

The Effect of Landscape-level Pesticide Applications on California Citrus Growers' Decisions for California Red Scale Management

Kelly A. Grogan and Rachael E. Goodhue

The mobility of many pests potentially allows nearby growers to affect each other through their pest management decisions. Using data from a 2010 survey of California citrus growers, we explore growers' use of a specific beneficial insect, *Aphytis melinus*, which parasitizes California red scale, a major citrus pest. The extent of growers' reliance on *A. melinus* and whether or not they choose to make augmentative releases varies with their production region and other characteristics. We also analyze how landscape-level pesticide use affects growers' decisions regarding whether or not to apply an insecticide to control California red scale. In some cases, pesticides applied on non-citrus increase the probability of an insecticide treatment for California red scale control on citrus fields.

A *phytis melinus*, a parasitic wasp, lays its eggs under the California red scale, a primary citrus pest. When the wasp's eggs hatch, the larvae consume the scale. The wasp is produced by commercial insectaries and can be purchased and released by growers to augment natural populations and improve the control of California red scale. However, applications of some pesticides will reduce *A. melinus* populations.

Chemical controls may be used to manage California red scale instead of, or in conjunction with, biological control provided by *A. melinus*. We examine whether or not pesticide use in the surrounding area affects a California citrus grower's decision to apply insecticide to manage California red scale. If others' pesticide use increases the likelihood that a grower applies an insecticide, then there is a negative externality of pesticide use.

We separate these pesticides into two types: pesticides used to control California red scale and other citrus pests, including carbaryl (Sevin™), chlorpyrifos (Lorsban™), and methidathion (Supracide™); and, pesticides not used to control California red scale but are used to manage other citrus pests, including acetamiprid (Assail™), cyfluthrin (Baythroid™), and fenpropathrin (Danitol™).

The potential cross-effects of growers' pest management decisions are not

limited to citrus growers. These pesticides are also used on non-citrus crops, and *A. melinus* provides control of certain pests of non-citrus crops as well.

We surveyed California citrus growers in spring 2010 regarding the presence and management decisions for four major citrus pests in the 2009–10 season, as well as other information regarding the operation and grower. Using information from 18 county agricultural commissioners' offices, surveys were mailed to 3,480 growers. Of these individuals, 429 responded, resulting in a 12.3% response rate. Some respondents did not answer all questions, so we report the number of respondents in each table below.

The presence of California red scale reported by respondents varied by region, as shown in Table 1, as did growers' decisions on whether or not an insecticide treatment was required for managing it. Growers in the San Joaquin Valley, who face the environment most favorable for pest development, were most likely to apply an insecticide. Growers in the coastal-intermediate and interior regions were least likely to do so.

Currently efforts are underway to eradicate California red scale in the desert region. The eradication program mandates growers' responses to an infestation, so we exclude the desert region from the remainder of the analysis. California red scale was least likely to be reported present in

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Table 1. California Red Scale Presence and Insecticide Use, Overall and by Region (N=394)

Region	% Pest Not Present	% Pest Present, No Insecticide	% Pest Present, Insecticide Applied
All	52.3	28.9	18.8
Northern Region	40.0	33.3	26.7
San Joaquin Valley Region	40.4	26.5	33.1
Coastal-Intermediate Region	60.8	28.9	10.3
Interior Region	50.0	40.6	9.4
Desert Region	80.0	0.0	20.0

that region, and, when reported present, required an insecticide treatment.

Use of Biological Control

An integrated pest management program may include biological, cultural, and chemical controls. The survey asked growers three questions regarding their use of *A. melinus* for California red scale control. The first question regarded whether or not there was a natural population of *A. melinus* in the grower’s groves (Table 2). The second queried the extent to which the grower relied on *A. melinus* for red scale control (Table 3). The third regarded whether or not the grower increased a natural population with augmentative releases.

Examining Table 2, roughly half of growers did not know whether or not a natural population of *A. melinus* was present. There are a number of possible reasons that may contribute to this high share, including, but not limited to, that growers did not scout for *A. melinus*, growers employed pest control advisors who scouted but did not tell the grower, or growers used

augmentative releases and thus did not know whether there was a natural population or whether the existing population should be considered natural.

Among growers indicating knowledge of whether or not a natural population existed, a natural population was most likely to be reported present in the interior and northern regions, and least likely to be reported present in the cooler coastal-intermediate region. A little more than 26% of respondents reported relying on *A. melinus* for control of red scale, with 11.4% relying entirely on *A. melinus* for control (Table 3). The interior and northern regions had the highest percentages of respondents relying entirely on *A. melinus* for red scale control.

Forty-seven respondents reported purchasing and releasing *A. melinus* for California red scale control. Releases were the most common in the San Joaquin Valley (17 respondents) and the coastal-intermediate region (24 respondents). Five respondents in the interior region made augmentative releases, and one did in the northern region.

Table 2. Percentage of Respondents Reporting that *A. melinus* is Naturally Occurring, Not Naturally Occurring, or They Do Not Know, Overall and by Region (N=310)

Region	% Naturally Occurring	% Not Naturally Occurring	% Unknown
All	22.3	26.5	51.3
Northern Region	33.3	22.2	44.4
San Joaquin Valley Region	26.5	23.9	49.6
Coastal-Intermediate Region	16.9	30.0	53.1
Interior Region	36.0	20.0	44.0

Respondent Characteristics

There are a number of farm and grower characteristics that can influence pest management decisions. In order to identify any effects of landscape-level pesticide use on an individual grower’s pest management decisions, we must control for the effects of these other characteristics. Table 4 reports key characteristics for all respondents, those who mostly or entirely relied on *A. melinus* for control of California red scale, and those who released *A. melinus*.

Growers who relied on and/or released *A. melinus* had substantially more citrus acreage and total acreage on average than did all respondents. Interestingly, respondents who had organic acreage were less likely to rely on or release the wasp than were all respondents. Of all respondents, a higher percentage of male growers relied on or released *A. melinus*; the same was true for white growers.

Growers who sold to a packing-house or shipper were a higher percentage of respondents who relied on or released *A. melinus*. However, growers who relied on other marketing outlets, such as farmers’ markets and processors, were much less likely to utilize *A. melinus*. Growers who relied primarily on a pest control advisor were more likely than other respondents to rely on or release *A. melinus*.

Statistical Analysis

The statistical analysis tests whether or not the use of certain pesticides in nearby fields affects respondents’ choice of pest management techniques, specifically their reliance on *A. melinus* for California red scale control. The analysis considers the effects of pesticide use within an 18-mile by 18-mile block surrounding each respondent, and considers the use of pesticides on both citrus and non-citrus fields using data from the California Department of Pesticide Regulation’s Pesticide Use Reporting database.

For the statistical analysis, we include three categories of pesticides: 1. Toxic to *A. melinus* only; 2. California red scale control, toxic to *A. melinus*; and 3. California red scale control only. The third category is included because the growers' choice of treatment may be influenced by the treatment choices of nearby growers, or by common biological factors or other considerations that they face. The results of the analysis regarding the variables of interest are reported in Table 5. The statistical model also controlled for the grower and farm characteristics summarized in Table 4.

We hypothesize that the surrounding use of pesticides that are toxic to *A. melinus* increases the probability that the respondent relies on chemical control of the scale because the beneficial insect populations will be reduced. We use a probit model that estimates the factors underlying a grower's decision to apply an insecticide as part of his California red scale management program to examine this hypothesis.

The results of the probit estimation (Table 5) provide partial support for this hypothesis. Surrounding use of insecticides that are toxic to *A. melinus* and used by non-citrus growers for California red scale control increases the probability that a respondent applies a chemical to treat California red scale.

Specifically, the use of three broad-spectrum pesticides on surrounding non-citrus fields—carbaryl (a carbamate), chlorpyrifos (an organophosphate), and methidathion (an organophosphate)—increases the probability that respondents relied on chemical control of California red scale. Table 5 reports the marginal effects of surrounding use of each group of pesticides on the likelihood that a citrus grower applies an insecticide for California red scale management.

The statistically significant support for our hypothesis is reported in the fifth row of Table 5. A respondent

Table 3. Extent of Reliance on *A. melinus* for California Red Scale Control, Overall and by Region (N=378)

	% With Pest Not Present	% With Pest Present, Did Not Rely on Natural Enemy	% Who Somewhat Relied on Natural Enemy	% Who Mostly Relied on Natural Enemy	% Who Entirely Relied on Natural Enemy
All Regions	51.6	22.2	9.3	5.6	11.4
Northern	61.5	7.7	7.7	7.7	15.4
SJV	40.2	35.6	9.8	7.6	6.8
Coastal	57.9	16.2	8.6	5.1	12.2
Interior	50.0	13.3	10.0	0.0	26.7

Table 4. Characteristics of All Respondents and Respondents Who Relied on or Released *A. melinus**

	All (N=422)	Mostly or Entirely Relied on (N=93)	Released (N=47)
Farm Characteristics			
Percent Non-Orange Acreage	39.1	38.8	37.0
Average Total Citrus Acres	76.4	224.7	402.1
Average Total Acres	167.6	347.0	632.9
Average Expected Value per Acre	\$6,242	\$6,445	\$6,841
% of Growers with Organic Acreage	14.5	10.8	6.4
Grower Characteristics			
Median Education Level	-----College Degree-----		
Average Experience (years)	25.7	29.9	29.4
Percent Female	18.0	14.9	15.9
Percent Race			
Asian	3.6	1.1	0.0
Hispanic	6.4	3.4	2.3
Other	3.6	4.6	4.5
Percent of Output Sold Through Outlet			
Packinghouse/Shipper	65.0	78.7	88.3
Processor	6.2	2.4	3.0
Other	21.7	3.3	4.3
Primary Source of Pest Control Information			
Pest Control Advisor	55.3	70.1	82.2
Extension Agent	13.5	9.2	4.4
Other Growers	8.1	2.3	0.0
Farm/Chemical Suppliers	7.2	0.0	0.0
Extension Publications	4.3	3.4	2.2
Organic Certifying Agent	3.7	0.0	0.0
Trade Magazines	1.1	1.1	2.2
Other	10.3	13.8	8.9
* Includes 5 respondents from the desert region			

Table 5. Marginal Effects of Determinants of Insecticide Application to Manage California Red Scale

	Marginal Effects	Robust Standard Error
Surrounding Pesticide Use on Citrus		
Toxic to <i>A. melinus</i> only	-0.0424	(0.0587)
California Red Scale Control, Toxic to <i>A. melinus</i>	0.2377	(0.1641)
California Red Scale Control Only	-0.3542	(0.2962)
Surrounding pesticide use on non-citrus		
Toxic to <i>A. melinus</i> Only	-0.1168*	(0.0537)
California Red Scale Control, Toxic to <i>A. melinus</i>	0.2864*	(0.0993)
California Red Scale Control Only	0.0157	(0.1094)
N	145	
Pseudo-R2	0.323	
Likelihood-Ratio Test	12.84*	
* indicates significance at the 5% level.		

surrounded by non-citrus use of these pesticides that falls at the 75th percentile (relatively high pesticide usage) is 28% more likely to rely on chemical control than a respondent surrounded by a median level of the use of these pesticides. This suggests that the use of these pesticides on nearby non-citrus fields lowers populations of *A. melinus* on respondents' fields, necessitating chemical control of California red scale.

On the other hand, contrary to expectations, the surrounding use of three pesticides toxic to *A. melinus* and not used by citrus growers to treat California red scale—acetamiprid, cyfluthrin, and fenprothrin—reduces the likelihood that a respondent will apply an insecticide to treat California red scale.

Acetamiprid is used to control citricola scale as well as other non-citrus pests. While it is not used for California red scale control due to lower relative efficacy, it does suppress populations. Surrounding use of this pesticide may actually generate a positive externality by lowering the area's California red scale populations. In addition, acetamiprid is a neonicotinoid, and cyfluthrin and fenprothrin are pyrethroids. While toxic to *A. melinus*, these pesticide classes are considered to have

fewer negative environmental effects than organophosphates and carbamates.

The use of these pesticides may indicate that overall, growers use fewer broad spectrum pesticides in their integrated pest management programs, and that the cumulative effect of these management decisions enhances regional *A. melinus* populations. A third possibility is that the timing of applications of these pesticides relative to *A. melinus* population development mitigates their toxicity. We do not have the data required to examine these potential explanations or others.

Policy Implications

Regulation of pesticides is commonly justified based on negative externalities. These negative externalities are effects on environmental quality, ecosystems, or human health that are not borne, or primarily borne, by the grower making the pesticide application. The statistical analysis suggests that in some instances, another type of externality may exist: the application of pesticides or certain classes of pesticides may affect other growers' need to use chemical pesticides for the management of specific pests.

The analysis focused on surrounding use. This suggests that any regulatory consideration of potential cross-grower

effects should take into account the possibility of local differences rather than beginning at the state or national level.

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For additional information, the authors recommend:

Grogan, Kelly A. and Rachael E. Goodhue. 2011. "California Citrus Pest Management Survey: A Summary of Responses." Department of Agricultural and Resource Economics, University of California, Davis. <http://agecon.ucdavis.edu/people/faculty/rachael-goodhue/docs/CitrusSurveyResults2010.pdf>.

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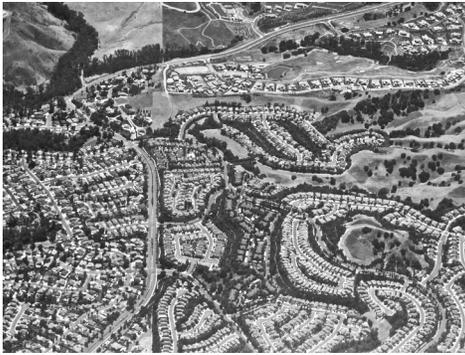
Goodhue, Rachael E. and Karen Klonsky. 2004. "Explaining Reduced Pesticide Use in Almonds." *Agricultural and Resource Economics Update* 7(5):9-11.

Jetter, Karen M., James Chalfant and Karen Klonsky. 1999. "Household Willingness to Pay for Biological and Chemical Public Pest Control Programs." *Agricultural and Resource Economics Update* 2(2):5-7.

Analysis of the Influence of Open Space on Residential Values

Monobina Mukherjee and Linda Fernandez

Residential property values decrease with increasing distance from open space in two Southern California counties, regardless of open space preservation policy. Homeowners residing in zones of these counties, with big cities and scarce open space, have a high value for proximity to open space.



Our results also show that there was a statistically significant increase in residential sale price with an increase in lot size for all the zones of San Bernardino and Riverside counties.

Concern over the preservation of open space has been growing in recent years with increasing urban development. Open space provides a range of benefits to residents of a community beyond the benefits that accrue to private landowners. In this study, open space refers to parks, areas with wild habitat, and the area of a residential lot aside from the residential structure itself. Our focus is on the Inland Empire region, which is a large urban area located in southeastern California, including Riverside and San Bernardino counties, indicated by the shaded areas in Figure 1.

To support the conservation of open space, Riverside County implemented

the Riverside County Integrated Project (RCIP) in 1999. This analysis measures the impact of open space variables on residential property values in different regions of Riverside County where RCIP is implemented, and different regions of San Bernardino County that do not have any conservation policy.

One objective of this study is to analyze how a policy of conservation and preservation of land influences the housing market. With data on residential property sales and distance measures to open space, it is possible to estimate the value of open space through a hedonic method of valuation. We discuss more about the hedonic method in the methodology section.

Background of RCIP

RCIP is a comprehensive, integrated program to determine future conservation, transportation, housing and economic needs in Riverside County. One of RCIP's primary aims is to protect the natural environment by conserving habitat and open space through a Multi-Species Habitat Conservation Plan (MSHCP). San Bernardino County is already endowed with abundant open space including wild habitat in the form of national and

state forests. Riverside County does not have such an endowment of open space with wild habitat and aims to gain such acreage through the RCIP.

Study Area

We divided the study region into six zones depicted in Figure 1. Zones 1, 3, and 5 belong to Riverside County, while Zones 2, 4, and 6 belong to San Bernardino County. The study compared the six zones across the two counties in the following three pairs: Zone 1 and Zone 2, Zone 3 and Zone 4, and Zone 5 and Zone 6.

The zones were paired based on similar socioeconomic characteristics and proximity to open space areas in order to compare the value of open space in a zone that has a conservation policy (RCIP) with its value in a zone without the policy. This study also compared the value of open space and other housing market variables in the zones during the years 1996–99 and 2000–04, to compare before and after introduction of the RCIP policy.

Methodology

We conducted a comparison of the zones using a statistical analysis to study the influence of open space and

Figure 1. Study Area

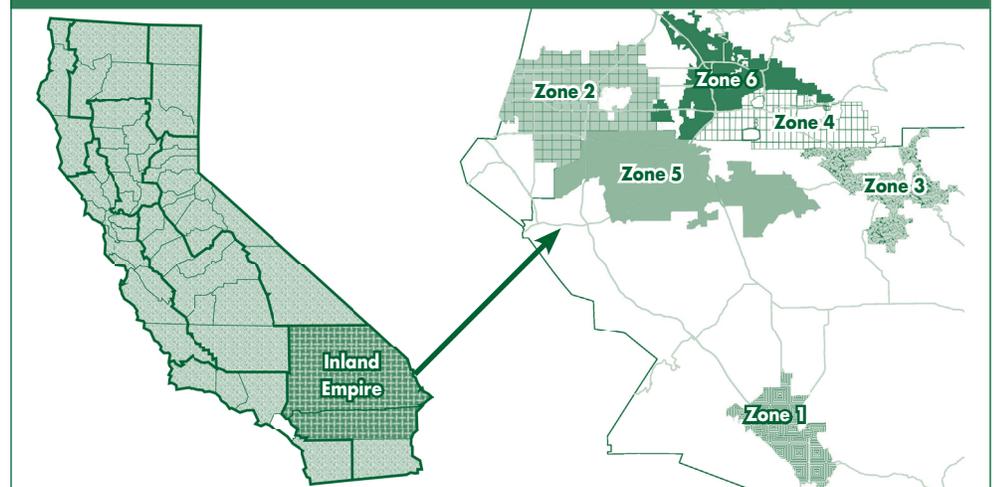


Table 1. Difference in Mean Values for Relevant Variables Pre- and Post-RCIP

Zones (1996–99) (Pre-Policy)	Sale Value (\$)	Distance from a Park (meters)	Distance from Wild Habitat (meters)	Lot Size (square feet)
1	186,621	819.3	2,698.2	22,202
2	149,598	1,964.8	1,664.5	9,735
3	111,336	689.8	2,044.2	26,086
4	162,329	1,220.4	843.9	14,447
5	123,275	1,844.7	2,340.3	12,614
6	99,767	4,053.1	1,511.7	10,927
Zones (2000–04) (Post-Policy)	Sale Value (\$)	Distance from a Park (meters)	Distance from Wild Habitat (meters)	Lot Size (square feet)
1	309,762	821.0	2,599.9	20,540
2	241,555	1,987.2	1,739.8	9,449
3	156,133	729.2	2,085.8	18,416
4	229,867	2,009.0	957.4	15,646
5	209,233	1,747.6	2,299.3	12,272
6	156,254	4,496.7	1,577.2	10,749

other variables on residential sale value. Our variables included distance from wild habitat, distance from parks, and lot size. The average values for these variables across different zones and two time periods are listed in Table 1.

Lot size is the area of the residential lot measured in square feet. Distance from parks is the straight-line distance from the residential property to the nearest park in meters. Distance from wild habitat is the straight-line distance from the residential property to the nearest wild habitat area in meters.

We use a spatial error hedonic model to estimate the value of open

space variables for the zones. Hedonic pricing models express the price of a good (in our case residential property) as a function of its characteristics. When the model is econometrically estimated using data on market prices and characteristics of the residential property, such as structural area of a house or environmental attributes, the resulting estimated coefficients indicate the homebuyers' marginal values of the attributes.

In statistical models involving property value data, there is high chance that property values might be spatially correlated or there might be a high

spatial correlation in error terms due to some unobserved factors that can influence the property values. This may produce biased estimates if the spatial correlation is not accounted for in the model. The inclusion of the spatial correlation of house sale prices or error terms in a hedonic pricing model may produce better marginal implicit price estimates of the environmental variables of interest.

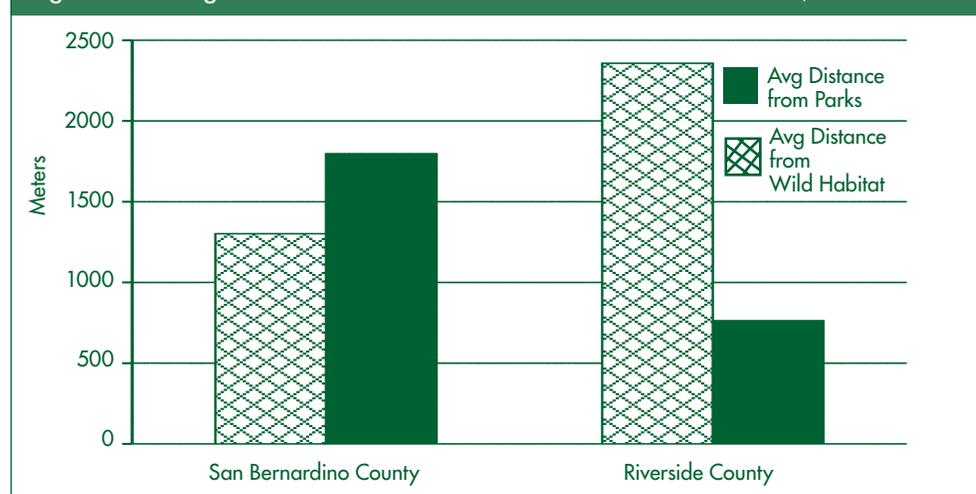
We compared the estimates of the Spatial Error Model (SEM) with other econometric models like Ordinary Least Squares (OLS) and Spatial Autoregressive (SAR) and find that SEM provides more robust estimates compared to these models. The coefficient for spatial error correlation also turns out to be positive and statistically significant, which validates the need to account for the spatial error correlation in the study.

We transformed the data into its logarithmic form. The logarithmic form produces more accurate estimates that can be compared in terms of relative size. In general, log transformations yielded a better fit of the model to the data than raw scale. In a log-log model the coefficients of the variables represent the percentage change in the dependent variable due to a 10% increase in the independent variable. In this study, the dependent variable is residential sale value and the independent variables are distance from parks, distance from wild habitats and lot size.

The results from estimating the SEM model are presented in Table 2. A negative value represents the percent decrease in the residential sale value and a positive value represents the percent increase in the residential sale value from a 10% increment in the variable. These numbers can also be interpreted as homebuyers' marginal percentage value for these amenities.

The number in parentheses is the t-statistic (t-stat). If the absolute value of the t-stat is greater than 2,

Figure 2. Average Distance of Residence from Wild Habitat and Parks, in meters



it means that the variable in question has a statistically significant impact on the sale value of housing.

Results for Riverside County

Table 2 shows that a 10% increase in the distance from the nearest park is associated with a statistically significant decrease in the sale value of the property in all zones of Riverside County, during both time periods, indicating that homebuyers in Riverside County attach value to living in close proximity to parks.

For example, Table 2 shows that an increase of 10% in distance from a park reduced the sale value of a house by 0.43%, 0.70%, and 0.03% in Zones 1, 3 and 5, respectively, during 1996–99. Similarly, a 10% increase in the distance from a park decreased home values decreased by 0.26%, 0.43%, and by 0.02% in Zones 1, 3 and 5, respectively, during 2000–04. For example, if the distance from the nearest park of a home in Zone 1 was 820 meters and the sale value was \$248,192, a 10% increase in distance from a park (82 meters) led to a 0.43% decrease in home value—\$1,067. Proximity to parks had a positive amenity value in all zones of Riverside County, although the effect was not statistically significant in Zone 5.

Table 2 shows that an increase of 10% in the distance from wild habitat areas reduced sale value of a property by 0.12% in Zone 3 during 1996–99. Home value also decreased by 0.54% during 1996–99, and by 0.21% during 2000–04, with an increase of 10% in distance from wild habitat areas in Zone 5. The negative impact on home value with an increase in distance from wild habitat areas was statistically significant only in Zone 5 of Riverside County. Zone 5 contains the cities of Riverside and Moreno Valley, which do not have adequate open space areas with wild habitat, causing buyers in that area to attach high value to wild habitat access.

Table 2 shows that the homebuyers' had a higher value for proximity to parks than wild habitat areas in Zones 1 and 3 of Riverside County during both time periods. In Zone 3 home values decreased by 0.70% with a 10% increase in distance from parks, but they were reduced by 0.12% with a 10% increase in distance from wild habitats during 1996–99. Homes in Riverside County are located closer to parks than wild habitat areas on average (Figure 2).

Home values increased with increases in lot size for all the zones of Riverside County during both time periods. Home values increased by 0.35% in Zone 1, 1.47% in Zone 3, and by 0.92% in Zone 5, with a 10% increase in lot size during 1996–99. Similar impacts on home values for lot size were found for 2000–04 for Riverside County.

Results for San Bernardino County

Table 2 shows that a 10% increase in distance from parks reduced residential sale value in Zone 2 by 0.25% and in Zone 6 by 0.58% during 1996–99. We also found a decrease in home value of 0.08% in Zone 2, 0.53% in Zone 4, and of 0.18% in

Zone 6 during 2000–04 with a 10% increase in distance from parks.

City parks have not been designated in San Bernardino County for over 20 years (Bluffstone et al. 2008), and the average distance from residences to parks in San Bernardino County is high relative to Riverside County (Table 1). The scarcity of parks in these zones of San Bernardino County contributes to their high amenity value.

A 10% increase in the distance from wild habitat areas reduced home value in Zone 2 by 0.73% during 1996–99, and by 0.74% during 2000–04. Home value was also reduced in Zone 6 by 0.14%, with a 10% increase in distance from wild habitat during 2000–04. The homebuyer's value for proximity to wild habitat areas was higher than the value of proximity to parks in Zone 2 during both time periods.

Zone 6 consists of big cities like San Bernardino, and this area does not have adequate parks. The average distance from a residence to a park was largest in Zone 6 compared to all other zones (Table 1). An increase in the distance from parks reduced home values by a greater percentage

Table 2. Spatial Error Model Regressions (SEM)

Zones (1996–99)	Distance from Park (meters)	Distance from Wild Habitat (meters)	Lot Size (square feet)
1	-0.43 (-13.49)	0.44 (7.11)	0.35 (6.51)
2	-0.25 (-5.45)	-0.73 (-16.89)	1.68 (33.59)
3	-0.70 (-6.83)	-0.12 (-0.82)	1.47 (10.49)
4	0.057 (0.62)	0.13 (1.26)	1.64 (19.71)
5	-0.03 (-0.77)	-0.54 (-10.09)	0.92 (19.90)
6	-0.5 (-13.04)	0.06 (1.01)	0.36 (10.86)
Zones (2000–04)	Distance from Park (meters)	Distance from Wild Habitat (meters)	Lot Size (square feet)
1	-0.26 (-12.02)	0.10 (2.94)	1.43 (38.72)
2	-0.08 (-2.53)	-0.74 (-24.71)	1.29 (37.79)
3	-0.43 (-8.38)	0.61 (7.21)	1.15 (16.47)
4	-0.53 (-11.19)	0.48 (8.26)	1.24 (31.81)
5	-0.02 (-1.09)	-0.21 (-7.50)	1.29 (43.61)
6	-0.18 (-5.64)	-0.14 (-3.67)	1.09 (24.53)

than an increase in the distance from wild habitats in Zone 6 during both time periods. Home values decreased by 0.18% with a 10% increase in the distance from parks, and by 0.14% with a 10% increase in the distance from wild habitat during 2000–04.

The average distance to wild habitat areas from residential properties in Zone 4 was approximately 900 meters, the lowest of any zones. Table 2 shows a negative amenity value for proximity to wild habitat areas in Zone 4 during both time periods. There was a 0.48% increase in home value with a 10% increase in distance from wild habitat in Zone 4 during 2000–04.

Zone 4 is relatively rural, with residents more isolated from immediate access to shopping, schools, etc. This can be a reason for the results presented above.

Our results also show that there was a statistically significant increase in residential sale price with an increase in lot size for all the zones of San Bernardino County during both time periods. Home value increased by 1.68% in Zone 2, 1.64% in Zone 4, and by 0.363% in Zone 6, with a 10% increase in lot size during 1996–99. Comparable results for the effect of lot size on home values in San Bernardino County were found for the 2000–04 period.

County Comparison

In some zones of both Riverside and San Bernardino County, we find that homeowners' value for lot size was higher than their value for proximity to open space areas. Home value decreased by 0.26% with a 10% increase in distance from parks, whereas they increased by 1.43% with a 10% increase in lot size in Zone 1 during 1996–99. In Zone 2 there was a 0.73% decrease in home value with a 10% increase in distance from wild habitat, whereas home value increased by 1.68% with a 10% increase in lot size during 1996–99.

Average residential property values increased for both the counties in 2000–04 compared to 1996–99. As Table 1 shows, this increase was higher for Zone 1 than Zone 2, and for Zone 4 than Zone 3, and for Zone 5 than Zone 6. Thus, Riverside County experienced greater appreciation of home values in two of the three study comparisons. Through its conservation plans, the RCIP could have played a key role in pushing up residential property values in the zones of Riverside County.

Conclusion

Our results show that residential sale value decreased with increases in distance from open space, regardless of the presence of an open-space policy such as RCIP. Our results also show that scarcity of open space in zones with big cities (Zones 5 and 6) can lead to homeowners having a high value for proximity to open space. Higher value for lot size compared to proximity to parks and wild habitat areas for some of our zones suggest that private lot size can sometimes be a substitute for proximity to public open space.

Another important observation, from the methodological standpoint, is that the spatial error hedonic model used in this study provides more robust estimates compared to other econometric models. With more accurate and efficient estimates of value of open space and other variables, the spatial error hedonic model can be used in the decision-making process associated with open space conservation policy and urban land-use planning.

The amenity values generated in this study can help in estimating the benefit of conservation of open space, which can be used as a tool by policy makers to set the conservation fees, e.g., development impact fees that help finance conservation. Additionally, this study can prove significant for land-use planning and

conservation decisions, not only in the Inland Empire region but for any other region with similar geographical characteristics and residential markets.

Suggested Citation:

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For additional information, the authors recommend:

Riverside County Integrated Project (www.rcip.org)

Bluffstone, R., M. Braman, L. Fernandez, T. Scott and P.-Y. Lee. 2008. "Housing, Sprawl, and the Use of Development Impact Fees: The Case of Inland Empire." *Contemporary Economic Policy*, 26(03) 433–447.

Why Are Outside Investors Suddenly Interested in Farmland?

Jennifer Ifft and Todd Kueth

There is a growing notion that a large volume of farmland purchases are being made by individuals and institutions outside of the traditional agricultural sector. Over the last 15 years, farmland has offered returns higher than the S&P 500, and farmland did not experience the price bust of residential housing. However, farmland price appreciation varies by regions.



Urban influence appears to have the largest impact on farmland values in the Central Valley of California.

While the rest of the economy struggles to overcome the recent recession, the agricultural sector is prospering as a result of high commodity prices, an expansion in agricultural exports, and rising farm income levels. The relative prosperity of the agricultural sector has attracted the attention of new investors, yet the agricultural sector offers few opportunities for outside investment. For example, only a small share of agribusiness firms are publicly traded.

The financial industry has responded by developing several new financial products that allow individuals to “invest” in the agricultural sector. The products include over-the-counter

swaps, exchange-traded funds, and exchange-traded notes. In addition, several firms are working to create publicly traded real estate investment trusts that specialize in farmland.

The most direct avenue for investing in the agricultural sector remains direct purchases of farmland. Outside investors are recognizing the financial opportunities of purchasing farmland, and many suggest speculative forces are bidding up prices. Given historically thin farmland markets, or infrequent farmland sales, competition to purchase prime farmland has always been fierce. According to a recent USDA report, the average value per acre for farm real estate (defined as the value of all land and buildings) in 2011 is \$2,350—a 6.8% increase over the previous year. The average value per acre for farm real estate in California is \$6,600 per acre, a reduction by 1.5%.

Farmland’s Return on Investment

Farmland differs from other investments in that it is illiquid – or not easily sold, and buyers often purchase farmland as a long-term investment.

Other investments, such as stocks and bonds, are easily transferred and are often held for much shorter investment horizons. The natural question is then, does investment in farmland or the stock market yield higher returns? To answer this question, we consider the return on investment (ROI) of farm real estate compared to the S&P 500, a frequently used measure of stock market performance. ROI measures the per-period rate of return on dollars invested, and for a single period, ROI is calculated as:

$$\text{Return on Investment (\%)} = \frac{\text{Net profit (\$)} / \text{Investment (\$)}}{1}$$

The value of ROI would therefore increase as profit increases or the cost of investment decreases. To control for the effects of inflation, all prices are expressed in real dollars using the consumer price index.

The ROI in 2011 for farmland and the S&P 500 since 1980 are shown in Figure 1. The lines show the percent return for an investment of \$1,000, in real 2011 dollars, in each year. For example, an investment of \$1,000 real

Figure 1. Return on Investment for S&P 500 and Farmland, 1980–2007

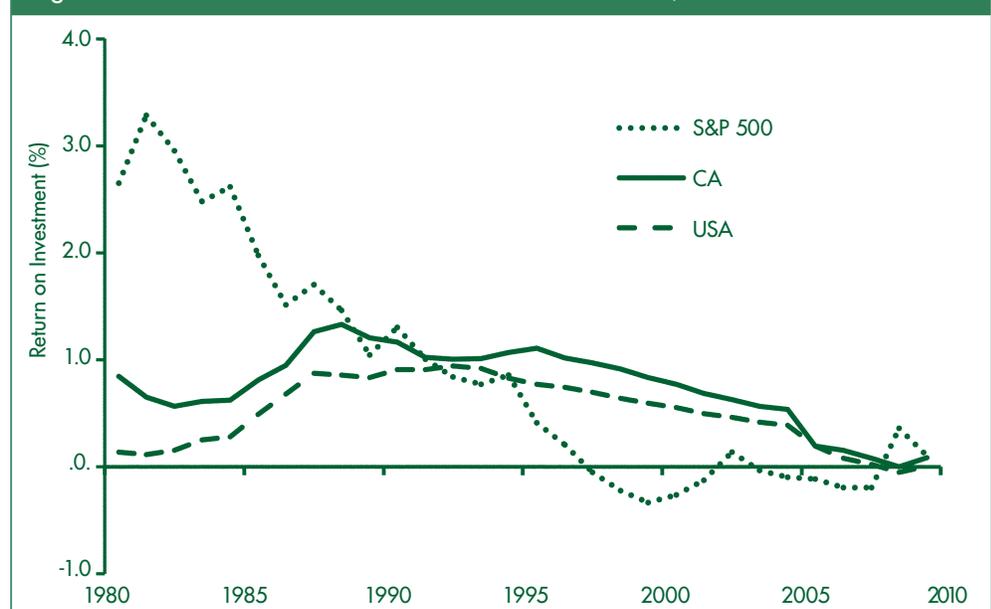
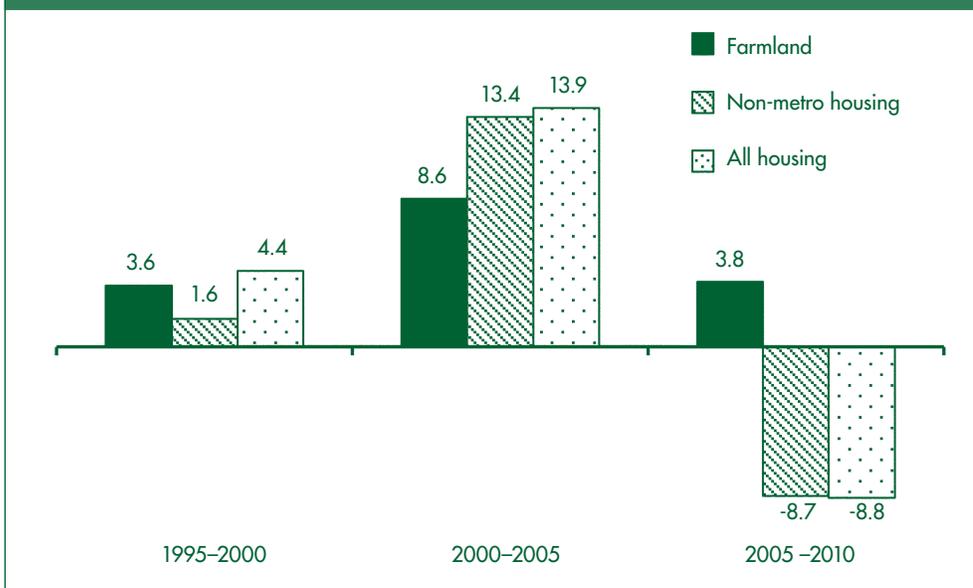


Figure 2. Average Annual Price Change for California Real Estate, 1995–2005



dollars in 1980 would yield a return of 2.6%. The same investment in farmland at the U.S. average price yields approximately one-tenth of a percent return (0.1%), yet an investment at the average California price yields 0.8%.

The early 1980s were a period of record losses for farmland values throughout the United States and, as a result, the S&P 500 represents a more attractive investment in that period. On the other hand, investment in farmland at both the average California and U.S. prices would have yielded higher returns in more recent years.

California farmland consistently outperformed the stock market from 1991–2007. Further, in two periods (1997–2001 and 2004–2007), the stock market exhibited a negative ROI while California farmland returns were positive throughout. When farmland values were peaking in the early 1980s, ROI for the S&P was higher; the opposite situation occurred in the late 1990s when stock markets were booming. It should be noted, however, that the ROI calculated above considers only the value of the asset and does not include potential annual returns, such as dividends (in the case of the S&P 500) or farm income or cash rents (in the case of farmland).

Farmland vs. Other Types of Real Estate

The real estate sector has received considerable attention in the last decade. Throughout the early 2000s, residential real estate values rapidly increased throughout the country, but in the last several years, real estate values declined substantially. This boom-and-bust cycle was particularly pronounced in several areas throughout California. At the same time, however, farmland values have exhibited a consistent upward trend.

Figure 2 shows the average annual price change, while controlling for inflation, for farmland values in California as compared to state-wide residential real estate prices. The figure also includes the appreciation rate for non-metropolitan housing in California. Both residential price indexes were obtained from the Federal Housing Finance Agency.

The chart shows that over the period of 1995–2005, residential real estate prices appreciated more than farmland. For example, in the first part of the last decade, farmland prices rose at average annual rate of 8.6%, compared to 13.9% for state-wide residential real estate. However, in the latter part of the decade, residential real estate values

fell substantially at 8.8% throughout California and 8.7% in rural areas. Farmland values continued to appreciate throughout the same period at an annual average of 3.8%. Although farmland exhibited a less pronounced appreciation over 1995–2005, it yielded consistently positive gains.

Statewide Trends in Farm Real Estate Values

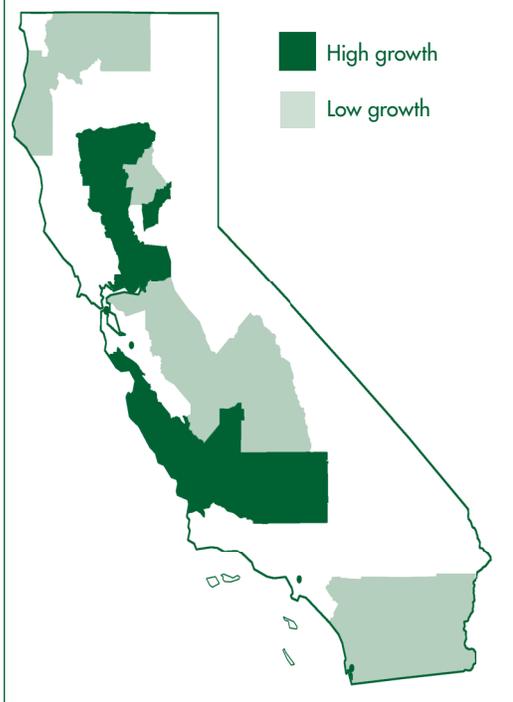
One of the challenges of measuring returns at an aggregate level is that it often masks significant regional differences. Trends in farm real estate could vary by region due to multiple reasons, such as differing degrees of urban pressure, type of commodity produced, and potential recreational uses for farmland.

Figure 3 divides agricultural counties into those with “high” growth in farm real estate values and those with “low” growth in farm real estate values, based on per acre estimates from the USDA/NASS June Area Survey. The dark-shaded areas experienced average annual growth in real estate values above the state-level median rate over the period 1998–2009, whereas the lighter areas represent counties below the median appreciation rate. The remaining counties are omitted due to insufficient observations for disclosure.

Farm real estate values in the Sacramento Valley, on average, appreciated more rapidly than in the San Joaquin Valley and agricultural counties in Northern and Southern California. Farm real estate values in the Central Coast and southern part of the San Joaquin Valley that specialize in fruit and vegetable production have also appreciated more rapidly.

In addition to the agronomic differences, the regional variation may be due, in part, to the influence of neighboring urban areas. Previous studies have shown that throughout the United States, farmland located near urban areas has higher values,

Figure 3. California Farm Real Estate Appreciation Varies by Region, 1998–2009



been greater than average returns in the stock market. In addition, farmland prices have not experienced the recent downturn observed in residential real estate values. California farmland values had an average annual appreciation rate of 3.8% over 2005–2010, while the value of residential real estate within the state declined. The growth in farmland values, however, has varied across the state over the past decade with the highest appreciation rates located in the Sacramento Valley and Central Coast.

Suggested Citation:

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Gruere, Guillaume, Karen Klonsky and Rachael Goodhue. 2003. "Do Farms Provide More than Food? Public Perspectives in California." *Agricultural and Resource Economics Update* 6(5):9-11.

Kovacs, Kent. 2008. "Farmland Conversion in California: Evidence from the Williamson Act Program." *Agricultural and Resource Economics Update* 11(5):5-8.

even when controlling for differences in agricultural production.

A recent study by Kueth, Ifft, and Morehart (2011) suggests that in California, urban influence appears to have the largest impact on farmland values in the Central Valley, yet the degree of urban influence is lower when compared to other regions in the United States. Although most of the state's major metropolitan areas are not in agricultural areas, Sacramento is an exception, and the counties surrounding Sacramento also experienced higher appreciation rates.

Conclusions

Farm real estate remains the most direct method of investing in the agricultural sector. In recent years, the agricultural sector has provided consistently positive returns as a result of high commodity prices and rising farm income levels. The success of the agricultural sector has led to increased attention from investors outside of the traditional agricultural finance sector.

Our analysis shows that in recent decades, farm real estate returns have

Jennifer Ifft and Todd Kueth are economists at the Economic Research Service, United States Department of Agriculture, Washington DC. Initial research on this topic was supported by a Giannini Foundation grant while Jennifer Ifft was a Ph.D. Candidate in the Agricultural and Resource Economics Department at University of California, Berkeley. The views expressed are those of the authors and should not be attributed to ERS or USDA.

For additional information, the authors recommend:

Federal Housing Finance Agency (2011) "Home Price Index." www.fhfa.gov/Default.aspx?Page=87.

Kueth, T.H., J. Ifft, and M. Morehart. 2011. "The Influence of Urban Areas on Farmland Values" *Choices*. www.choicesmagazine.org/choices-magazine/theme-articles/farmland-values/the-influence-of-urban-areas-on-farmland-values.

National Agricultural Statistics Survey. 2011. "Land Values 2011 Summary." <http://usda.mannlib.cornell.edu/usda/nass/AgriLandVa/2010s/2011/AgriLandVa-08-04-2011.pdf>.



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