fourth application would need to use a different material. Second, chlorpyrifos provides very consistent control. It has a very long residual period, compared to alternatives. Because it is toxic to multiple stages of the codling moth life cycle it can provide effective control even if the application is later than the recommended stage. Spinetoram, in contrast, is a larvicide. A late application will reduce efficacy.

When codling moth populations are low, other alternatives may be feasible, such as pheromones (Pickel et al. 2010). In some cases, pheromones supplemented with a reduced spray program may provide adequate control. Given current application technologies, the share of total walnut acreage for which pheromone application is economically viable is limited. More susceptible tree varieties may require more chemical control. For heavy pest pressure, pheromones are not a viable alternative.

<u>Other factors affecting the potential costs of the draft regulations.</u> The majority of walnut acreage uses sprinkler, micro-sprinkler, or drip irrigation, so compliance will primarily regard drift management rather than runoff management.

Application and management costs will increase more if the buffer treatment does not have the same timing as the orchard treatment. Lorsban 4E and Delegate 25 WG are applied at the same stage of codling moth population development. Insect growth regulators require application one to two weeks earlier. Although costs increase, there's no expectation that efficacy will decrease due to different application times for the field and the buffer.

3.3.8.c Analyzed Impacts

In all, eight scenarios regarding codling moth control are considered. In four scenarios, an alternative is applied only to the buffer and in the other four scenarios it is applied to the entire field.

<u>Codling moth control.</u> We consider four specifications, one in which spinetoram (Delegate 25 WG) is applied only in the buffer and chlorpyrifos (Lorsban 4E) is applied in the remainder of the orchard, and one in which spinetoram is applied to the entire orchard. The application method is air blast, so the 100-ft. buffer applies. We assume that the two treatments provide

equal control, so that there is no reduction in yield or quality.[23] The per acre cost of the pesticide material is 23% higher on acreage treated with spinetoram at the lowest experimental rate of 3.2 oz./acre, and 168% higher at the maximum label rate of 7 oz./acre examined by Van Steenwyk, Kiss and Evers (2009). In order to bound the cost effects of the various combinations of application rates and buffer versus field use, we report two possibilities: the lowest rate of spinetoram applied only to the buffer, and the maximum label rate applied to the entire orchard. The treatment in each scenario cost assumes two applications are made. Within each of the four combinations we consider the effects of maintaining quality with the use of spinetoram, so that growers receive the price premium for all walnuts produced, and the effects of reduced quality of walnuts produced on acreage treated with spinetoram, leading to the loss of the premium.

[23] Because spinetoram efficacy is dependent on application timing, there is the possibility that a late application will reduce quality even if a similarly timed application of chlorpyrifos would have provided adequate control. The price growers obtain at harvest is reduced if a sufficient percentage of nuts at harvest containing codling moth worms.

3.3 References

[ABC, 2008] Almond Board of California. 2008. *California Almond Acreage Report: 2004-2008.* Available at http://www.almondboard.com/Trade/content.cfm?ItemNumber=533&snItemNumber=457&tnItemNumber=817&qnItemNumber=846. Accessed May 2009.

Alston, J., H. Carman, J. Christian, J. Dorfman, J-R. Murua, and R. Sexton. 1995. "Optimal Reserve and Export Policies for the California Almond Industry: Theory, Econometrics and Simulations." *Giannini Foundation Monograph*, 42, February 1995.

Askari, Hossein and Cummings, John Thomas. 1977. Agricultural Supply Response with the Nerlove Model: A Survey. *International Economic Review* 18, 2: 257-292.

BASF n.d. "Specimen Label Prowl H20." http://www.cdms.net/LDat/ld6CT021.pdf. Accessed July 2011.

Bayer CropScience. n.d. "Specimen Label: Movento." Available at http://www.cdms.net/LDat/ld8L5028.pdf. Accessed August 2011.

Bayer CropScience. n.d. "Specimen Label: Provado Flowable Insecticide." Available at http://www.cdms.net/LDat/ld6AQ006.pdf. Accessed August 2011.

Bolda, Mark P., Laura Tourte, Karen M. Klonsky and Richard L. De Moura. 2010. "Sample Costs to Produce Strawberries: Central Coast Region, Santa Cruz and Monterey Counties." UC Cooperative Extension ST-CC-10. Available at http://coststudies.ucdavis.edu/files/StrawberriesCC2010.pdf. Accessed July 2011.

Boriss, H. and H. Brunke. 2005a. "Commodity Profile: Lettuce." University of California Agricultural Issues Center. October. Available at http://aic.ucdavis.edu/profiles/lettuce-2005.pdf. Accessed July 2009.

Boriss, H. and H. Brunke. 2005b. "Commodity Profile: Processing Tomatoes." University of California Agricultural Issues Center. December 2005. Available at http://www.aic.ucdavis.edu/profiles/Processing_Tomatoes-2005.pdf. Accessed July 2009.

Boriss, H. and H. Brunke. 2006a. "Commodity Profile: Table Grapes." Agricultural Issues Center, University of California. Available at http://aic.ucdavis.edu/profiles/sFreshMarket-2006.pdf. Accessed July 2011.

Boriss, H. and H. Brunke. 2006b. Commodity Profile: Raisins (dried grapes). Agricultural Issues Center, University of California. Available at http://aic.ucdavis.edu/profiles/Raisins-2006.pdf. Accessed July 2011.

Boriss, H. and H. Brunke. 2008. “Commodity Profile: Broccoli.” Agricultural Marketing Resource Center. December (Revised). Available at http://www.agmrc.org/commodities__products/vegetables/broccoli_profile.cfm. Accessed June 2009.

Boriss, H. and H. Brunke. 2009a. “Commodity Profile: Lettuce.” Agricultural Marketing Resource Center. May (Revised). Available at http://www.agmrc.org/commodities__products/vegetables/lettuce_profile.cfm. Accessed July 2009.

Boriss, H. and H. Brunke. 2009b. “Commodity Profile: Almonds.” University of California Agricultural Issues Center. Available at http://www.agmrc.org/commodities__products/nuts/almond_profile.cfm. Accessed May 2009.

Burfield, Tom. 2009. “Kiss Lygus Bugs Goodbye.” *The Grower*. Available at http://www.thegrower.com/issues/the-grower/kiss_lygus_bugs_goodbye_117876884.html. Accessed July 2011.

[Butte County, 2010]. Butte County 2009 Agricultural Crop Report. 29 June 2010. Available at http://www.buttecounty.net/Agricultural%20Commissioner/~/media/County%20Files/Agriculture/Public%20Internet/2009%20Crop%20Report.ashx. Accessed July 2011.

[CAFA, 2004] California Alfalfa and Forage Association. 2004. “Commodity Fact Sheet: Alfalfa.” Available at http://alfalfa.ucdavis.edu/-files/pdf/alfalfaFactSheet.pdf. Accessed August 2009.

California Tomato Commission. Available at: www.tomato.org. Accessed July 2009.

Carter, Colin A. ; Chalfant, James A.; Goodhue, Rachael E.; Han, Frank M., and DeSantis, Massimiliano. 2005. The Methyl Bromide Ban: Economic Impacts on the California Strawberry Industry. *Appl. Econ. Perspect. Pol.* 27, 2:181–197.

[CCAC, 2010] County Agricultural Commissioner's Data 2009. December 2010. USDA National Agricultural Statistics Service, California Field Office. Available at http://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/200910cactb00.pdf. Accessed July 2011.

[CCAC, 2000] County Agricultural Commissioner's Data 1999. August 2000. California Agriculture Statistics Office. Available at http://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/199908cactb00.pdf. Accessed July 2011.

[CCAC, 2005-2009] County Agricultural Commissioner's Data. Available at http://nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Detail/index.asp. Accessed July 2011.

Central Coast Vineyard Team. 2008. "Central Coast Vineyard Team Pesticide Reduction and Identification of Source Mitigation (PRISM) Project, Central Coast California: Final Report." Prepared for Regional Water Quality Control Board, San Luis Obispo, CA. March.

Chemtura Corporation. n.d. "Specimen Label: Dimilin 2L." Available at http://www.cdms.net/LDat/ld08S035.pdf. Accessed July 2011.

Chemtura Corporation, n.d. *Rimon Specimen Label*. Available at http://www.cdms.net/LDat/ld6LD006.pdf. Accessed July 2011.

Chern, W.S. 1976. "Acreage Response and Demand for Processing Tomatoes in California." American Journal of Agricultural Economics 58(2):209-216.

Chern, W.S. and R.E. Just. 1978. "Econometric Analysis of Supply Response and Demand for Processing Tomatoes in California." Giannini Foundation Monograph No. 37. University of California, Berkeley. September 1978.

Cullen, Eileen M. and Frank G. Zalom. 2007. "On-farm Trial Assessing Efficacy of Three Insecticide Classes for Management of Stink Bug and Fruit Damage on Processing Tomatoes." Pest Management Network. *Plant Health Progress* doi:10.1094/PHP-2007-0323-01-RS. Available at http://www.plantmanagementnetwork.org/sub/php/research/2007/stink/ProcessingTomatoes.pdf. Accessed July 2011.

Daane, Kent M., Rhonda J. Smith, Karen M. Klonsky and Walter J. Bentley. 2005. "Organic Vineyard Management in California." *Organic-Research.com*. 5:7-55.

Dow AgroSciences. n.d. "Specimen Label: Asana." Available at http://www.cdms.net/LDat/ld184029.pdf. Accessed August 2011.

Dow AgroSciences. n.d. "Specimen Label: Entrust." Available at http://www.cdms.net/LDat/ld62B024.pdf. Accessed August 2011.

Dow AgroSciences. n.d. "Specimen Label: Intrepid." Available at http://www.cdms.net/LDat/ld61K016.pdf. Accessed August 2011.

Dow AgroSciences n.d. "Specimen Label: Lorsban-4E Insecticide." Available at http://www.cdms.net/ldat/ld02A011.pdf. Accessed July 2011.

Dow AgroSciences. n.d. "Specimen Label: Success." Available at http://www.cdms.net/LDat/ld0HQ025.pdf. Accessed August 2011.

DuPont. n.d. Speciment Label: Matrix SG." Available at
http://www.cdms.net/LDat/ld8O3006.pdf. Accessed August 2011.

[ERS, 2005a] Perez, A. and S. Pollack. 2005. "California Citrus Plentiful This Summer But Sweet Cherry, Almonds Crops Down." Publication No. FTS-317, Economic Research Service, U.S. Department of Agriculture. July.

[ERS, 2005b] Economics Research Service, U.S. Department of Agriculture. 2005. "'Table 67 - U.S. lettuce: Per capita use, 1960-2005." Available at http://usda.mannlib.cornell.edu/data-sets/crops/lettuce/. Accessed July 2009.

[ERS, 2007a] Perez, A. and S. Pollack. 2007. "Fruit and Tree Nuts Outlook: Bigger Crops Forecast for Most Stone Fruit and Almonds in 2007 Than A Year Ago." Publication No. FTS-328, Economic Research Service, U.S. Department of Agriculture. July.

[ERS, 2007b] Economic Research Service, United States Department of Agriculture. *Fruit and Tree Nuts Situation and Outlook Yearbook* FTS-2007. October. Available at http://www.ers.usda.gov/publications/fts/2007/Yearbook/FTS2007s.txt. Accessed March 2008.

[ERS, 2008] Perez, A. and S. Pollack. 2008. "Fruit and Tree Nuts Outlook: Lower U.S. Production Forecast for Most Stone Fruit in 2008." Publication No. FTS-333, Economic Research Service, U.S. Department of Agriculture. July.

[ERS, 2009a] Economic Research Service, U.S. Department of Agriculture. 2009. "Fruit (All uses)." February. Available at
http://www.ers.usda.gov/data/foodconsumption/FoodAvailSpreadsheets.htm. Accessed June 2009.

[ERS, 2009b] Economic Research Services, U.S. Department of Agriculture. 2009. "USDA Feed Grain Baseline, 2009-2018." February 12 (Updated). Available at http://www.ers.usda.gov/briefing/Baseline/present2009.htm. Accessed August 2009.

[ERS, 2010a] Economic Research Service, U.S. Department of Agriculture. 2010. "Food Availability Spreadsheet: Fruit (All uses)." Available at
http://www.ers.usda.gov/data/foodconsumption/FoodAvailSpreadsheets.htm. Accessed March 2011.

[ERS, 2010b] Economics Research Service, U.S. Department of Agriculture. 2011. Table 3: US Head Lettuce: Area, yield, production, value: 1950-2010. Available at http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1576.
Accessed July 2011.

[ERS, 2010c] Economics Research Service, U.S. Department of Agriculture. 2011. Table 5: US Leaf Lettuce: Area, yield, production, value: 1992-2009. Available at http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1576. Accessed July 2011.

[ERS, 2010d] USDA ERS. Table 7: US broccoli, all uses: area, use, production, price and value: 1950-2010. Available at http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1816. Accessed July 2011.

[ERS, 2010e] Table 2: US Processing Tomatoes: Area, Yield, Production and Value 1960-2009. US Tomatoes Statistics. Available at http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1210. Accessed July 2011.

[FAS, 2011]. Global Agricultural Trade Service Online database. USDA Foreign Agricultural Service. Available at http://www.fas.usda.gov/gats/ExpressQuery1.aspx. Accessed July 2011.

Fennimore, Steven A. and Douglas J. Doohan. 2008. "The Challenges of Specialty Crop Weed Control, Future Directions." *Weed Technology* 24:364-372.

Fennimore, Steven A., Laura Tourte, John S. Rachuy, Richard F. Smith, and Christina George. 2010. "Evaluation and Economics of a Machine-Vision Guided Cultivation Program in Broccoli and Lettuce." *Weed Technology* 24:33-38.

Ferrier, Peyton and Zhen, Chen. 2011. Habit Effects and Producer Welfare In the Fresh Vegetable Trade. *Agricultural and Applied Economics Association Summer Meeting*, July 24-26, 2011, Pittsburgh, PA.

Fischer, Albert J., Comfort M. Ateh, David E. Bayer, and James E. Hill. 2000. "Herbicide-resistant *Echinochloa oryzoides* and *E. phyllopogon* in California *Oryza sativa* fields." *Weed Science* 48:225-230.

[Fresno County, 2008] Agricultural Commissioner, County of Fresno. 2007. "2007 Fresno County Agricultural Crop and Livestock Report." Available at http://www.co.fresno.ca.us/DepartmentPage.aspx?id=23215. Accessed July 2009.

[Fresno County, 2010] Fresno Department of Agriculture. 2009. "Annual Agricultural Crop and Livestock Report." Available at www.co.fresno.ca.us/ViewDocument.aspx?id=44077. Accessed July 2011.

Gast, Roger E. 2008. "Industry Views of Minor Weed Control." *Weed Technology* 22:385-388.

George, P.S. and G.A. King. 1971. "Consumer Demand for Food Commodities in the United States with Projections for 1980." Giannini Foundation Monograph No. 26. University of California, Davis. March 1971.

Glaser, L.K. and G.D. Thompson. 1998. "Demand for Organic and Conventional Frozen Vegetables." Paper presented at AAEA annual meeting, Salt Lake City, UT, 2-5. August.

Godfrey, Larry and Dan Putnam. 2002. "Management of Egyptian Alfalfa Weevil and Protection of Yields with Selected Insecticides." Proceedings of the 32nd Western Alfalfa and Forage Conference, Reno, NV. Available at http://alfalfa.ucdavis.edu/+symposium/proceedings/2002/02-041.pdf. Accessed July 2011.

Godfrey, Larry D., Richard R. Lewis, Karey Windbiel-Rojas, and Wade Pinkston. 2007. "Impact of Management Strategies for Rice Water Weevil on Populations of Non-target Invertebrates in California Rice." 4th International Temperate Rice Conference. 2 pages.

Godfrey, Larry D., W. Pinkston, Kirin Basuta, and Evan Goldman. 2008. "Rice Protection from Invertebrate Pests." Annual Report Project R9-3, Comprehensive Research on Rice. 33 pages. http://www.carrb.com/08rpt/Godfrey%20RP3%2008.pdf. Accessed July 2011.

Godfrey, Larry D., and Evan Goldman. 2009. "Rice Protection from Invertebrate Pests." Annual Report Project R9-3, Comprehensive Research on Rice. 36 pages. http://www.carrb.com/09rpt/Godfrey%20RP3%2009.pdf. Accessed July 2011.

Godfrey, Larry D., and Evan Goldman. 2010. "Rice Protection from Invertebrate Pests." Annual Report Project R9-3, Comprehensive Research on Rice. 45 pages. http://www.carrb.com/10rpt/2010%20RP3%20Godfrey.pdf. Accessed July 2011.

Goodhue, Rachael E., Karen Klonsky and Sandeep Mohapatra. 2010. "Can a Grower Education Program be a Substitute for a Regulation that Bans Pesticides? Evidence from a Panel Selection Model." *American Journal of Agricultural Economics* 92(4):956-971.

Gowan Co. n.d. "Supplemental Label: Imidan 70-W for Control of Peach Twig Borer on Apricots, Peaches, Nectarines, Plums, Prunes, and Almonds." Available at http://www.cdms.net/LDat/ld7DS023.pdf. Accessed August 2011.

Green, R. 1999. "Demand for California Agricultural Commodities." *ARE Update* 2(2). Department of Agricultural and Resource Economics, University of California, Davis.

Haar, Milton J. and Steven A. Fennimore. 2003. "Evaluation of Integrated Practices for Common Purslane (*Portulaca oleracea*) Management in Lettuce (*Lactuca sativa*)." *Weed Technology* 17:229-233.

Hammig, Michael and Mittelhammer, Ron. 1980. An Imperfectly Competitive Market Model of the U.S. Lettuce Industry. *Western Journal of Agricultural Economics* 5: 1-12.

Heintz, Chris. 2000. "Update a Pest Management Evaluation for the Almond Industry." Prepared for the California Department of Pesticide Regulation. Available at *cdpr.ca.gov/docs/pestmgt/grants/alliance/99-00/evals/99-0198.pdf.* Accessed August 2011.

Henneberry, S.R., K.P. Piewthongngam, and H. Qiang. 1999. "Consumer Safety Concerns and Fresh Produce Consumption." Journal of Agricultural Resource Economics 24: 98-113.

Huang, K. 1986. "US Demand for Food: A Complete System of Price and Income Effects." United States Department of Agriculture, Economic Research Service. Technical Bulletin 1714.

Jackson, L., K. Mayberry, F. Laemmlen, S. Koike, K. Schulbach, and W. Chaney. 1996. "Iceberg Lettuce Production in California." Publication No. 7215, *Division of Agricultural and Natural Resources, University of California*. Available at http://anrcatalog.ucdavis.edu/pdf/7215.pdf. Accessed July 2009.

Konya K., and K. Knapp. 1988. "Market Analysis of Alfalfa Hay: California Case." *Agribusiness* 4(3):271-284.

Lanini, W. Thomas and Michelle Le Strange. 1991. "Low-input Management of Weeds in Vegetable Fields." *California Agriculture* 45(1):11-13.

Lave, Lester. 1963. The Value of Better Weather Information to the Raisin Industry. *Econometrica* 31, 1/2: 151-164.

Linquist, Bruce, Albert Fischer, Larry Godfrey, Chris Greer, James Hill, Kaden Koffler, Michael Moeching, Randall Mutters and Chris Van Kessel. 2008. "Minimum Tillage Could Benefit California Rice Farmers." *California Agriculture* 62(1):24-29.

Lucier, G., and A. Jerardo. 2005. "Vegetables and Melons Outlook." Publication No. VGS-307, Economic Research Service, U.S. Department of Agriculture. February.

Lucier, G., and A. Jerardo. 2006. "Vegetables and Melons Outlook." Publication No. VGS-317, Economic Research Service, U.S. Department of Agriculture. October.

Lucier, G., S. Pollack, and A. Perez. 2006. "Fruit and Vegetable Backgrounder." Publication No. VGS-313-01, Economic Research Service, U.S. Department of Agriculture. April.

Makhteshim Agan of North America, Inc. n.d. "Specimen Label: Thionex 3EC Insecticide." http://www.cdms.net/LDat/ld9P4000.pdf Accessed July 2011.

Mutters, Randall, Christopher Greer, Karen M. Klonsky and Pete Livingston. 2007. "Sample Costs to Produce Rice: Sacramento Valley, Rice Only Rotation." University of California Cooperative Extension. http://coststudies.ucdavis.edu/files/ricesv07.pdf. Accessed July 2011.

[NASS 2010a]. California Agricultural Statistics: Crop Year 2009. USDA National Agricultural Statistics Service. Dec. 2010. Available at http://www.nass.usda.gov/Statistics_by_State/California/Publications/California_Ag_Statistics/Reports/2009cas-all.pdf Accessed July 2011.

[NASS 2010b]. "California Alfalfa Hay, 1919-2008". California Historic Commodity Data. USDA, NASS, California Field Office. Feb. 2010. Available at http://www.nass.usda.gov/Statistics_by_State/California/Historical_Data/Hay-Alf.pdf Accessed July 2011.

[NASS 2010c]. US Strawberry Production, Utilization, Prices and Values: 1970-2009. Available at http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1381 Accessed July 2011.

Nuckton, C. 1978. "Demand Relationship for California Tree Fruits, Grapes, and Nuts: A Review of Past Studies." Giannini Foundation, August 1978.

Perez de Vida, Fernando B., Emilio A. Laca, David J. Mackill, Grisel M. Fernandez and Albert J. Fischer. 2006. "Relating Rice Traits to Competitiveness and Yield: A Path Analysis." *Weed Science* 54:1122-1131.

Pickel, Carolyn. 2002. "Appendix: Almonds." In "The Economic Importance of Organophosphates in California Agriculture." Mark Metcalfe, Bruce McWilliams, Brent Hueth, Robert Van Steenwyk, David Sunding, and David Zilberman. Available at www.cdfa.ca.gov/files/pdf/**Organophosphates**CAAgriculture.pdf. Accessed August 2011.

Pickel, Carolyn C., Frank G. Zalom, Douglas B. Walsh, and Norman C. Welch. 1994. "Efficacy of Vacuum Machines for *Lygus Hesperus* (Hemiptera: Miridae) Control in Coastal California Strawberries." *Horticultural Entomology* 87(6):1636-1640.

Pickel, Carolyn C., Frank G. Zalom, Douglas B. Walsh, and Norman C. Welch. 1995. "Vacuums Provide Limited Lygus Control in Strawberries." *California Agriculture* 49(2):19-22.

Price, D.W., and R.C. Mittelhammer. 1979. "A Matrix of Demand Elasticities for Fresh Fruit." *Western Journal of Agricultural Economics* 4, 1:69-86.

Pickel, C. J. Grant, S. Welter, R. Buchner, C. DeBuse, W. Bentley, C. Abbott, and S. Goldman Smith. 2010. "Using Aerosol Pheromone 'Puffers' for Area-wide Suppression of Codling Moth in Walnuts: Year Six." California Walnut Board. Walnut Research Reports 2010. P.127-139.

Russo, C., R. Green, and R. Howitt. 2008. "Estimation of Supply and Demand: Elasticities of California Commodities." Working paper. Department of Agricultural and Resource Economics, University of California, Davis. June.

[Sage Foods, 2011] Rice Production in the World and the US. Sage Foods. 2011. Available at http://www.sagevfoods.com/MainPages/Rice101/Production.htm Accessed July 2011.

Sexton, R.J. and Mingxia Zhang. 1996. "A Model of Price Determination for Fresh Produce with Application to California Iceberg lettuce." *American Journal of Agricultural Economics* 78(4):924-934.

Sharma, R.K. and M. Stern. 1976. "Economic Treatment Levels for the Blue Alfalfa Aphid." Proceedings of the 6th California Alfalfa Symposium, Fresno, CA. Available at http://alfalfa.ucdavis.edu/+symposium/proceedings/1976/76-68.pdf. Accessed July 2011.

Shem-Tov, Shachar, Steve A. Fennimore, and W. Thomas Lanini. 2006. "Weed Management in Lettuce (*Lactuca sativa*) with Preplant Irrigation." *Weed Technology* 20:1058-1065.

[Stanislaus County 2010] Stanislaus County Agricultural Crop Report 2009. June 2010. Available at http://www.stanag.org/ag/croprpts/croppdf/2009-crop-report.pdf Accessed July 2011.

Swezey, Sean, Diego J. Nieto, and Janet A. Bryer. 2007. "Control of Western Tarnished Plant Bug *Lygus hesperus* Knight (Hemiptera: Miridae) in California Organic Strawberries Using Alfalfa Trap Crops and Tractor-Mounted Vacuums." *Environmental Entomology* 36(6):1457-1465.

Syngenta Crop Protection Inc. n.d. *Actara* Supplemental Label: Directions for Use on Tropical Fruit and Revised Berry and Small Fruit Crops. Available at http://www.cdms.net/LDat/ld55M006.pdf. Accessed July 2011.

Syngenta Crop Protection Inc. n.d. *Actara Specimen Label*. Available at http://www.cdms.net/LDat/ld55M030.pdf. Accessed July 2011.

Syngenta. n.d. "Specimen Label: Princep Caliber 90." Available at http://www.cdms.net/LDat/ld442002.pdf. Accessed August 2011.

Syngenta Crop Protection Inc. n.d. "Specimen label: Warrior II with Zeon." Available at http://www.cdms.net/LDat/ld8JD040.pdf. Accessed August 2011.

[UCCE, 1999] University of California Cooperative Extension, University of California Davis. 1999. "Crop Profile for Almonds in California." January, 26. Available at http://ucce.ucdavis.edu/files/datastore/391-12.pdf. Accessed May 2009.

[UCCE, 2004] Meister, H.S. 2004. “Sample Costs to Establish an Orchard and Produce Iceberg lettuce: Imperial County.” Available at http://coststudies.ucdavis.edu/files/icelettuce04.pdf. Accessed July 2009.

[UCCE, 2008] Freeman, M. W., M. A. Viveros, K. M. Klonsky, and R. L. De Moura. 2008. “Sample Costs to Establish an Orchard and Produce Almonds: San Joaquin Valley South.” Available at http://coststudies.ucdavis.edu/files/almondvs08sprink.pdf. Accessed May 2009.

[UC IPM 2010 St-LB] UC IPM Pest Management Guidelines: Strawberry, Lygus Bug. 2010. Available at http://www.ipm.ucdavis.edu/PMG/r734300111.html. Accessed July 2011.

[UC IPM A 2008] University of California Integrated Pest Management Program. 2008. “Alfalfa: How to Manage Pests.” Available at http://www.ipm.ucdavis.edu/PMG/selectnewpest.alfalfa-hay.html. Accessed July 2011.

[UC IPM A-H] University of California Integrated Pest Management Program. 2009. “Alfalfa: Herbicide Treatment Table for Established Alfalfa.” Available at http://www.ipm.ucdavis.edu/PMG/r1700311.html. Accessed July 2011.

[UC IPM-A-IWM 2009] University of California Integrated Pest Management Program. 2009. “Almond: Integrated Weed Management.” Available at http://www.ipm.ucdavis.edu/PMG/r3700111.html. Accessed August 2011.

[UC IPM A-NOW 2009] University of California Integrated Pest Management Program. 2009. “Almond: Navel Orangeworm.” Available at http://www.ipm.ucdavis.edu/PMG/r3300311.html. Accessed August 2011.

[UC IPM A-PTB 2009] University of California Integrated Pest Management Program. 2009. “Almond: Peach Twig Borer.” Available at http://www.ipm.ucdavis.edu/PMG/r3300211.html. Accessed August 2011.

[UC IPM G-IWM 2008] University of California Integrated Pest Management Program. 2008. “Grape: Integrated Weed Management.” Available at http://www.ipm.ucdavis.edu/PMG/r302700111.html. Accessed August 2011.

[UC IPM G-HTT 2010] University of California Integrated Pest Management Program. 2010. “Grape: Herbicide Treatment Table.” Available at http://www.ipm.ucdavis.edu/PMG/r302700311.html. Accessed August 2011.

[UC IPM 2008 G-MB] University of California Integrated Pest Management Program. 2008. “Grape: Mealybugs (*Pseudococcus*).” Available at http://www.ipm.ucdavis.edu/PMG/r302301811.html. Accessed August 2011.

[UC IPM 2008 G-VMB] University of California Integrated Pest Management Program. 2008. “Grape: Vine Mealybug.” Available at http://www.ipm.ucdavis.edu/PMG/r302301911.html. Accessed August 2011.

[UC IPM L-IWM 2007] University of California Statewide Integrated Pest Management Program. 2007. “UC Pest Management Guidelines: Lettuce, Integrated Weed Management.” Available at http://www.ucipm.ucdavis.edu/PMG/r441700111.html. Accessed August 2011.

[UC IPM R-RWW 2009] University of California Statewide Integrated Pest Management Program. 2009.” UC Pest Management Guidelines: Rice.” http://www.ipm.ucdavis.edu/PMG/r682300511.html. Accessed July 2011.

[UC IPM T-SB 2008] “UC Pest Management Guidelines: Tomato, Stink Bugs.” http://www.ucipm.ucdavis.edu/PMG/r783300211.html. Accessed July 2011.

United Phosphorus, Inc. n.d. “Specimen label: Stam 4SC.” http://www.cdms.net/LDat/ld7T6000.pdf. Accessed July 2011.

United Phosphorus Inc. n.d. *Assail 30SG Specimen label*. Available at http://www.cdms.net/LDat/ld7BT027.pdf. Accessed July 2011.

[USITC, 2008]. Monitoring of US Imports of Tomatoes. US International Trade Commission. November 2008. Investigation No. 332-350. Available at http://www.usitc.gov/publications/332/pub4048.pdf Accessed July 2011.

Valent Co. 2007. “Important Notice for Almond Growers in Merced, Stanislaus and San Joaquin Counties.” http://www.cdms.net/LDat/ld6ED019.pdf. Accessed August 2011.

Valent. n.d. “Specimen Label: Clutch.” Available at http://www.cdms.net/LDat/ld8B8004.pdf. Accessed August 2011.

Valent. n.d. “Specimen Label: Venom.” Available at http://www.cdms.net/LDat/ld74M003.pdf. Accessed August 2011.

Valent U.S. Corp. n.d. “Supplemental Label: Chateau Herbicide SW Use in Alfalfa.” http://www.cdms.net/LDat/ld6ED045.pdf. Accessed July 2011.

Van Steenwyk, R.A., A.B. Kiss, and C.A. Evers. 2009. “Codling Moth Controls in Walnuts, 2009.” University of California, Berkeley. Mimeo.

Volpe, Richard, Green, Richard and Heien, Dale. 2008. “Estimating the Supply of California Wine Grapes using Regional Systems of Equations.” Working Paper. Department of Agricultural and Resource Economics, University of California, Davis.

Williams, J.F., S.R .Roberts, J.E. Hill, S.C. Scardaci, and G. Tibbits. 1990. “Managing Water for Weed Control in Rice.” *California Agriculture* 44(5):7-10.

[WRIC-UCCE 2009] Weed Research and Information Center, University of California Cooperative Extension. “Weed Susceptibility to Herbicides Database.” Available at http://info.ucanr.org/weed_sept/Default.asp. Accessed August 2011.

You, Z., J.E. Epperson, and C.L. Huang. 1996. "A Composite System Demand Analysis for Fresh Fruit and Vegetables in the United States." *Journal of Food Distribution Research* October: 11-22.

Chapter 4
Results

Results are reported alphabetically by county, and alphabetically by crop for each county.

4.1 Butte County Results

Almond, rice, and walnut are the three crops evaluated for Butte County.

4.1.1 Almond

We examine two scenarios for almonds. For both the effect of a switch from Goal to Matrix (and a double application of Round-up) in order to control weeds is combined with the switch from Asana to Entrust to control major insect pests. The first scenario considers the impact on revenues when the acreage treated with the alternative chemicals incurs no yield losses, and the second scenario considers the impact when there is a 15% yield loss on acreage treated with the alternative chemicals.

Under the draft regulations, 6% of Butte County almond acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 93% of all fields would be required to implement a 100 ft. buffer. On average, affected fields would have 15% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 1% of county almond acreage would be included in a 25 ft. buffer, 33% of fields would be required to implement a 25 ft. buffer, and on average 3% of each affected field's acreage would be included. We examine the combined effects when farmers switch to the alternative for both herbicides and insecticides, and we use the 6% affected area under the 100 ft. buffers for both effects; this will overestimate the impacts of the alternative herbicide treatment, but greatly simplifies the analysis.

Table 4.4.1a reports results for the first scenario. As discussed in section 3.1.1, we consider three cases. The first two columns below report results for cases where the price of almonds changes with the quantity produced in Butte County (column 1) and with the quantity produced in California assuming that all almond production in the state faces the same effects as Butte County production (column 2). The final column reports results for Butte County when price does not respond to a change in quantity produced.

In the first scenario, with zero loss in yields, total revenues are identical across the cases. Net revenue will decline by $161,336. There is no difference between the cases because there is no change in quantity or price, only an increase in treatment cost per acre.

Table 4.1.1a Effects of Draft Regulations: Almonds, Butte County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal and Asana
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	3.1%	3.1%	3.1%
County Net Revenues (%)	-2.4%	-2.4%	-2.4%
County Net Revenues ($)	-$161,336	-$161,336	-$161,336

The demand for California almonds is inelastic, implying that a given percentage decrease in quantity will lead to relatively greater percentage increase in price. In the second scenario, with a 15% yield loss on acreage treated with the alternative chemicals, the resulting price increase is enough to offset the increase in costs if all of California is affected by the regulations (see column two in Table 4.1.1b below) but not if only Butte County is affected. In the latter case, total revenues are expected to decrease by $802,256 and net revenues to decrease by $964,053. If price does not increase when quantity decreases because suppliers outside of the state increase their quantity, then total revenues in Butte will decline by $850,987 and net revenues by $1 million.

Table 4.1.1b Effects of Draft Regulations: Almonds, Butte County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal and Asana
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.9%	-0.9%	-0.9%
Price (%)	0.1%	1.3%	0.0%
County Total Revenues (%)	-0.8%	0.4%	-0.9%
County Total Revenues ($)	-$802,256	$398,304	-$850,987
Cost Per Acre (%)	3.1%	3.1%	3.1%
County Net Revenues (%)	-14.3%	3.1%	-15.0%
County Net Revenues ($)	-$964,053	$209,968	-$1,012,323

4.1.2 Rice

We examine two impacts of the draft regulations on rice. The first looks at the effect on revenues when growers are longer able to use propanil (Stam 4SC) as an herbicide within 25 ft. buffer zones from sensitive aquatic sites. The second looks at the effect on revenues when lambda-cyhalothrin (Warrior II with Zeon) can no longer be applied at all as an insecticide on a 25 ft. buffer and must be applied via ground application instead of aerial spray on the additional area between that 25 ft. buffer boundary and the edge of a 100 ft. buffer. For this latter effect, we examine two possible scenarios: an 13% yield loss on the area receiving a ground application of lambda-cyhalothrin with an 11% yield loss on the 25 ft. buffer area receiving no insecticide, or a 15% yield loss on the area receiving a ground application with a 23% yield loss on the 25 ft. buffer receiving no insecticide.

Under the draft regulations, 1% of Butte County rice acreage would be included in a 25 ft. buffer, which applies to the herbicide treatment and the insecticide treatment included in the analysis. 83% of all fields would be required to implement a 25 ft. buffer. On average, affected fields would have 1% of their acreage in a buffer. 10% of Butte County rice acreage would be included in a 100 ft. buffer, which applies to the herbicide treatment and the insecticide treatment included in the analysis. 93% of all fields would be required to include a 100 ft. buffer. On average, affected fields would have 15% of their acreage in a buffer.

In the first scenario, where the effects on revenues when Stam 4SC is no longer applied in the buffer zones, and no other herbicide is used to replace it, gross and net revenues in Butte County would increase by over $1.3 million if the draft regulations affected all of California in the same way, as can be seen in Table 4.1.1a below. This is because there is a substantial yield effect which reduces quantity of rice supplied, and the own-price elasticity of demand for rice is highly inelastic so a small reduction in quantity leads to a large increase in price. The effect on revenues in Butte is quite different if just Butte is affected by the regulations. Total revenues would decrease by $332,918 and net revenues would decrease by $295,670. This difference is due to the fact that Butte County's 20% share of California rice production is too small for its decline in production to increase the price sufficiently to offset that decline. If the price did not increase with a decrease in quantity in Butte or California as a whole because of an increase in rice supplied from producers outside the state, then total revenue would decline by $735,299 and net revenue by $695,568.

Table 4.1.2a Effects of Draft Regulations: Rice, Butte County
Effect due to changes in Stam 4SC application
40% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.4%	-0.4%	-0.4%
Price (%)	0.2%	1.1%	0.0%
County Total Revenues (%)	-0.2%	0.7%	-0.4%
County Total Revenues ($)	-$332,918	$1,329,893	-$735,299
Cost Per Affected Acre (%)	-4.5%	-4.5%	-4.5%
County Net Revenues (%)	-0.3%	1.4%	-0.7%
County Net Revenues ($)	-$295,670	$1,338,760	-$695,568

In the second scenario, where we consider the impact on revenue due to the induced changes in Warrior II with Zeon application with 13% and 11% losses, there is a positive effect on total and net revenues in Butte if all of California is affected equally by the regulations, as shown in column two of Table 4.1.2b below. The increase in revenues far exceeds those in Table 4.1.2a. Price still increases due to the decline in quantity and the highly inelastic demand, but the smaller decline in quantity means that overall revenues are higher on balance. Column one shows that Butte County is disproportionately affected by the draft regulations when just the county is affected. Its total revenues decrease by $574,566. Butte's net revenues actually still increase in this case, but by $522,820 which is far less than the $5.9 million increase when all of California is affected. If outside suppliers prevent a quantity change in Butte or California from increasing the price, then total revenues would decline by $2.4 million and net revenues would decrease by $1.9 million.

Note that the definition of the change in cost per acre is different because two types of buffers are considered. In this table the percentage cost change is a per *field* acre average.

Table 4.1.2b Effects of Draft Regulations: Rice, Butte County
Effect due to changes in Warrior II with Zeon application
13% and 11% yield losses (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-1.3%	-1.3%	-1.3%
Price (%)	0.7%	3.7%	0.0%
County Total Revenues (%)	-0.6%	2.5%	-1.3%
County Total Revenues ($)	-$574,566	$2,400,963	-$2,444,834
Avg. Cost Per Field Acre (%)	-0.6%	-0.6%	-0.6%
County Net Revenues (%)	0.5%	6.2%	-2.0%
County Net Revenues ($)	$522,820	$5,906,475	-$1,907,027

In the third scenario, with 15% and 23% losses due to changes in Warrior II with Zeon application, the increases in revenue for Butte if all of California is affected by the regulations and price increased with the decrease in quantity is even greater than in the previous scenario (Table 4.1.2c). However, if only Butter is affected, then the total revenue decreases by $689,306, a larger decrease than with 11% and 13% yield losses, and net revenue increases by $290,921, a smaller increase. If price does not increase with the change in quantity of rice, then Butte stands to lose $2.9 million in total revenues and $2.4 million in net revenues.

Table 4.1.2c Effects of Draft Regulations: Rice, Butte County
Effect due to changes in Warrior II with Zeon application
15% and 23% yield losses (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-1.6%	-1.6%	-1.6%
Price (%)	0.9%	4.4%	0.0%
County Total Revenues (%)	-0.7%	3.0%	-1.6%
County Total Revenues ($)	-$689,306	$2,917,349	-$2,938,290
Avg. Cost Per Field Acre (%)	-0.6%	-0.6%	-0.6%
County Net Revenues (%)	0.3%	7.0%	-2.5%
County Net Revenues ($)	$290,921	$6,743,590	-$2,394,717

4.1.3 Walnut

We analyze eight scenarios for walnuts that vary in terms of pesticide application rates, yield effects, acres treated, and effect on walnut quality and price premium, with Delegate 25 WG sprayed across the entire field or just in 150 ft. buffer zones at two different application rates, and with and without a $0.06 per pound price premium for walnuts treated with Lorsban but not walnuts treated with Delegate 25 WG. The two different application rates were a high application rate of 7 oz./acre and an intermediate application rate of 3.2 oz./acre. The alternative pesticide for controlling codling moth, Delegate 25 WG, is just as effective as Lorsban in terms of the quantity produced per acre, so there is no yield effect.

We consider the possibility that Delegate 25 WG will not control sufficiently for growers to obtain a price premium for walnut quality. Quantities and thus the base price will not change significantly as a result of the regulations, and the change in total revenues will be zero under all four scenarios that do not consider the price premium effect. The price premium effect causes prices received to decline for production from acreage treated with Delegate 25 WG in the remaining four scenarios.

Under the draft regulations, 3.2% of Butte County walnut acreage would be included in a 150 ft. buffer. 41% of all fields would be required to implement a 150 ft. buffer. On average, affected fields would have 16% of their acreage in a buffer.

Regardless of whether or not the price premium is considered, the production cost per affected acre would increase under the regulations-- by 5.8% when the 7 oz./acre application rate is used, and 1.0% higher when applied at the 3.2 oz./acre application rate. Thus, net revenues would decrease under all scenarios. In the scenarios with a net price effect, price would decrease by 6.3% if the alternative pesticide was sprayed at the high application rate and -0.5% if it was applied at the lower application rate.

If Delegate 25 WG was applied at 7 oz./acre to the entire field and there was no price premium for walnuts harvested from acres treated with Delegate 25 WG, then net revenues in Butte County would decrease by $3.7 million whether the regulation applied to just Butte County or to all of California, and whether price is allowed to change with quantity or not. The numbers are all the same because there is no change in quantity or in the corresponding base price received.

Table 4.1.3a Effects of Draft Regulations: Walnut, Butte County
Delegate 25 WG applied to entire field at 7 oz/acre
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California*	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	7.3%	7.3%	7.3%
County Net Revenues (%)	-5.7%	-5.7%	-5.7%
County Net Revenues ($)	-$3,697,317	-$3,697,317	-$3,697,317

If Delegate 25 WG is applied to the entire field at 7 oz./acre and there is a price premium of $0.06 per pound for every ton of walnuts receiving the base treatment then net revenues in Butte would decrease by approximately $4 million, while total revenues would decrease by $8.5 million (Table 4.1.3b below).

Table 4.1.3b Effects of Draft Regulations: Walnut, Butte County
Delegate 25 WG applied to entire field at 7 oz/acre
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-7.4%	-7.4%	-7.4%
County Total Revenues (%)	-7.4%	-7.4%	-7.4%
County Total Revenues ($)	-$8,532,270	-$8,532,270	-$8,532,270
Cost Per Acre Affected (%)	5.8%	5.8%	5.8%
County Net Revenues (%)	-7.8%	-7.8%	-7.8%
County Net Revenues ($)	-$3,953,285	-$3,953,285	-$3,953,285

If Delegate 25 WG was applied at the intermediate application rate of 3.2 oz./acre to the entire field, net revenues in Butte County would decrease by $505,616 in all three cases (Table 4.1.3c). This is a much smaller decrease in revenues than under the previous scenario because the lower application rate decreases the cost of the alternative pesticide significantly.

Table 4.1.3c Effects of Draft Regulations: Walnut, Butte County
Delegate 25 WG applied to entire field at 3.2 oz/acre
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	1.0%	1.0%	1.0%
County Net Revenues (%)	-0.8%	-0.8%	-0.8%
County Net Revenues ($)	-$505,616	-$505,616	-$505,616

If there was a price premium effect, no yield loss, and the same application rate, then net revenues would decline by $778,649 while total revenues would decrease by $8.5 million (Table 4.1.3d).

Table 4.1.3d Effects of Draft Regulations: Walnut, Butte County
Delegate 25 WG applied to entire field at 3.2 oz/acre
0% yield loss and price premium effect

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-7.4%	-7.4%	-7.4%
County Total Revenues (%)	-7.4%	-7.4%	-7.4%
County Total Revenues ($)	-$8,532,270	-$8,532,270	-$8,532,270
Cost Per Acre Affected (%)	0.8%	0.8%	0.8%
County Net Revenues (%)	-1.5%	-1.5%	-1.5%
County Net Revenues ($)	-$778,649	-$778,649	-$778,649

If Delegate 25 WG was applied at 7 oz./acre only to 150 ft. buffer strips, net revenues in Butte County would decrease by $118,314, as shown in Table 4.1.3e below. As expected, this would be a smaller decrease than when Delegate 25 WG is applied at 7 oz./acre to the entire field. It is also a smaller decrease than when Delegate 25 WG is applied to the entire field at 3.2 oz./acre because such a small portion of the acreage, 3.2%, is in buffers. 96.8% is still sprayed with the lower-cost Lorsban, and so spraying the small buffer area with Delegate 25 WG, even at the high application rate, will result in a lower cost increase than if the entire field is sprayed at the lower rate. Results would be different if the acreage affected by buffers was sufficiently large.

Table 4.1.3e Effects of Draft Regulations: Walnut, Butte County, Delegate 25 WG applied to buffers at 7 oz/acre, Lorsban 4E applied to remainder 0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	7.3%	7.3%	7.3%
County Net Revenues (%)	-0.2%	-0.2%	-0.2%
County Net Revenues ($)	-$118,314	-$118,314	-$118,314

If there was a price premium, no yield loss, and the same application rate then net revenues would decrease by $391.347 and total revenues would decrease by $273,033, as shown in Table 4.1.3f below.

Table 4.1.3f Effects of Draft Regulations: Walnut, Butte County,
Delegate 25 WG applied only to buffers at 7 oz/acre, Lorsban 4E applied to remainder
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-7.4%	-7.4%	-7.4%
County Total Revenues (%)	-0.2%	-0.2%	-0.2%
County Total Revenues ($)	-$273,033	-$273,033	-$273,033
Cost Per Acre Affected (%)	5.8%	5.8%	5.8%
County Net Revenues (%)	-0.8%	-0.8%	-0.8%
County Net Revenues ($)	-$391,347	-$391,347	-$391,347

If Delegate 25 WG was applied at 3.2 oz./acre only to 100 ft. buffer strips, net revenues in Butte County would decrease by $16,180 in all four modeled scenarios, as shown in Table 4.1.3g below. This is the lowest possible decrease in revenues because the less costly application rate of Delegate 25 WG is used and it affects only 3.2% of the field, while 96.8% is still sprayed with the cheaper Lorsban.

Table 4.1.3g Effects of Draft Regulations: Walnut, Butte County
Delegate 25 WG applied only to buffers at 3.2 oz/acre, Lorsban 4E applied to remainder
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	1.0%	1.0%	1.0%
County Net Revenues (%)	0.0%	0.0%	0.0%
County Net Revenues ($)	-$16,180	-$16,180	-$16,180

If there is a price premium effect, no yield loss, and the same application rate net revenue would decline by $289,212 and total revenue would decline by $273,033, as shown in Table 4.1.3h below.

Table 4.1.3h Effects of Draft Regulations: Walnut, Butte County
Delegate 25 WG applied only to buffers at 3.2 oz/acre, Lorsban 4E applied to remainder
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-7.4%	-7.4%	-7.4%
County Total Revenues (%)	-0.2%	-0.2%	-0.2%
County Total Revenues ($)	-$273,033	-$273,033	-$273,033
Cost Per Acre Affected (%)	0.8%	0.8%	0.8%
County Net Revenues (%)	-0.6%	-0.6%	-0.6%
County Net Revenues ($)	-$289,212	-$289,212	-$289,212

4.2 Colusa County Results

Almonds, processing tomatoes, and rice are the three crops evaluated for Colusa County.

4.2.1 Almond

As in section 4.1.1 we examine two different scenarios for almonds. For both the effect of a switch from Goal to Matrix (and a double application of Round-up) in order to control weeds is combined with the switch from Asana to Entrust to control major insect pests. The first scenario considers the impact on revenues when acres treated with the alternative chemicals incur no yield losses, and the second scenario considers the impact when there is a 15% yield loss on acreage treated with the alternative chemicals.

Under the draft regulations, 4% of Colusa County almond acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 45% of all fields would include a 100 ft. buffer, and on average, affected fields would have 10% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 0.3% of acreage would be included in a 25 ft. buffer, 29% of fields would be impacted and on average 1% of each affected field's acreage would be included in a 25 ft. buffer. We consider the combined effects when farmers switch to the alternative herbicide, Matrix, and alternative insecticide, Entrust. We use the 4% affected area under the 100 ft. buffers for both effects; this will overestimate the impacts of the alternative herbicide treatment, but greatly simplifies the analysis.

In the first scenario, total revenues will not change under any of our assumptions regarding the own-price elasticity of demand for California almonds. Net revenue will decline by the same amount, $76,648. There is no difference between the cases because there is no change in quantity or price, only an increase in treatment cost per acre.

Table 4.2.1a Effects of Draft Regulations: Almonds, Colusa County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal and Asana
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	3.1%	3.1%	3.1%
County Net Revenues (%)	-0.2%	-0.2%	-0.2%
County Net Revenues ($)	-$76,648	-$76,648	-$76,648

The demand for California almonds is inelastic so a decrease in quantity will lead to a larger percentage increase in price. In the second scenario with a 15% yield loss under the alternative treatments, the resulting price increase is enough to offset the increase in costs if all of California is affected by the regulations (see column two in Table 4.2.1b below) but not if only Colusa County is affected. In the latter case, total revenues are expected to decrease by $567,289 and net revenues to decrease by $644,280. If price does not increase when quantity decreases then total revenues in Colusa will decline by $612,612 and net revenues by $689,260.

Table 4.2.1b Effects of Draft Regulations: Almonds, Colusa County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal and Asana
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.6%	-0.6%	-0.6%
Price (%)	0.0%	0.8%	0.0%
County Total Revenues (%)	-0.5%	0.3%	-0.6%
County Total Revenues ($)	-$567,289	$282,393	-$612,612
Cost Per Acre (%)	3.1%	3.1%	3.1%
County Net Revenues (%)	-1.5%	0.5%	-1.6%
County Net Revenues ($)	-$644,208	$193,642	-$689,260

4.2.2 Processing tomatoes

We examine two scenarios for processing tomatoes. In both cases growers will simply not plant any tomatoes in the 25 ft. buffer zones, rather than attempt to find alternative pesticide treatments. In the first scenario we assume that all these buffer zones were previously fully planted with tomatoes. In the second scenario, we consider that the 20 ft. closest to the waterways were previously left unplanted for use in turning harvesting equipment, so only a 5 ft. zone is affected by the regulations.

Under the draft regulations, 1% of Colusa County tomato acreage would be included in a 25 ft. buffer and 0.4% would be included in the 5 ft. remaining buffer zone if 20 ft. in all the buffers was already left unplanted for equipment turning. 70% of all fields would need to include a 25 ft. buffer. On average, affected fields would have 1% of their acreage in a 25 ft. buffer (in the first scenario modeled) and 0.33% of their acreage in a 5 ft. buffer (in the second scenario modeled).

The impact of the draft regulations in the first scenario is shown in Table 4.2.2a below. Yields are decreased by 100% in the un-planted buffer zones, so this sizable decrease in quantity leads to an increase in price. Because the own-price elasticity of demand for processing tomatoes is highly inelastic, a relatively small decrease in quantity leads to a relatively large increase in price. Thus, if California as a whole is affected in the same way as Colusa County by the draft regulations, farmers there will experience significant increases in total and net revenues, as shown in column two below. However, if only Colusa is affected by the draft regulations then total revenues will decrease by $328,865 and net revenues will decline by $108,125. This difference occurs because Colusa County's 6% share of California processing tomato production is too small for its decline in production to increase the price of California processing tomatoes sufficiently to offset the effect of that decline on total revenues. If price does not increase with the decline in quantity then total revenues will decline by $504,599 and net revenues will decline by $282,263.

Table 4.2.2a Effects of Draft Regulations: Processing Tomatoes, Colusa County
All 25 ft. of buffer affected by regulations
100% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.7%	-0.7%	-0.7%
Price (%)	0.2%	3.8%	0.0%
County Total Revenues (%)	-0.4%	3.2%	-0.7%
County Total Revenues ($)	-$328,865	$2,403,903	-$504,599
Cost Per Acre (%)	-100.0%	-100.0%	-100.0%
County Net Revenues (%)	-0.3%	6.0%	-0.7%
County Net Revenues ($)	-$108,125	$2,502,134	-$282,263

The results of the second scenario, which assumes that all affected buffers were previously left unplanted for 20 ft. and thus only 5 ft. in each will be affected by the draft regulations, are shown in Table 4.2.2b below. As in the previous scenario, when all of California is affected by the regulations there is a large increase in both total and net revenues due to the increase in processing tomato price. However, this increase is significantly smaller than in the first scenario because a smaller area is affected, so quantity and price changes by a smaller amount. If only Colusa County is affected by the regulations, then total revenues will decline by $210,928 and net revenues will decline by $69,046. If the price remains constant, total revenues will decline by $323,495 and net revenues will decline by $180,957.

Table 4.2.2b Effects of Draft Regulations: Processing Tomatoes, Colusa County
Only 5 ft. within buffer affected by regulations
100% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.4%	-0.4%	-0.4%
Price (%)	0.2%	2.4%	0.0%
County Total Revenues (%)	-0.3%	2.0%	-0.4%
County Total Revenues ($)	-$210,928	$1,516,928	-$323,495
Cost Per Acre Affected (%)	-100.0%	-100.0%	-100.0%
County Net Revenues (%)	-0.2%	3.8%	-0.4%
County Net Revenues ($)	-$69,046	$1,608,458	-$180,957

4.2.3 Rice

As in section 4.1.2, we examine two impacts of the draft regulations on rice: those due to changes in the application of the herbicide propanil (Stam 4SC) and the insecticide lambda cyhalothion (Warrior II with Zeon).

Under the draft regulations, 7% of Colusa County rice acreage would be included in a 25 ft. buffer. 89% of all fields would be required to include a 25 ft. buffer. On average, affected fields would have 2% of their acreage in a buffer.

In the first scenario, where the effects on revenues when Stam 4SC is no longer applied in the buffer zones, and no other herbicide is used to replace it, total revenue in Colusa County would increase by over $1.7 million if the draft regulations affected all of California in the same way, as can be seen in Table 4.2.3a below. This is because there is a substantial yield effect which reduces quantity of rice supplied, and the own-price elasticity of demand for rice is highly inelastic so a small reduction in quantity leads to a large increase in price. The effect on revenues in Colusa is significantly different if just Colusa is affected by the regulations. Total revenues would decrease by $214,278 and net revenues would decrease by $162,597. This difference is due to the fact that Colusa County's share of California rice production is too small, at only 28%, for its decline in production to increase the price of California alfalfa sufficiently to offset that decline. If price remains constant, then total revenue would decline by $943,183 and net revenue by $886,356.

Table 4.2.3a Effects of Draft Regulations: Rice, Colusa County
Effect due to changes in Stam 4SC application
40% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.4%	-0.4%	-0.4%
Price (%)	0.3%	1.1%	0.0%
County Total Revenues (%)	-0.1%	0.7%	-0.4%
County Total Revenues ($)	-$214,278	$1,705,881	-$943,183
Cost Per Acre (%)	-4.5%	-4.5%	-4.5%
County Net Revenues (%)	-0.1%	1.6%	-0.8%
County Net Revenues ($)	-$162,597	$1,723,117	-$886,356

In the second scenario, where we look at the impact on revenue due to the induced changes in Warrior II with Zeon application with 13% and 11% losses, there is a positive effect on total and net revenues in Colusa if all of California is affected equally by the regulations, as shown in column two of Table 4.2.3b below. The increase in revenues far exceeds that caused by the induced changes in Stam 4SC application. Price still increases due to the decline in quantity and the highly inelastic demand, though not as much as in the Stam 4SC case, but the smaller decline in quantity means that overall revenues are higher on balance. Column one shows that Colusa County is disproportionately affected by the draft regulations, because when just the county is affected its total revenues decrease by $262,755 and its net revenues. Colusa's net revenues actually still increase in this case, by $1.6 million, though this is significantly less than the $6.2 million increase when all of California is affected. If price does not respond to the quantity change, then total revenues would decline by $2.3 million and net revenues would decrease by $1.8 million.

Table 4.2.3b Effects of Draft Regulations: Rice, Colusa County
Effect due to changes in Warrior II with Zeon application
13% and 11% yield losses (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.9%	-0.9%	-0.9%
Price (%)	0.7%	2.6%	0.0%
County Total Revenues (%)	-0.2%	1.7%	-0.9%
County Total Revenues ($)	-$262,755	$2,169,127	-$2,340,799
Average Cost Per Acre (%)	-0.4%	-0.4%	-0.4%
County Net Revenues (%)	1.3%	4.9%	-1.4%
County Net Revenues ($)	$1,584,767	$6,239,850	-$1,802,339

In the final scenario, with 15% and 23% losses due to changes in Warrior II with Zeon application, the increases in revenue for Colusa if all of California is affected by the regulations and price increased with the decrease in quantity is even greater than in the previous scenario. However, if only Colusa is affected, then the total revenue decreases by $314,219, a larger decrease than under 11% and 13% yield losses, and net revenue increases by $1.5 million, a slightly smaller increase. If price remains constant, then Colusa would lose $2.8 million in total revenues and $2.3 in net revenues.

Table 4.2.3c Effects of Draft Regulations: Rice, Colusa County
Effect due to changes in Warrior II with Zeon application
15% and 23% yield losses (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-1.1%	-1.1%	-1.1%
Price (%)	0.9%	3.1%	0.0%
County Total Revenues (%)	-0.2%	2.1%	-1.1%
County Total Revenues ($)	-$314,219	$2,627,346	-$2,813,256
Average Cost Per Acre (%)	-0.4%	-0.4%	-0.4%
County Net Revenues (%)	1.2%	5.6%	-1.8%
County Net Revenues ($)	$1,468,857	$7,052,904	-$2,268,792

4.3 Fresno County Results

Alfalfa, almonds, grapes (including wine grapes and other grapes), and processing tomatoes are the four crops evaluated for Fresno County

4.3.1 Alfalfa

We examine one scenario for alfalfa. Lorsban 4EC (alfalfa weevil and aphid control) and Prowl H20 (weed control) are replaced by Steward (alfalfa weevil control) and Chateau (weed control) only in the buffers.

Under the draft regulations, 10.3% of Fresno County alfalfa acreage would be included in a 150 ft. buffer. 59% of all fields would be required to implement a 150 ft. buffer. On average, affected fields would have 20% of their acreage in a buffer.

The estimated effects of the draft regulations on alfalfa in Fresno County are very dependent on the price response to a change in the quantity produced, as well as to the production area assumed to be affected by the regulations, as shown in table 4.3.1a. In the first two columns, price changes with the quantity produced. In the first column, the scenario assumes that only Fresno County is affected by the draft regulations. In the second column, the scenario assumes that all California alfalfa production is affected by the draft regulations in the same way that Fresno County production is. Under this scenario, revenue increases by $55.8 million. In this case, Fresno county alfalfa producers' net revenue declines by slightly more than $34.8 million.

Any substantial increase in the price of alfalfa in California is likely to lead to increased movement of alfalfa from other producers into the California market. In the limit, so much alfalfa produced elsewhere would be sold in California that the price would not increase in response to a decrease in production in Fresno County or the state as a whole. The third column reports this outcome. Because the price is unchanged, the effects on total and net revenues for Fresno County alfalfa growers are not changed as a result of whether the county or the entire state is affected by the draft regulations. In this case, net revenue losses to Fresno County are $4.4 million.

Table 4.3.1a Effects of Draft Regulations: Alfalfa, Fresno County
Combined effect of Steward and Chateau in buffer, remainder of field treated with Lorsban 4EC and Prowl H20
12% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-5.1%	-5.1%	-5.1%
Price (%)	1.8%	46.2%	0.0%
County Total Revenues (%)	-3.4%	62.4%	-5.1%
County Total Revenues ($)	-$3,009,334	$55,800,111	-$4,541,202
Cost Per Acre (%)	-1.9%	-1.9%	-1.9%
County Net Revenues (%)	-17.5%	212.0%	-26.8%
County Net Revenues ($)	-$2,866,660	$34,788,783	-$4,398,527

4.3.2 Almonds

As in sections 4.1.1 and 4.2.1 we examine two scenarios for almonds. For both the effect of a switch from Goal to Matrix (and a double application of Round-up) in order to control weeds is combined with the switch from Asana to Entrust to control major insect pests. The first scenario looks at the impact on revenues when the alternative chemicals incur no yield losses, and the second scenario looks at the impact when there is a 15% yield loss.

Under the draft regulations, 6% of Fresno County almond acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 45% of all fields would include a 100 ft. buffer. On average, affected fields would have 16% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 1% of acreage would be included in a 25 ft. buffer. 39% of fields would be required to include a 25 ft. buffer. On average 5% of each affected field's acreage would be included in a 25 ft. buffer. We look at the combined effects when farmers switch to the alternative herbicide Matrix and the alternative insecticide Applaud. We use the 6% affected area under the 100 ft. buffers for both effects; this will overestimate the impacts of the alternative herbicide treatment.

As in the earlier almond analyses, under the first scenario total revenues will not change across cases regarding the affected area and the own-price elasticity of demand, and net revenue will decline by the same amount, $345,787, for all cases.

Table 4.3.2a Effects of Draft Regulations: Almonds, Fresno County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal and Asana
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	3.1%	3.1%	3.1%
County Net Revenues (%)	-0.2%	-0.2%	-0.2%
County Net Revenues ($)	-$345,787	-$345,787	-$345,787

The demand for California almonds is inelastic so a decrease in quantity will lead to a larger percentage increase in price. In the second scenario, with a 15% yield loss under the alternative treatments, the resulting price increase is enough to offset the increase in costs if all of California is affected by the regulations (see column two in Table 4.3.2b below) but not if only

Fresno County is affected. In the latter case, total revenues are expected to decrease by $2.2 million and net revenues to decrease by $2.6 million. If price does not increase when quantity decreases, total revenues in Fresno will decline by $3 million and net revenues by $3.4 million.

Table 4.3.2b Effects of Draft Regulations: Almonds, Fresno County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal and Asana
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.9%	-0.9%	-0.9%
Price (%)	0.2%	1.3%	0.0%
County Total Revenues (%)	-0.6%	0.4%	-0.9%
County Total Revenues ($)	-$2,200,514	$1,417,503	-$3,031,695
Cost Per Acre (%)	3.1%	3.1%	3.1%
County Net Revenues (%)	-1.7%	0.6%	-2.2%
County Net Revenues ($)	-$2,555,494	$978,027	-$3,377,482

4.3.3 Grapes

Unlike the other counties in our case studies, Fresno County produces a substantial amount of table, raisin and wine grapes. For our analysis, we looked at the effects of the draft regulations on wine grapes in Fresno separately from the effects on the other two types of grapes. Also, unlike the other two grape case studies, there are reliable data on operating costs per acre for all three types of grapes in Fresno (GR-SJ-06-1 for raisin grapes, GR-VS-07-1 for table grapes, and GR-VN-08 for wine grapes, from http://coststudies.ucdavis.edu/current.php) so that we can report estimates for net revenues.

Under the draft regulations, 5% of Fresno County grape acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 35% of all vineyards would include a 100 ft. buffer, and on average, affected vineyards would have 17% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 1% of acreage would be included in a 25 ft. buffer. 30% of vineyards would include a 25 ft. buffer and on average 5% of each affected vineyard's acreage would be included in a 25 ft. buffer. We look at the combined effects when farmers switch to the alternative for both herbicides and insecticides, and we use the 5% affected area under the 100 ft. buffers for both effects; this overestimates the impacts of the alternative herbicide treatment. We assume that acreage in wine grape vineyards and acreage in other grape vineyards is affected identically by the buffer requirements.

We examine two different scenarios for wine grapes. The first looks at the combined effects of switching from the currently used insecticide, Provado, to Applaud, and from the currently used herbicide, Goal plus one application of Glystar, to Matrix plus two applications of Glystar across the entire vineyard, which results in combined 15% yield losses. The second scenario looks at this combined switch to alternative chemicals just within the buffer zone, resulting in zero yield loss. We do not report results for two intermediate scenarios in which the alternative treatment is applied to the entire vineyard and there is no yield loss, or in which the alternative treatment is applied only to the buffer and there is a 15% yield loss on that ground.

We also consider two scenarios for other types of grapes. The treatments considered are different from those for wine grapes. Provado is replaced with Movento instead of Applaud, and the base treatment for weed control is Simazine plus an application of Glystar, which is replaced with Chateau and two applications of Glystar. When the alternatives are applied to the entire vineyard the combined yield loss is 25%. When they are applied only to the buffers there is no yield loss. These two scenarios are intended to bound intermediate cases where the alternatives are applied to the entire field and there is no yield loss, and where the alternatives are applied only to the buffer and there is a 25% yield loss. We assume that wine grapes and other grapes have the same proportion of acres affected by buffers, in the absence of specific buffer data on each type of grape.

<u>Wine grapes.</u> In the first scenario, with a 15% yield loss across the entire vineyard, the resulting price increase is enough to offset the increase in costs whether all of California is affected by

the regulations or if only Fresno is affected, if price responds to a decrease in quantity. There is a large revenue increase if all of California is affected, as shown in column two of Table 4.3.3a below. There is a much smaller, though still substantial increase in price and revenues if only Fresno County is affected. In this case, total revenues are expected to increase by $20.9 million and net revenues to increase by $2.6 million. This is different from the other wine grape case study counties, which show a decrease when only they are affected by regulations; the difference is due to the fact that Fresno accounts for a much larger portion of wine grape production, 20%, so a decrease in quantity in Fresno has a much larger effect on wine grape price. If price does not increase when quantity decreases, then total revenues in Fresno will decline by $42.9 million and net revenues by $43 million.

Table 4.3.3a Effects of Draft Regulations: Wine Grapes, Fresno County
Combined effect of Matrix and Applaud applied to entire field
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-15.0%	-15.0%	-15.0%
Price (%)	18.8%	93.8%	0.0%
County Total Revenues (%)	7.3%	166.6%	-15.0%
County Total Revenues ($)	$20,922,055	$476,582,793	-$42,899,154
Cost Per Acre (%)	0.1%	0.1%	0.1%
County Net Revenues (%)	2.8%	202.5%	-47.2%
County Net Revenues ($)	$2,588,570	$184,821,737	-$43,080,020

In the second scenario, with alternative pesticides applied only to buffer zones and with no effect on yields, total revenues do not change in the three modeled cases, and net revenues actually increase by a trivial amount because costs per acre are lower under the alternative treatments (Table 4.4.3b).

Table 4.3.3b Effects of Draft Regulations: Wine Grapes, Fresno County
Combined effect of Matrix and Applaud in buffer, remainder of field treated with Goal 2XL and Provado
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.1%	0.1%	0.1%
County Net Revenues (%)	0.0%	0.0%	0.0%
County Net Revenues ($)	-$8,273	-$8,273	-$8,273

Other grapes. In the first scenario for table and raisin grapes, with the alternative treatment applied to the entire field and 25% yield losses, the average demand elasticity for the two types of grapes, weighted by acreage, is highly inelastic. Thus, as in the wine grape scenario, if the entire state is affected by the 25% decrease in yields when alternative pesticides are applied, then the resulting increase in price is substantial enough to cause a large increase in total and net revenues in Fresno County. This is shown in column two of Table 4.4.3c below. However, as shown in column one, if only Fresno County is affected by the draft regulations then total revenues will increase by $68 million but net revenues will decrease by $43.4 million. Unlike in the scenarios for wine grapes, costs per acre under the alternative treatments for other grapes are substantially higher than under the current treatment, which causes this decline in net revenues. If price is not able to increase in response to the decrease in quantity, then total revenues will decline by $143.6 million and net revenues will decline by $166.7 million.

Table 4.3.3c Effects of Draft Regulations: Other Grapes, Fresno County
Combined effect of Chateau and Movento applied to entire field
25% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-25.0%	-25.0%	-25.0%
Price (%)	28.6%	92.6%	0.0%
County Total Revenues (%)	11.8%	153.3%	-25.0%
County Total Revenues ($)	$68,037,209	$880,496,993	-$143,565,714
Cost Per Acre Affected (%)	5.5%	5.5%	5.5%
County Net Revenues (%)	-28.8%	153.8%	-110.5%
County Net Revenues ($)	-$43,376,360	$232,051,250	-$166,742,400

In the second scenario for other grapes, with the alternative treatment applied only in the buffer zones and with 0% yield losses, there will be no change in total revenues. Net revenues will decline by $1 million due to the increase in treatment cost per acre.

Table 4.3.3c Effects of Draft Regulations: Other Grapes, Fresno County
Combined effect of Chateau and Movento applied to buffer
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre Affected (%)	5.5%	5.5%	5.5%
County Net Revenues (%)	-0.7%	-0.7%	-0.7%
County Net Revenues ($)	-$1,060,075	-$1,060,075	-$1,060,075

4.3.4 Processing Tomatoes

As in Section 4.2.2, we examine two different possible scenarios. In both cases the growers will simply not plant any tomatoes in the 25 ft. buffer zones, rather than attempt to find alternative pesticide treatments. In the first scenario we consider that all these buffer zones were previously fully planted with tomatoes. In the second scenario, we consider that the 20 ft. closest to the waterways were previously left unplanted for use in turning harvesting equipment, so only a 5 ft. zone is affected by the regulations.

Under the draft regulations, 1% of county tomato acreage would be included in a 25 ft. buffer and 0.3% would be included in the 5 ft. remaining buffer zone if 20 ft. in all the buffers was already left unplanted for equipment turning. 46% of all fields would be impacted by the buffer regulation. On average, affected fields would have 3% of their acreage in a 25 ft. buffer (in the first scenario modeled) and 0.7% of their acreage in a 5 ft. buffer (in the second scenario modeled).

The impacts of the regulations in the first scenario are shown in Table 4.3.4a below. Yields decrease by 100% in the un-planted buffer zones. This decrease in quantity leads to an increase in price. Because the price elasticity of demand for processing tomatoes is highly inelastic, a given decrease in quantity leads to a relatively large increase in price. Thus, if California as a whole is affected in the same way as Fresno County by the draft regulations, Fresno growers will experience increases in total revenue ($27 million) and net revenue ($32 million), as shown in column two below. If only Fresno is affected by the draft regulations then revenues will still increase, but by much less because the change in the quantity of tomatoes produced in California would be smaller. Total revenues would increase by $6.6 million and net revenues by $13.7 million. Fresno County's 39% share of California tomato production is substantial enough that its decline in production increases the price of California processing tomatoes sufficiently to offset that decline, but not as much as if production declined in the entire state. If price does not increase with the decline in quantity due to increased supply by producers outside the state then total revenues will decline by $5.5 million and net revenues will decrease by $2 million.

Table 4.3.4a Effects of Draft Regulations: Processing Tomatoes, Fresno County
All 25 ft. of buffer affected by regulations
100% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-1.2%	-1.2%	-1.2%
Price (%)	2.6%	6.7%	0.0%
County Total Revenues (%)	1.4%	5.9%	-1.2%
County Total Revenues ($)	$6,612,398	$27,046,792	-$5,489,952
Cost Per Affected Acre (%)	-100.0%	-100.0%	-100.0%
County Net Revenues (%)	8.1%	19.0%	-1.2%
County Net Revenues ($)	$13,686,914	$32,164,243	-$2,031,172

The results of the second scenario, which assumes that all affected buffers were previously left unplanted for 20 ft. and thus only 5 ft. in each will be affected by the draft regulations, are shown in Table 4.3.4b below. As in the previous scenario, when all of California is affected by the regulations there is a significant increase in both total and net revenues due to the increase in processing tomato price. However, this increase is significantly smaller than in the first scenario, because a smaller area is affected, so quantity and price changes by a smaller amount. If only Fresno County is affected by the regulations, then total revenues will increase by $1.3 million and net revenues will increase by $2.9 million. If the price remains constant with the decrease in quantity of processing tomatoes in Fresno, then total revenues will decline by $1.1 million and net revenues will decline by $0.4 million.

Table 4.3.4b Effects of Draft Regulations: Processing Tomatoes, Fresno County
Only 5 ft. within buffer affected by regulations
100% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.3%	-0.3%	-0.3%
Price (%)	0.5%	1.4%	0.0%
County Total Revenues (%)	0.3%	1.2%	-0.3%
County Total Revenues ($)	$1,327,533	$5,299,659	-$1,143,926
Cost Per Acre Affected (%)	-100.0%	-100.0%	-100.0%
County Net Revenues (%)	1.7%	4.0%	-0.3%
County Net Revenues ($)	$2,875,298	$6,762,454	-$423,230

4.4 Monterey County Results

Grapes (wine grapes), lettuce, and strawberries are the three crops evaluated for Monterey County.

4.4.1 Grapes

We examine two scenarios for wine grapes. The first looks at the combined effects of switching from the currently used insecticide, Provado, to an alternative, and from the currently used herbicide, Goal, to an alternative across the entire field, which results in combined 15% yield losses. The second scenario looks at this combined switch to alternative chemicals just within the buffer zone, resulting in zero yield loss.

Under the draft regulations, 5% of Monterey County grape acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 54% of all fields would include a 100 ft. buffer, and on average, affected fields would have 12% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 1% of acreage would be included in a 25 ft. buffer, 50% of fields would be required to include a 25 ft. buffer, and on average 3% of each affected field's acreage would be included in a 25 ft. buffer. We consider the combined effects when farmers switch to the alternative for both herbicides and insecticides. We use the 5% affected area under the 100 ft. buffers for both effects; this overestimates the impacts of the alternative herbicide treatment.

The demand for California wine grapes is highly inelastic so a given percentage decrease in quantity will lead to a larger percentage increase in price. In the first scenario, with a 15% yield loss across the entire field, the resulting price increase is enough to offset the increase in costs if all of California is affected by the regulations. The results in a substantial total revenue increase, as shown in column two in Table 4.4.1a below. However, the increase in price is not substantial enough to offset the decrease in quantity if only Monterey County is affected. In this case, total revenues are expected to decrease by $24.6 million and net revenues to decrease by $26.5 million. If price does not increase when quantity decreases, because suppliers outside of the state increase their quantity, then total revenues in Monterey will decline by $36.9 million.

Table 4.4.1a Effects of Draft Regulations: Wine Grapes, Monterey County
Combined effect of Matrix and Applaud applied to entire field
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-15.0%	-15.0%	-15.0%
Price (%)	4.8%	93.8%	0.0%
County Total Revenues (%)	-10.0%	166.6%	-15.0%
County Total Revenues ($)	-$24,573,230	$410,407,414	-$36,942,440

In the second scenario, with alternative pesticides applied only to buffer zones and with no effect on yields, total revenues do not change. Results reported in Table 4.4.1b are trivial; the table is included only for consistency in presentation across case studies.

Table 4.4.1b Effects of Draft Regulations: Wine Grapes, Monterey County
Combined effect of Matrix and Applaud in buffer, remainder of field treated with Goal 2XL and Provado
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0

4.4.2 Lettuce

For lettuce, we considered four scenarios. In the first and third, farmers spray Pre-far 4E (Pre-far 4E) as an herbicide instead of pronamide (Kerb 50W) on their entire field, which will involve an increase in labor costs for thinning and weeding, but an overall reduction in cost because Pre-far 4E is significantly cheaper than the Kerb 50W. In the first scenario yields increase by 4% when Pre-far 4E is applied, and thinning and weeding costs increase by 50% and 20%, respectively. In the third scenario yields decrease by 3% and thinning and weeding costs increase by 72% and 37%, respectively, under Pre-far 4E. In the second and fourth scenarios, farmers use the alternative treatment on only the 25 ft. buffer zone, with each of the yield and cultivation cost changes described above.

Under the draft regulations, 1% of county lettuce acreage would be included in a buffer. 25% of all fields would include a 25 ft. buffer; on average, affected fields would have 5% of their acreage in a buffer.

In the first scenario, the 4% increase in yield leads to a significant decrease in the price of lettuce because demand for lettuce is highly inelastic. As a result, total and net revenues decline both when only Monterey is affected by the regulations and when all of California is affected. The revenue decrease is smaller when only Monterey is affected because the overall increase in quantity, and thus the decrease in price, is smaller than when the entire state is forced to switch to Pre-far 4E. As shown in column one below, total revenues decrease by $3.7 million and net revenues decrease by $3.9 million. If the price does not change with quantity, then revenues will increase in Monterey due to higher production and lower costs. Total revenues would increase by $15 million and net revenues would increase by $16.1 million.

Table 4.4.2a Effects of Draft Regulations: Lettuce, Monterey County
Pre-far 4E sprayed on entire field
3% yield increase, 50% increase in thinning costs, 20% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	4.0%	4.0%	4.0%
Price (%)	-3.1%	-5.6%	0.0%
County Total Revenues (%)	1.0%	-1.3%	4.0%
County Total Revenues ($)	$3,705,482	-$4,964,800	$15,085,930
Cost Per Acre (%)	-0.3%	-0.3%	-0.3%
County Net Revenues (%)	7.1%	-11.0%	29.4%
County Net Revenues ($)	$3,876,340	-$6,005,222	$16,092,478

In the second scenario, with the same yield and cultivation cost changes as in the first scenario but with Pre-far 4E applied only to the 25 ft. buffer zones, the overall increase in quantity is negligible and thus so is the corresponding decrease in price, if just Monterey is affected by the regulations. Total revenues will increase by $35,567 due to the increase in yield, and net revenues will increase by $46,180 due to the decrease in pesticide costs and increase in yield. If the entire state is affected equally, then there will be a more substantial increase in quantity and decrease in price, and so total and net revenues in Monterey will decrease, as shown in column two in Table 4.4.2b. If price does not change with quantity at all, then total revenues will increase by $160,477 and net revenues will increase by $171,184.

Table 4.4.2b Effects of Draft Regulations: Lettuce, Monterey County
Pre-far 4E sprayed on buffer only, Kerb 50W on remainder
3% yield increase, 50% increase in thinning costs, 20% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	-0.1%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$35,567	-$65,412	$160,477
Cost Per Acre Affected (%)	-0.3%	-0.3%	-0.3%
County Net Revenues (%)	0.1%	-0.1%	0.3%
County Net Revenues ($)	$46,180	-$54,936	$171,184

In the third scenario, with Pre-far 4E applied to the entire affected field and a 4% decrease in lettuce yields, 72% increase in thinning costs and 37% increase in weeding costs, revenues increase substantially in Monterey if all of California is affected by the regulations because the decrease in yields and the highly inelastic demand for lettuce leads to a significant increase in the price of lettuce. If only Monterey is affected, this does not lead to a large enough increase in price to overcome the increase in costs of cultivation, and total revenues in the county will decrease by $2.3 million while net revenues decrease by $3 million. If price does not change with quantity, then the total revenue loss in Monterey will be $11.3 million and the net revenue loss will be $11.6 million.

Table 4.4.2c Effects of Draft Regulations: Lettuce, Monterey County
Pre-far 4E sprayed on entire field, Kerb 50W on remainder
4% yield decrease, 72% increase in thinning costs, 37% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-3.0%	-3.0%	-3.0%
Price (%)	2.3%	4.2%	0.0%
County Total Revenues (%)	-0.6%	1.4%	-3.0%
County Total Revenues ($)	-$2,298,948	$5,294,739	-$11,314,447
Cost Per Acre Affected (%)	0.1%	0.1%	0.1%
County Net Revenues (%)	-5.7%	7.0%	-21.3%
County Net Revenues ($)	-$3,092,467	$3,819,876	-$11,637,891

In the final scenario, with the same yield and cultivation cost changes as the previous scenario but with Pre-far 4E applied only to the 25 ft. buffers in affected fields, revenues will increase by a much smaller amount compared with the previous scenario if the regulations apply to all of California, as shown in column two of Table 4.4.2d below. If the regulations only apply to Monterey, then total revenues will decrease by $26,621 and net revenues will decrease by $30,115, a much smaller decrease in revenues than in the previous scenario because of the smaller area affected. If price does not change with quantity then total revenues in Monterey will decrease by $120,358 and net revenues will decrease by $123,799.

Table 4.4.2d Effects of Draft Regulations: Lettuce, Monterey County
Pre-far 4E sprayed on buffer only, Kerb 50W on remainder
4% yield decrease, 72% increase in thinning costs, 37% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	-$26,621	$49,236	-$120,358
Cost Per Acre Affected (%)	0.1%	0.1%	0.1%
County Net Revenues (%)	-0.1%	0.1%	-0.2%
County Net Revenues ($)	-$30,115	$45,666	-$123,799

4.4.3 Strawberries

We examine four scenarios for strawberries. We consider the changes in costs and revenue if farmers respond to the regulations by vacuuming the entire field instead of applying any pesticides to control lygus bug, or if they vacuum only the buffer area and continue applying the same treatment to the rest of the field. For each of these responses, we look at the effects if there is no yield loss and if there is a 5% yield loss due to vacuuming.

Under the draft regulations, 5% of Monterey County strawberry acreage would be included in a 100 ft. buffer. 39% of all fields would include a buffer; on average, affected fields would have 14% of their acreage in a buffer.

In the cases when there is no yield effect, shown in Table 4.4.3a and Table 4.4.3b below, price and quantity would not change and the change in total revenues would be zero, whether the whole state or just Monterey County is affected by the regulations. This result changes if there is a 5% yield loss. However, even when there is no yield loss, net revenue will decrease by a significant amount as a result of the draft regulations because the vacuuming procedure is much more costly than the pesticides currently used. The magnitude of net revenue decrease depends on the cost of the vacuuming process and the number of acres affected by the buffers. Our analysis shows that net revenues in Monterey County would decrease by $125,750 if the draft regulations took effect and growers replaced the current treatment with vacuuming in the buffer strips.

Table 4.4.3a Effects of Draft Regulations: Strawberries, Monterey County
Only buffer vacuumed
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.5%	0.5%	0.5%
County Net Revenues (%)	0.0%	0.0%	0.0%
County Net Revenues ($)	-$125,750	-$125,750	-$125,750

If farmers chose to vacuum the entire field instead of applying any pesticides to control lygus bug, but there was still no yield loss, then net revenues would decrease by $2.5 million, as shown below. This is a very significant increase in losses in comparison to the first scenario because the much higher costs of vacuuming are applied over a much larger land area.

Table 4.4.3b Effects of Draft Regulations: Strawberries, Monterey County
Entire field vacuumed
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.5%	0.5%	0.5%
County Net Revenues (%)	-0.9%	-0.9%	-0.9%
County Net Revenues ($)	-$2,514,996	-$2,514,996	-$2,514,996

If there was a 5% yield loss when the vacuuming alternative is used instead of the current treatment, then there would be a change in total revenue, because the total quantity sold would decline. The decrease in revenue would be partially mitigated by a rise in price, but this effect would be very slight because the demand for California strawberries is highly elastic.

Thus, a reduction in the quantity of strawberries would result in a relatively small increase in their price.

In the case where only the buffers were vacuumed, there would be a $1.5 million total revenue decrease and a $1.6 million net revenue decrease if the regulations only affected Monterey county, as shown in column one of Table 4.4.3c below. If the regulations affected the entire state of California, then the decreases in both types of revenue for Monterey County would be smaller, as seen in column two. If price did not change with quantity, because other growers increased their sales to compensate for a quantity reduction in Monterey, then total revenue losses to the county would be $1.9 million and net revenue losses would be $2 million.

Table 4.4.3c Effects of Draft Regulations: Strawberries, Monterey County
Only buffer vacuumed
5% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.3%	-0.3%	-0.3%
Price (%)	0.1%	0.1%	0.0%
County Total Revenues (%)	-0.2%	-0.1%	-0.3%
County Total Revenues ($)	-$1,477,426	-$900,651	-$1,904,159
Cost Per Acre (%)	0.5%	0.5%	0.5%
County Net Revenues (%)	-0.6%	-0.4%	-0.7%
County Net Revenues ($)	-$1,604,480	-$1,030,225	-$2,029,908

If growers chose to vacuum their entire field, and 5% yield losses were expected, then Monterey would experience a $29.5 million loss in total revenues and a $32.5 million loss in net revenues, if just the county were affected by the regulations. This would be moderated somewhat if all of California were affected by the regulations in the same way as Monterey, but losses would still be substantial, as is shown in column two of Table 4.4.3d below. Losses would be even larger if the price did not increase with a decrease in quantity of strawberries from Monterey. The county would experience a $38.1 million loss in total revenue and a $40.6 million loss in net revenue.

Table 4.4.3d Effects of Draft Regulations: Strawberries, Monterey County
Entire field vacuumed
5% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-5.0%	-5.0%	-5.0%
Price (%)	1.1%	2.6%	0.0%
County Total Revenues (%)	-3.9%	-2.3%	-5.0%
County Total Revenues ($)	-$29,457,762	-$17,511,929	-$38,083,172
Cost Per Acre (%)	0.5%	0.5%	0.5%
County Net Revenues (%)	-11.7%	-7.8%	-14.6%
County Net Revenues ($)	-$32,494,779	-$21,556,582	-$40,598,168

4.5 Santa Barbara County Results

Grape (wine grape), lettuce, and strawberry are the three crops evaluated for Santa Barbara County.

4.5.1 Grapes

We examine two different scenarios for wine grapes in Santa Barbara County. The first looks at the combined effects of switching from the currently used insecticide, Provado, to Applaud, and from the currently used herbicide, Goal, to Matrix across the entire field, which together results in a 15% yield loss. The second scenario looks at this combined switch to alternative chemicals just within the buffer zone, resulting in zero yield loss. These two scenarios bound total revenues for the intermediate cases where the alternative treatments are used in the entire field and there is no yield loss and the alternative treatments are used in the buffer and there is a yield loss. We do not report information regarding net revenues because there is not a current cost study for wine grape production in this region.

Under the draft regulations, 3% of Santa Barbara County grape acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 25% of all fields would include a 100 ft. buffer, and on average, affected fields would have 14% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 1% of acreage would be included in a 25 ft. buffer, 24% of fields would be impacted and on average 4% of each affected field's acreage would be included in a 25 ft. buffer. We consider the combined effects when farmers switch to the alternative for both herbicides and insecticides. We use the 3% affected area under the 100 ft. buffers for both effects; this overestimates the impacts of the alternative herbicide treatment.

In the first scenario, with a 15% yield loss across the entire field, the resulting price increase is enough to offset the increase in costs if all of California is affected by the regulations. The result is substantial revenue increases, as shown in column two in Table 4.5.1a below. However, the increase in price is not large enough to offset the decrease in quantity if only Santa Barbara County is affected. In this case, total revenues are expected to decrease by $20.8 million. If price does not increase when quantity decreases, then total revenues in Santa Barbara will decline by $324.7 million.

Table 4.5.1a Effects of Draft Regulations: Wine Grapes, Santa Barbara County
Combined effect of Matrix and Applaud applied to entire field
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-15.0%	-15.0%	-15.0%
Price (%)	2.3%	93.8%	0.0%
County Total Revenues (%)	-12.6%	166.6%	-15.0%
County Total Revenues ($)	-$20,810,674	$274,654,516	-$24,722,769

In the second scenario, with alternative pesticides applied only to buffer zones and with no effect on yields, total revenues do not change. Although the results are trivial, the table is included for consistency in reporting.

Table 4.5.1b Effects of Draft Regulations: Wine Grapes, Santa Barbara County
Combined effect of Matrix and Applaud in buffer, remainder of field treated with Goal 2XL and Provado
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0

4.5.2 Lettuce

As in Section 4.4.2 we examine four scenarios. In the first and third, farmers spray bensulide (Pre-far 4E) as an herbicide instead of pronamide (Kerb 50W) on their entire field, which will involve increased labor costs for thinning and weeding, but will reduce total weed control costs because Pre-far 4E is significantly cheaper than Kerb 50W. In the second and fourth scenarios, farmers use the alternative treatment on only the 25 ft. buffer zone. The first and second scenarios use one pair of the yield and cultivation cost changes described in Section 3.3.4 and the third and fourth scenarios use the other pair.

Under the draft regulations, 1% of county lettuce acreage would be included in a 25 ft. buffer. 15% of all fields would be required to include a buffer; on average, affected fields would have 4% of their acreage in a 25 ft. buffer.

In the first scenario, the 4% increase in yield leads to a decrease in the price of lettuce because demand for lettuce is highly inelastic. As a result, total and net revenues for Santa Barbara lettuce producers decline when all of California is affected. Revenues actually increase when only Santa Barbara is affected because the overall increase in quantity, and thus the decrease in price, is much smaller than when the entire state switches to Pre-far 4E. As shown in column one below, total revenues increase by $1.7 million and net revenues increase by $1.8 million. If price is constant, then revenues will increase in Santa Barbara substantially due to higher production and lower costs. Total revenues will increase by $1.9 million and net revenues would increase by $2 million.

Table 4.5.2a Effects of Draft Regulations: Lettuce, Santa Barbara County
Pre-far 4E sprayed on entire field
4% yield increase, 50% increase in thinning costs, 20% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	4.0%	4.0%	4.0%
Price (%)	-0.5%	-5.6%	0.0%
County Total Revenues (%)	3.5%	-1.9%	4.0%
County Total Revenues ($)	$1,649,390	-$871,372	$1,874,769
Cost Per Affected Acre (%)	-0.3%	-0.3%	-0.3%
County Net Revenues (%)	15.0%	-5.6%	16.8%
County Net Revenues ($)	$1,833,994	-$686,768	$2,059,373

In the second scenario, with the same yield and cultivation cost changes as in the first scenario but with Pre-far 4E applied only to the 25 ft. buffer zones, so the increase in revenues when just

Santa Barbara is affected and the decrease in revenues when all of California is affected are negligible; less than $11,000 in all cases.

Table 4.5.2b Effects of Draft Regulations: Lettuce, Santa Barbara County
Pre-far 4E sprayed on buffer only, Kerb 50W on remainder
4% yield increase, 50% increase in thinning costs, 20% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$8,372	-$3,863	$9,466
Cost Per Acre Affected (%)	-0.3%	-0.3%	-0.3%
County Net Revenues (%)	0.1%	0.0%	-0.1%
County Net Revenues ($)	$9,304	-$2,937	$10,398

In the third scenario, with Pre-far 4E applied to the entire affected field but with a 4% decrease in lettuce yields, a 72% increase in thinning costs and 37% increase in weeding costs, revenues increase in Santa Barbara if all of California is affected by the regulations because the decrease in yields and the highly inelastic demand for lettuce leads to a significant increase in the price of lettuce. If only Santa Barbara is affected, this does not lead to a large enough increase in price to overcome the increase in costs of cultivation, and total revenues in the county will decrease by $1.2 million while net revenues decrease by $1.3 million. If price does not change with quantity, then the total revenue loss in Santa Barbara will be $1.4 million and the net revenue loss will be $1.5 million.

Table 4.5.2c Effects of Draft Regulations: Lettuce, Santa Barbara County
Pre-far 4E sprayed on entire field, Kerb 50W on remainder
3% yield decrease, 72% increase in thinning costs, 37% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-3.0%	-3.0%	-3.0%
Price (%)	0.3%	4.2%	0.0%
County Total Revenues (%)	-2.7%	1.4%	-3.0%
County Total Revenues ($)	-$1,242,980	$657,992	-$1,406,077
Cost Per Acre Affected (%)	0.1%	0.1%	0.1%
County Net Revenues (%)	10.7%	3.7%	-11.9%
County Net Revenues ($)	-$1,307,740	$455,581	-$1,465,397

In the final scenario, with the same yield and cultivation cost changes as the previous scenario but with Pre-far 4E applied only to the 25 ft. buffers in affected fields, revenues will increase by a negligible amount if the regulations apply to all of California, as shown in column two of Table 4.5.2d below. If the regulations only apply to Santa Barbara or if price is unaffected by a change in quantity, then total and net revenues will decrease by a negligible amount due to the small amount of affected acreage.

Table 4.5.2d Effects of Draft Regulations: Lettuce, Santa Barbara County
Pre-far 4E sprayed on buffer only, Kerb 50W on remainder
3% yield decrease, 72% increase in thinning costs, 37% increase in weeding costs (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	-$6,279	$2,902	-$7,100
Cost Per Acre Affected (%)	0.1%	0.1%	0.1%
County Net Revenues (%)	-0.1%	0.0%	-0.1%
County Net Revenues ($)	-$6,579	$2,599	-$7,399

4.5.3 Strawberries

As in section 4.4.3 we examine four different scenarios for strawberries. We look at the changes in costs and revenue if farmers respond to the regulations by vacuuming the entire field instead of applying pesticides to control lygus bug, or if they vacuum only the 100 ft. buffer and continue applying the same treatment to the rest of the field. For each of these responses, we look at the effects if there is no yield loss and if there is a 5% yield loss due to vacuuming.

Under the draft regulations, 2% of Santa Barbara County strawberry acreage would be included in a 100 ft. buffer. 18% of all fields would be required to include a 100 ft. buffer; on average, affected fields would have 13% of their acreage in a buffer.

When there is no yield loss, as in the first two scenarios below, there is no change in quantity or price and thus no change in total revenue; there will be a change in net revenue, however, because of the increase in costs for the alternative, vacuuming treatment. Our analysis shows that net revenues in Santa Barbara County would decrease by a negligible amount, $24,279, if only the buffer strips were vacuumed and there was no yield loss (Table 4.5.3a).

Table 4.5.3a Effects of Draft Regulations: Strawberries, Santa Barbara County
Only buffer vacuumed
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.7%	0.7%	0.7%
County Net Revenues (%)	0.0%	0.0%	0.0%
County Net Revenues ($)	-$24,279	-$24,279	-$24,279

If growers chose to vacuum the entire field and there was no yield loss, then there would still be no change in total revenues. Net revenues would decrease by $1.3 million because of the significant increase in costs applied over the entire acreage instead of just the buffers.

Table 4.5.3b Effects of Draft Regulations: Strawberries, Santa Barbara County
Entire field vacuumed
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.7%	0.7%	0.7%
County Net Revenues (%)	-0.8%	-0.8%	-0.8%
County Net Revenues ($)	-$1,348,821	-$1,348,821	-$1,348,821

If only the buffer strips were vacuumed and there was a 5% yield loss, then total revenues would decrease because of the decrease in quantity sold. This would be partially mitigated by a price increase, but this increase would be only very slight because the demand for strawberries is elastic. The effect is even smaller here because Santa Barbara accounts for a smaller share of state strawberry production than Monterey does. Total revenue would decrease by $336,480 and net revenue would decrease by $360,767 in Santa Barbara County if only that county were affected by the regulations. If all of California was affected, then this would lead to decreases in revenue of approximately half the size, as shown in column two of Table 4.5.3c below. If price did not respond to a change in quantity then losses would be substantially higher for the county, with $345,357 lost in total revenue and $369,636 lost in net revenue.

Table 4.5.3c Effects of Draft Regulations: Strawberries, Santa Barbara County
Only buffer vacuumed
5% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.1%	-0.1%	-0.1%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	-0.1%	0.0%	-0.1%
County Total Revenues ($)	-$336,480	-$163,504	-$345,357
Cost Per Acre (%)	0.7%	0.7%	0.7%
County Net Revenues (%)	-0.2%	-0.1%	-0.2%
County Net Revenues ($)	-$360,767	-$188,033	-$369,636

If the entire field was vacuumed and there were 5% yield losses, then this would result in a total revenue loss of $18.7 million and net revenue loss of $20.1 million in Santa Barbara. These losses would decrease in magnitude by about half if all of California was affected in the same way by the regulations, as shown in column two of Table 4.5.3d. If price did not increase in response to the decreased quantity supplied by Santa Barbara, then total revenues in the county would decrease by $19.2 million and net revenues would decrease by $20.5 million.

Table 4.5.3d Effects of Draft Regulations: Strawberries, Santa Barbara County
Entire field vacuumed
5% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-5.0%	-5.0%	-5.0%
Price (%)	0.1%	2.6%	0.0%
County Total Revenues (%)	-4.9%	-2.3%	-5.0%
County Total Revenues ($)	-$18,692,705	-$8,822,609	-$19,186,517
Cost Per Acre (%)	0.7%	0.7%	0.7%
County Net Revenues (%)	-11.2%	-6.1%	-11.5%
County Net Revenues ($)	-$20,066,819	-$10,942,079	-$20,535,338

4.6 Stanislaus County Results

Alfalfa, almonds, processing tomatoes and walnuts are the four crops evaluated for Stanislaus County.

4.6.1 Alfalfa

As in section 4.3.1, we examine one scenario for alfalfa. Lorsban 4EC (alfalfa weevil and aphid control) and Prowl H20 (weed control) are replaced by Steward (alfalfa weevil control) and Chateau (weed control) only in the buffers.

Under the draft regulations, 9.2% of county alfalfa acreage would be included in a 150 ft. buffer. 45% of all fields would include a 150 ft. buffer; on average, affected fields would have 19% of their acreage in a buffer.

The estimated effects of the draft regulations on alfalfa in Stanislaus County are very dependent on the price response to a change in the quantity produced, as well as to the area assumed to be affected by the regulations. As noted in section 3.3.1a, demand for California alfalfa is highly inelastic. That is, a relatively small reduction in quantity is associated with a relatively large increase in price. If the draft regulations affected alfalfa production in all of California the same way as in Stanislaus County, total and net revenues for Stanislaus County alfalfa growers would increase by over $15.7 million and $10.2 million, respectively, as shown in the second column of Table 4.6.1a. If only Stanislaus County were affected by the regulations, its total and net revenues would decline by $845,580 and $831,933, respectively. This difference occurs because Stanislaus County's share of California alfalfa production is too small for its decline in production to increase the price of California alfalfa sufficiently to offset that decline. Comparing these two columns, it is clear that if Stanislaus County is disproportionately affected due to a greater share of acreage included in buffers for sensitive aquatic sites than is the case for alfalfa production elsewhere in the state, its losses will be larger.

If other producers compensate fully for any reduction in production by Stanislaus or California producers, the price of alfalfa will not change. The third column reports this outcome. Because the price is unchanged, the effects on total and net revenues for Stanislaus County alfalfa growers are not changed as a result of whether the county or the entire state is affected by the draft regulations. In this case, losses to Stanislaus County are $1.3 million.

Table 4.6.1a Effects of Draft Regulations: Alfalfa, Stanislaus County
Combined effect of Steward and Chateau in buffer, remainder of field treated with Lorsban 4EC and Prowl H20
12% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-4.6%	-4.6%	-4.6%
Price (%)	1.6%	41.6%	0.0%
County Total Revenues (%)	-2.9%	54.3%	-4.6%
County Total Revenues ($)	-$845,580	$15,710,676	-$1,323,589
Cost Per Acre (%)	-1.9%	-1.9%	-1.9%
County Net Revenues (%)	-18.8%	230.5%	-28.9%
County Net Revenues ($)	-$831,933	$10,201,656	-$1,280,793

4.6.2 Almonds

As in sections 4.1.1 and 4.3.2 we examine two scenarios for almonds. For both, the effect of a switch from Goal to Matrix (and a double application of Glystar Plus) in order to control weeds is combined with the switch from Warrior to Entrust to control major insect pests. The first scenario considers the impact on revenues when the alternative chemicals incur no yield losses, and the second scenario looks at the impact when there is a 15% yield loss.

Under the draft regulations, 7% of Stanislaus County almond acreage would be included in a 100 ft. buffer, which applies to the insecticide treatment. 38% of all fields would include a 100 ft. buffer, and on average, affected fields would have 17% of their acreage in a 100 ft. buffer. A 25 ft. buffer would apply for the herbicide treatment under the draft regulations. 2% of acreage would be included in a 25 ft. buffer, 34% of fields would be required to include a buffer, and on average 5% of each affected field's acreage would be included in a 25 ft. buffer. We look at the combined effects when farmers switch to the alternative for both herbicides and insecticides, and we use the 7% affected area under the 100 ft. buffers for both effects; this will overestimate the impacts of the alternative herbicide treatment, switching from Goal to Matrix and adding another application of Glystar Plus.

In the first scenario, with zero loss in yields, total revenues will not change for any of our assumptions regarding the own-price demand elasticity of almonds. Net revenue will decline by the same amount, $358,560, as well. There is no difference across the cases because there is no change in quantity, only an increase in treatment cost per acre (Table 4.6.2a).

Table 4.6.2a Effects of Draft Regulations: Almonds, Stanislaus County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal, Asana, and Warrior
0% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	2.4%	2.4%	2.4%
County Net Revenues (%)	-0.3%	-0.3%	-0.3%
County Net Revenues ($)	-$358,560	-$358,560	-$358,560

The demand for California almonds is inelastic, so a given percentage decrease in quantity will lead to a larger percentage increase in price. In the second case, with a 15% yield loss under the alternative treatment, the resulting price increase is enough to offset the increase in costs if all of California is affected by the regulations (see column two in Table 4.6.2b below) but not if only Stanislaus County is affected. In the latter case, total revenues are expected to decrease by $2.5 million and net revenues to decrease by $2.9 million. In the final two cases, price does not increase when quantity decreases because suppliers outside of the state increase their quantity. Consequently, total revenues in Stanislaus will decline by $3.4 million and net revenues by $3.7 million.

Table 4.6.2b Effects of Draft Regulations: Almonds, Stanislaus County
Combined effect of Matrix and Entrust in buffer, remainder of field treated with Goal, Asana, and Warrior
15% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-1.0%	-1.0%	-1.0%
Price (%)	0.3%	1.4%	0.0%
County Total Revenues (%)	-0.7%	0.5%	-1.0%
County Total Revenues ($)	-$2,497,600	$1,591,044	-$3,386,400
Cost Per Acre (%)	2.4%	2.4%	2.4%
County Net Revenues (%)	-2.4%	0.9%	-3.1%
County Net Revenues ($)	-$2,867,109	$1,114,830	-$3,744,960

4.6.3 Processing Tomatoes

As in sections 4.2.2 and 4.3.4, we examine two scenarios. In both cases the farmers will simply not plant any tomatoes in the 25 ft. buffer zones, rather than attempt to find alternative pesticide treatments. In the first scenario we consider that all these buffer zones were previously fully planted with tomatoes. In the second scenario, we consider that the 20 ft. closest to the waterways were previously left unplanted for use in turning harvesting equipment, so only a 5 ft. zone is affected by the regulations.

Under the draft regulations, 2% of county tomato acreage would be included in a 25 ft. buffer and 0.3% would be included in the 5 ft. remaining buffer zone if 20 ft. in all the buffers was already left unplanted for equipment turning. 49% of all fields would be required to include a 25 ft. buffer. On average, affected fields would have 4% of their acreage in a 25 ft. buffer (in the first scenario modeled) and 0.77% of their acreage in a 5 ft. buffer (in the second scenario modeled).

The impacts of the regulations in the first scenario are shown in Table 4.6.3a below. Yields are decreased by 100% in the unplanted buffer zone, so this sizable decrease in quantity leads to an increase in price. Because the demand for processing tomatoes is highly inelastic, a relatively small decrease in quantity leads to a relatively large increase in price. Thus, if California as a whole is affected in the same way as Stanislaus County by the draft regulations, Stanislaus growers will experience significant increases in total and net revenues, as shown in column two below. If only Stanislaus is affected by the draft regulations then total revenues will actually decrease, by $437,751 and net revenue will still increase, but only by $724,398. This difference is due to the fact that the county only accounts for 7% of the processing tomato production in California, so a decline in production there only leads to a small increase in price. If price does not increase with the decline in quantity due to increased supply by producers outside the state then total revenues will decline by $711,747 and net revenues will decline by $456,265. Total revenues decline by more than net revenues because the variable costs of processing tomato production as reported in the UC Cooperative Extension cost study are greater than the revenue per acre.

Table 4.6.3a Effects of Draft Regulations: Processing Tomato, Stanislaus County
All 25 ft. of buffer affected by regulations
100% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-1.6%	-1.6%	-1.6%
Price (%)	0.6%	8.6%	0.0%
County Total Revenues (%)	-1.0%	7.8%	-1.6%
County Total Revenues ($)	-$437,751	$3,584,371	-$711,747
Cost Per Affected Acre (%)	-100.0%	-100.0%	-100.0%
County Net Revenues (%)	2.5%	14.8%	-1.6%
County Net Revenues ($)	$724,398	$4,348,860	-$456,265

The results of the second scenario, which assumes that all affected buffers were previously left unplanted for 20 ft. and thus only 5 ft. in each will be affected by the draft regulations, are shown in Table 4.6.3b below. As in the previous scenario, when all of California is affected by the regulations total and net revenues increase due to the increase in the processing tomato price. However, this increase is significantly smaller than in the first scenario because a smaller area is affected, so quantity and price change by a smaller amount. If only Stanislaus County is affected by the regulations, then total revenues will decrease by $88,065 and net revenues will increase by $145,592. If the price remains constant, then total revenues will decline by $142,383 and net revenues will increase by $91,274.

Table 4.6.3b Effects of Draft Regulations: Processing Tomatoes, Stanislaus County
Only 5 ft. within buffer affected by regulations
100% yield loss (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	-0.3%	-0.3%	-0.3%
Price (%)	0.1%	1.7%	0.0%
County Total Revenues (%)	-0.2%	1.4%	-0.3%
County Total Revenues ($)	-$88,065	$646,169	-$142,383
Cost Per Acre Affected (%)	-100.0%	-100.0%	-100.0%
County Net Revenues (%)	0.5%	3.0%	-0.3%
County Net Revenues ($)	$145,592	$879,826	$91,274

4.6.4 Walnut

As in section 4.1.3, we analyze eight scenarios for walnuts, with spinetoram (Delegate 25 WG) sprayed across the entire field or just in 100 ft. buffer zones at two different application rates, and with and without a $0.06 per pound price premium for walnuts treated with chlorpyrifos (Lorsban 4E) but not walnuts treated with Delegate. Importantly, recall that the change in total revenues will be the same in all three columns of any given table of results because there is no base price or quantity change in any of the scenarios. The change in total revenues, however, is not always zero. It will change when the effect of losing the price premium is considered. In the scenarios with a price premium effect, price would decrease by 6.3% if the alternative pesticide was sprayed, leading to a 6.3% decrease in net revenue when sprayed on the entire field and a 0.5% decrease when sprayed only on the buffer. In both cases there is also a larger decrease in net revenues than in the absence of the price premium.

Under the draft regulations, 7.8% of Stanislaus County walnut acreage would be included in a 100 ft. buffer. 42% of all fields would be required to include a 100 ft. buffer; on average, affected fields would have 19% of their acreage in a buffer.

If the alternative pesticide was applied at 7 oz./acre to the entire field and there was no price premium effect, net revenues in Stanislaus County would decrease by $3.2 million whether the regulation applied to just Butte County or to all of California, and whether price is allowed to change with quantity or not. Total revenue remains unchanged.

Table 4.6.4a Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied to entire field at 7 oz/acre
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	5.8%	5.8%	5.8%
County Net Revenues (%)	-6.4%	-6.4%	-6.4%
County Net Revenues ($)	-$3,172,806	-$3,172,806	-$3,172,806

If there was a price premium for the walnuts from acreage treated with Lorsban 4E, then net revenues would decrease by $3.7 million in Stanislaus County, as shown in the first two columns of Table 4.6.4b below. Because the quantity produced does not change, the base price does not change. Instead, growers lose a price premium based on reduced quality of walnuts harvested from acreage treated with Delegate. Total revenues would decrease by $6.6 million in Stanislaus in all three of the modeled cases.

Table 4.6.4b Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied to entire field at 7 oz/acre
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-6.3%	-6.3%	-6.3%
County Total Revenues (%)	-6.3%	-6.3%	-6.3%
County Total Revenues ($)	-$6,638,486	-$6,638,486	-$6,638,486
Cost Per Acre Affected (%)	5.8%	5.8%	5.8%
County Net Revenues (%)	-7.5%	-7.5%	-7.5%
County Net Revenues ($)	-$3,690,608	-$3,690,608	-$3,690,608

If the alternative pesticide was applied at the intermediate application rate of 3.2 oz./acre to the entire field and there was no price premium effect, net revenues in Stanislaus County would decrease by a $433,888 in all three cases shown in Table 4.6.4c below. This is a much smaller decrease in revenues than under the previous scenario, because the lower application rate decreases the cost of the alternative pesticide significantly.

Table 4.6.4c Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied to entire field at 3.2 oz/acre
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.8%	0.8%	0.8%
County Net Revenues (%)	-0.9%	-0.9%	-0.9%
County Net Revenues ($)	-$433,888	-$433,888	-$433,888

If there was a price premium effect, then net revenues would decrease by $951,690 and total revenues would decrease by $6.6 million, as shown in Table 4.6.4d below.

Table 4.6.4d Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied to entire field at 3.2 oz/acre
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-6.3%	-6.3%	-6.3%
County Total Revenues (%)	-6.3%	-6.3%	-6.3%
County Total Revenues ($)	-$6,638,486	-$6,638,486	-$6,638,486
Cost Per Acre Affected (%)	0.8%	0.8%	0.8%
County Net Revenues (%)	-1.9%	-1.9%	-1.9%
County Net Revenues ($)	-$951,690	-$951,690	-$951,690

If the alternative pesticide was applied at 7 oz./acre only to 100 ft. buffer strips and there was no price premium effect, net revenues in Stanislaus County would decrease by $247,479, as shown in Table 4.6.4e below. As expected, this is a smaller decrease in revenues than when the alternative pesticide is applied at either application rate to the entire field. This occurs because the buffers still are only 7.8% of the total acreage.

Table 4.6.4e Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied only to buffers at 7 oz/acre, Lorsban 4E applied to remainder
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	5.8%	5.8%	5.8%
County Net Revenues (%)	-0.5%	-0.5%	-0.5%
County Net Revenues ($)	-$247,479	-$247,479	-$247,479

If there was a price premium effect, then net revenues would decline by $765,281 and total revenues would decline by $517,802, as shown in Table 4.6.4f.

Table 4.6.4f Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied only to buffers at 7 oz/acre, Lorsban 4E applied to remainder
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-6.3%	-6.3%	-6.3%
County Total Revenues (%)	-0.5%	-0.5%	-0.5%
County Total Revenues ($)	-$517,802	-$517,802	-$517,802
Cost Per Acre Affected (%)	5.8%	5.8%	5.8%
County Net Revenues (%)	-1.5%	-1.5%	-1.5%
County Net Revenues ($)	-$765,281	-$765,281	-$765,281

If the alternative pesticide was applied at 3.2 oz./acre only to 100 ft. buffer strips and there was no price premium effect, net revenues in Butte County would decrease by $33,843 in all three modeled cases, as shown in Table 4.6.4g below. This is the lowest possible decrease in revenues, because the lower application rate of Delegate is used and it affects only 7.8% of the field, while 92.2% is still sprayed with the cheaper Lorsban 4E.

Table 4.6.4g Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied only to buffers at 3.2 oz/acre, Lorsban 4E applied to remainder
0% yield loss and no price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	0.0%	0.0%	0.0%
County Total Revenues ($)	$0	$0	$0
Cost Per Acre (%)	0.8%	0.8%	0.8%
County Net Revenues (%)	-0.1%	-0.1%	-0.1%
County Net Revenues ($)	-$33,843	-$33,843	-$33,843

If there was a price premium effect, then net revenue would decrease by $551,645 and total revenue would decrease by $517,802, as shown in Table 4.6.4h below.

Table 4.6.4h Effects of Draft Regulations: Walnut, Stanislaus County
Delegate 25 WG applied only to buffers at 3.2 oz/acre, Lorsban 4E applied to remainder
0% yield loss and price premium effect (2009 base)

Price Response	Changes with Quantity		Does Not Change
Area Affected	County	California	with Quantity
Change in:			
County Total Quantity (%)	0.0%	0.0%	0.0%
Price (%)	-6.3%	-6.3%	-6.3%
County Total Revenues (%)	-0.5%	-0.5%	-0.5%
County Total Revenues ($)	-$517,802	-$517,802	-$517,802
Cost Per Acre Affected (%)	0.8%	0.8%	0.8%
County Net Revenues (%)	-1.1%	-1.1%	-1.1%
County Net Revenues ($)	-$551,645	-$551,645	-$551,645

Chapter 5
Discussion

This chapter includes a summary of the results of the analysis (section 5.1) and a discussion of some common themes that emerged across crops (section 5.2).

5.1 Summary of Results

Table 5.1a reports maximum and minimum total revenue losses across all scenarios for each crop, assuming that there is no price response to the change in quantity. Table 5.1b reports maximum and minimum net revenue losses under the same specification. Within each table, losses across crops for a given county and across counties for a given crop differ based on planted acreage, acreage in buffers, the relative costs of current treatments and alternative treatments that would be used under the draft regulations, the base value of production per acre, and differences in yields between the two treatments.

Unsurprisingly, the amount of land that would be included in a buffer is a critical determinant of the size of estimated losses. Rice is the most notable example of a crop with a large amount of acreage in buffers, as well as being a crop with a large percentage of fields being required to include a buffer. In contrast, all crops in Santa Barbara County had relatively low percentages of land included in buffers, which is one reason for its relatively smaller estimated losses. Of course, its smaller total acreage in the study crops was another important determinant.

The extent of yield losses, if any, is another critical determinant of the size of estimated losses because of the many high value crops considered in the case studies. Notably, many crops show zero losses as the minimum. These losses are almost certainly an understatement. In many instances data were limited or non-existent, as discussed in Chapter 3. Even when data were available, the relative efficacy of alternatives is often dependent on the severity of pest pressure and on whether or not the applications were timed correctly. These factors are not necessarily reflected in the available data. Finally, none of the analyses in Chapter 3 considered the additional management costs of administering two pest management programs; one for a buffer and one for the remainder of the field, orchard, or vineyard. These costs would reduce net revenues, thus increasing the maximum and minimum losses reported in Table 5.1b.

Potential losses based on the Chapter 4 results could be substantial. Maximum total revenue losses for the case study crops and counties are $359.44 million, and minimum losses are $10.84 million. For purposes of comparison, the value of the case study crops in the case study counties in 2009 was $3.008 billion. Maximum losses would be 11.9% of total revenues. Minimum losses would be much smaller: 0.36%. Subject to the caveats regarding extending results from selected crops and counties, for all field crops, vegetables and melons, and fruits and nuts in California, the resulting total revenue losses would be $2.77 billion and $83.9 million.

Table 5.1a County and crop case studies: Range of changes in total revenues ($ millions), Price does not change in response to a change in quantity

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus	TOTAL
Alfalfa							
Min. loss			-4.54			-1.32	-5.86
Max. loss			-4.54			-1.32	-5.86
Almond							
Min. loss	0.00	0.00	0.00			0.00	0.00
Max. loss	-0.85	-0.61	-3.01			-3.39	-7.86
Grape (all)							
Min. loss			0.00	0.00	0.00		0.00
Max. loss			-186.46	-36.94	-24.72		-248.12
Lettuce							
Min. loss				0.16	0.00		0.16
Max. loss				-11.31	-1.41		-12.72
Tomato (processing)							
Min. loss		-0.32	-1.14			-0.14	-0.60
Max. loss		-0.50	-5.49			-0.71	-6.7
Rice							
Min. loss	-2.44	-2.34					-4.78
Max. loss	-2.94	-2.8					-5.74
Strawberry (fresh)							
Min. loss				0.00	0.00		0.00
Max. loss				-38.08	-19.19		-57.27
Walnut							
Min. loss	0.00					0.00	0.00
Max. loss	-8.53					-6.64	-15.17
TOTAL							
Min. loss	-2.44	-2.66	-2.25	0.16	0.00	-0.46	**-10.84**
Max. loss	-12.32	-3.91	-196.07	-86.33	-45.32	-11.06	**-359.44**

Maximum net revenue losses for the 18 case study crops and counties for which regional cost and return studies are available are $314.12 million, and minimum losses are $12.24 million. For purposes of comparison, the value of the case study crops in the case study counties in 2009 was $3.008 billion. Because net revenues are not known for all field crops, vegetables and melons, and fruits and nuts in California, no net revenue loss for these crops overall can be calculated.

Table 5.1b County and crop case studies: Range of changes in net revenues ($ millions), Price does not change in response to a change in quantity

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus	TOTAL
Alfalfa							
Min. loss			-4.34			-1.28	-5.62
Max. loss			-4.34			-1.28	-5.62
Almond							
Min. loss	-0.16	-0.08	-0.35			-0.36	-0.95
Max. loss	-1.01	-0.69	-3.38			-3.74	-8.82
Grape (all)							
Min. loss			-1.02	N.A.	N.A.		-1.02
Max. loss			-209.82	N.A.	N.A.		-209.82
Lettuce							
Min. loss				0.17	0.01		0.18
Max. loss				-11.64	-1.47		-13.11
Tomato (processing)							
Min. loss		-0.18	-0.42			-0.09	-0.69
Max. loss		-0.82	-2.03			-0.46	-3.31
Rice							
Min. loss	-1.91	-1.90					-3.81
Max. loss	-2.39	-2.27					-4.66
Strawberry (fresh)							
Min. loss				-0.13	-0.02		-0.15
Max. loss				-40.60	-20.54		-61.14
Walnut							
Min. loss	-0.02					-0.03	-0.05
Max. loss	-3.95					-3.69	-7.64
TOTAL							
Min. loss	-2.09	-2.16	-3.00	0.04	-0.01	-0.83	**-12.24**
Max. loss	-7.35	-3.78	-216.44	-52.24	-22.01	-8.24	**-314.12**

Additional management costs due to the regulations could be substantial. Table 5.1c reports the number of fields affected by crop and county. Assuming a loss of only $100 per affected field, additional management costs due to the draft regulations would be $1.38 million. These costs are distributed unequally across crops and counties; rice has a particularly high number of fields (4,777). The coastal counties, Monterey and Santa Barbara, have relatively few affected fields, so lettuce, strawberries, and coastal grapes have relatively few affected fields as well.

Table 5.1c Number of Fields with Buffer Acreage by County and Crop

	Butte	Colusa	Fresno	Monterey	Santa Barbara	Stanislaus	TOTAL
Alfalfa			829			460	1,289
Almond	625	441	594			1,294	2,954
Grape (all)			2,154	142	248		2,544
Lettuce				497	44		541
Tomato (processing)		234	368			106	708
Rice*	1,743	3,034					4,777
Strawberry (fresh)				35	67		102
Walnut	240					597	837
TOTAL	2,608	3,709	3,945	674	359	2,457	**13,752**

*1,538 fields in Butte County and 2,767 fields in Colusa County are affected by the 25-ft. buffer as well as the 150-ft. buffer. We do not double-count management costs for those fields, although there may be additional costs.

5.2 Common Issues

The case studies have a number of common issues that will almost certainly affect other crops, although as the case studies demonstrate the relative importance of these issues will differ by crop and county. The first issue regards the per-acre treatment cost of pesticide products including the listed active ingredients versus the per-acre treatment cost of pesticide products containing alternative active ingredients. The active ingredients listed in the regulations tend to be ones that have been on the market for some time. They tend to be cheaper to use. Alternatives tend to be newer and more expensive. Of course, not all of the individual case studies addressed here show an increase in cost per affected acre. In the case of processing tomatoes, because growers do not plant in the buffer at all, costs decline. The same is true for the 25-ft. buffer acreage in rice. It is also worth noting that the case studies focus on a single treatment comparison, and rely on list prices for pesticides. Individual growers may face different prices. It may also be the case that some PCAs and growers may prefer specific products in spite of a slightly higher cost per acre, perhaps due to a different spectrum of control, effects on beneficial insects, or other considerations.

Second, most active ingredients are listed for control of multiple pests. Active ingredients that can serve as substitutes for one target pest may not serve as substitutes for another. Thus, growers' choices regarding active ingredients will depend on the specific set pest populations they face. This complicates the evaluation of active ingredient use reported in the 2009 PUR data because a listed active ingredient listed above may be applied for multiple pests, and the alternatives will differ depending on the target pest.

A third issue is that some active ingredients are subject to application limitations for resistance management reasons. When a pest management program requires multiple applications, it can become important to maintain access to pesticides with different classes of action. Even if individually efficacious alternatives to active ingredients listed in the draft regulations are available, they may not be sufficient for implementing an efficacious control program.

A fourth issue is that it is very difficult to determine whether or not growers may simply move to alternatives entirely rather than administer (or pay their PCAs to administer) one pest management program in buffers and one on all other acreage. If they implement two programs, it will increase the cost of monitoring pest populations, the total human and machine time devoted to applying pesticide treatments, and other related costs. The magnitude of these cost increases will vary greatly by crop, idiosyncratic field characteristics, pest pressure, and other considerations.

A fifth issue is that pest control in a buffer and pest control in the rest of a field are not independent activities. Pest pressure is generally heaviest at the edge of a field or orchard. If growers must use less efficacious pesticides along a field edge in order to comply with a buffer requirement, then increased pest pressure and associated yield damage may affect production on interior acreage in addition to any effects on the buffer itself. Using different treatments on buffers and interiors may promote resistance development by providing reservoirs for pest populations. Any such effects will increase the economic costs of the draft regulations to an undetermined degree.

Finally, all economic effects of the draft regulations are dependent on the definition of sensitive aquatic site. Because this definition appears to differ from the definition in the Water Code, and from the definitions on some product labels for important pesticides, its implications will depend highly on how it is defined and interpreted in practice. The broader the scope of the definition, the greater the acreage that will be affected.