VALUE OF OAK WOODLANDS AND OPEN SPACE ON PRIVATE PROPERTY VALUES IN SOUTHERN CALIFORNIA

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SUMMARY

This paper evaluates the extent to which dedicated open space in California's oak woodlands in a rapidly urbanizing area in southern California, influences private land and home prices. The Santa Rosa Plateau area in southern Riverside County was the location for this pilot study. Data on home and land value for 4,800 parcels surrounding an 8,300 acre oak woodland open space owned and operated a private land conservancy were collected. This was merged with spatial data from vegetation maps using a geographic information system (GIS). Distance from each parcel to the edge of the open space land, to the nearest trailhead and to the nearest stand of native oaks was calculated. Hedonic regression showed that both land and home value decreased as the distance from the open space boundary, trailheads, and local stands of native oak habitat increased. The model results were applied to the overall home and land parcels in the study area. A decrease of 10 percent in the distance to the nearest oak stands and to the edge of the permanent open space land resulted in an increase of $4 million in the total home value, and an increase of $16 million in total land value in the community. This demonstrates the off-site benefits of open space areas and native oak woodland stands in increasing overall land and home value of an entire community. There is economic value for conservation of native habitats. This promising method of analysis will be useful in future work to characterize how different configurations of open space design influence the land and home markets.

KEY WORDS: Oak woodlands
Hedonic regression
Open space
Environmental value
Off-site value

INTRODUCTION

Rapid urbanization of California's wildland resources is having a pronounced effect on natural habitats. These natural habitats are sought out as sources of new residential sites to a large degree because of the amenity values they represent. In response to rapid

exurban migration into forests and rangelands, there has been an increase in policy tools that have sought to conserve open space values. Despite the increasing use of conservation easements and purchase of development rights by land trusts and other entities, the implication of dedicated open space on land markets has not been adequately addressed. This project is designed to evaluate the extent to which oak woodland open space influences land and home prices in a rapidly growing area in southern California. This information will quantify how aesthetic and environmental values of adjacent open space are captured in parcel sale prices. This will help to suggest if the market place values these conservation areas, and determine the extent to which market mechanisms can be used to conserve open space areas.

California has one of the most rapidly growing human populations in the world. The state's population has grown from less than 100,000 people in 1850, to over 31 million people today (an average annual rate of growth of 3.4 percent) to a projected 63 million people in the next 50 years (Medvitz and Sokolow, 1995). This is resulting in large increases in new home construction, much of it concentrated in California's oak woodlands. Over 30,000 acres of oak woodlands are converted each year to residential and commercial land uses (Bolsinger, 1988). Oak woodlands cover approximately 10 percent of the state's total land area (Bolsinger, 1988), and are the most biologically diverse habitat in California, with over 300 vertebrate species relying on these areas (Standiford and Tinnin, 1996). As new home construction expands into oak woodlands, many of the habitat values of oak woodlands are lost as extensively managed large blocks of grazing land are fragmented into smaller blocks (Standiford, 1999). A survey of oak woodland owners showed that the majority of all owners now live less than 5 miles from a subdivision (Huntsinger and Fortmann, 1990; Huntsinger *et al.*, 1997). These surveys also showed that approximately one-third of the properties changed owners between 1985 and 1992, and 5 percent were subdivided for residential development. The urban interface with oak woodlands, once confined to the major population centers of the San Francisco Bay, Sacramento, and the Los Angeles basin, now extends throughout the entire state.

Most authors discuss the impact of urban sprawl (Wheeler, 1996; Scott and Sullivan, 2000; Hood, 1998) from the perspective of tract housing, focusing on the complete conversion of landscapes into suburban homes. Figure 1 shows that in Southern California, episodes of suburban housing occur in two to three years bursts when land-use planning is effectively overwhelmed by the demand for housing permits (Scott and Sullivan, 2000), These waves of development often radically change communities on the suburban fringe, creating a demand for rural housing. This is particularly true for areas within driving distance of jobs centers, where it is not uncommon to have rural lands subdivided into 1 to 5 acre *ranchette* (Sullivan and Scott, 2000). In these communities, value can be driven by factors other than lot size and structures.

One of the reasons for exurban migration into oak woodlands is because of the amenity values of the oaks and the natural landscapes of these areas. Previous work has shown that native oak trees on rural subdivisions may contribute as much as 27 percent to the value of the property (Standiford *et al.*, 1987; Diamond *et al.,* 1987). These earlier studies constructed theoretical markets for parcels with different oak tree cover using a contingent valuation approach (Donnelly *et al.*, 1984).

Although privately owned grazing lands have maintained oak woodland ecological values, this demand for amenity values has caused a rapid acceleration of land values that

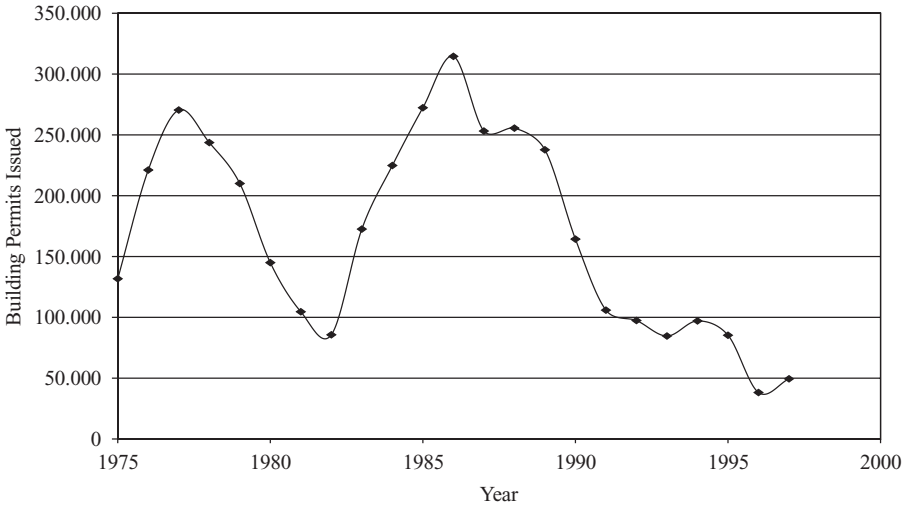

Fig. 1.–Number of building permits issued for five Southern California Counties, showing annual patterns of suburban growth (from Scott and Sullivan 2000)

has hastened the rate of conversion to residential uses. Preliminary analysis indicates that land values for grazing may be less than 20 percent of the current land values in the Central Sierra Nevada (Johnson, 1997).

Concerns about conservation of open space values has resulted in an increasing market for conservation easements, and for land deeded to land trusts to maintain large blocks. However, some of the economic aspects of open space conservation on overall property value in an area, and how different patterns of development and open space conservation affect land values, are poorly understood. These economic factors affect property tax revenues for a particular area, as well as having a potential for new mechanisms to fund open space purchases for conservation purposes.

It is hypothesized that tracts adjacent to oak woodland open space would have higher property values than those tracts away from open space areas. If the economic benefits of having open space areas were sufficiently large, then this may suggest that new patterns of development, such as cluster development with large blocks of open space (Giusti and Tinnin, 1993; Arendt, 1996), may be justified on economic values.

Previous studies have utilized hedonic methods to evaluate the economic contribution of environmental and amenity values on property values. Hedonic pricing methods involve the observation of market transactions for various goods (land costs, house values, recreation leases), and decomposing the prices for these into their component parts. Rosen (1974) and Edmonds (1984) lay the theoretical groundwork for hedonic prices. The underlying assumption of this method is that a good receives value form the bundle of characteristics of that good that contribute to a consumer's utility. The marginal value of the

components of the good are estimated and policy implications of changes in the various components of the good on overall value can be calculated.

Other studies have shown that urban land values are increased near open space and greenbelts (Weicher and Zerbst, 1973; Correll *et al.*, 1978; Li and Brown, 1980; Nelson, 1985). Hedonic prices have also been used to investigate how house prices are influenced by their location to services and amenities (Gatzlaff and Smith, 1993; Song, 1995). Hedonic methods have also been used to evaluate wildlife values in hunting and recreational leases (Livengood, 1983; Pope and Stoll, 1985; Standiford and Howitt, 1992).

METHODS

To understand the economic values of oaks and open space on actual land and housing markets, this pilot study was carried out in the Santa Rosa Plateau area of Riverside County, located at the southern end of the Santa Ana Mountains in Southern California (Figure 2). This area is the site of an 8300 acre reserve owned and managed by The Nature Conservancy (TNC). It is surrounded by one of the most rapidly growing urban areas in the state. The initial land purchase by TNC was in the early 1990's. Important ecological characteristics of the area include the largest expanse of native grasslands in

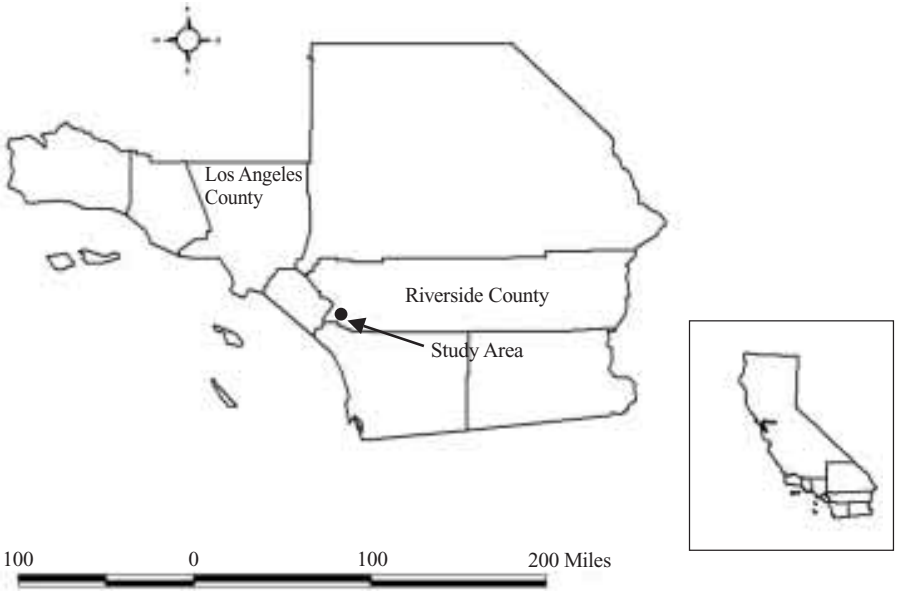

Fig. 2.–Location of study area in southern Riverside County, California

Southern California, vernal pool habitats, and Engelmann oak *(Quercus engelmanii* Greene) woodlands, one of the most imperiled California oak species (TNC, 2001). The area is used by sixty sensitive, threatened, and endangered plant and animal species (Steinetz, 1997).

Information on the 4,800 parcels immediately surrounding the TNC reserve on the Santa Rosa Plateau was collected from the Riverside County Assessor's office and a local title company. Data was collected on property size and location, improvements on the property (house size, number of bedrooms, pools, out-buildings, fences, etc.), amount and date of the most recent sales transaction, current assessed value of the land and structures, and current zoning. Figure 3 shows the parcel map of the study area, with the location of the open space preserve in the center. The Riverside County Planning Department provided a detailed habitat map of the various vegetation types found in the study area. Figure 4 shows the spatial pattern of the native oak stands for the western edge of the study area. There were 6,450 acres of native oak woodland in the entire study area. The dedicated open space preserve had 21 percent of the native oak woodland habitat, and the rest was located on adjacent lands. A geographic infor-

Fig. 3.–Parcel map and location of Santa Rosa Plateau reserve

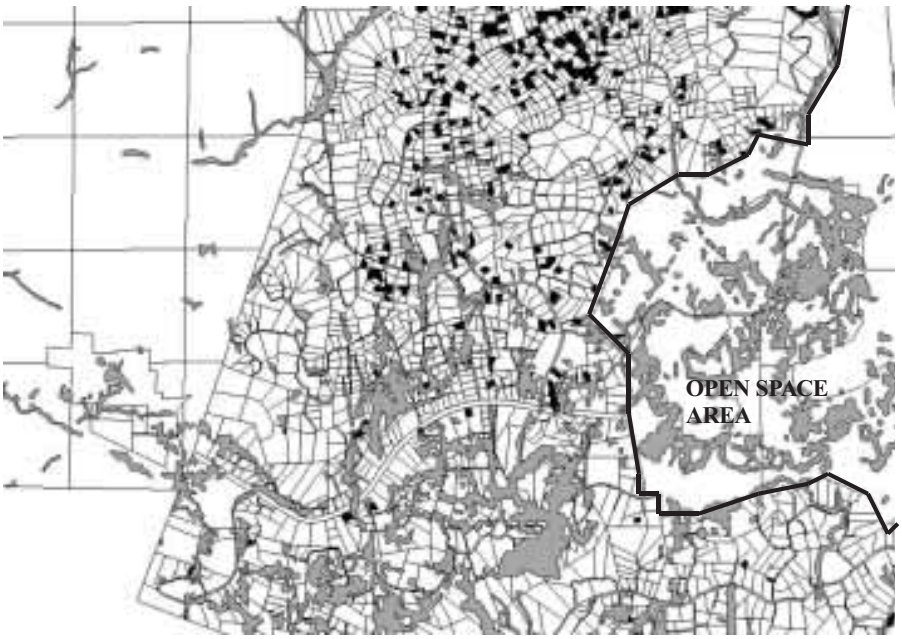

Fig. 4.–Western end of study area with private parcels and adjacent open space land. Gray shaded areas are native oak woodland stands. Black shaded areas are developed areas

mation system (GIS) was used to develop information on the spatial relationship between each private parcel in the study area and the open space values surrounding the parcel. Figure 5 shows a schematic representation of the open space value data derived from the GIS. The distance to the nearest native oak stand, OAKDIST, was calculated for each parcel, as the straight line distance from the center of the parcel to the nearest stand of native oak woodlands. The straight line distance from the center of the parcel to the boundary of the dedicated open space land, OPENDIST, was also calculated for each parcel. A similar calculation was made for the distance from the individual parcels to the nearest trailhead in the open space area.

It was hypothesized that housing and land value is a function of the characteristics of the housing (size, number of rooms, presence of swimming pools, etc.), location of the units (access to job location, condition of roads), the improvements at the site (roads, fencing, utilities), and the amenity aspects of the area (view, vegetation type, access to open space). Hedonic regression was used to decompose the relative contribution of these various components to the overall value of the property (Rosen, 1974; Edmonds, 1984).

Since the functional form of the hedonic prices for residential homes and land was not known, the Box-Cox transformation was carried out (Box and Cox, 1964; Zarembka,

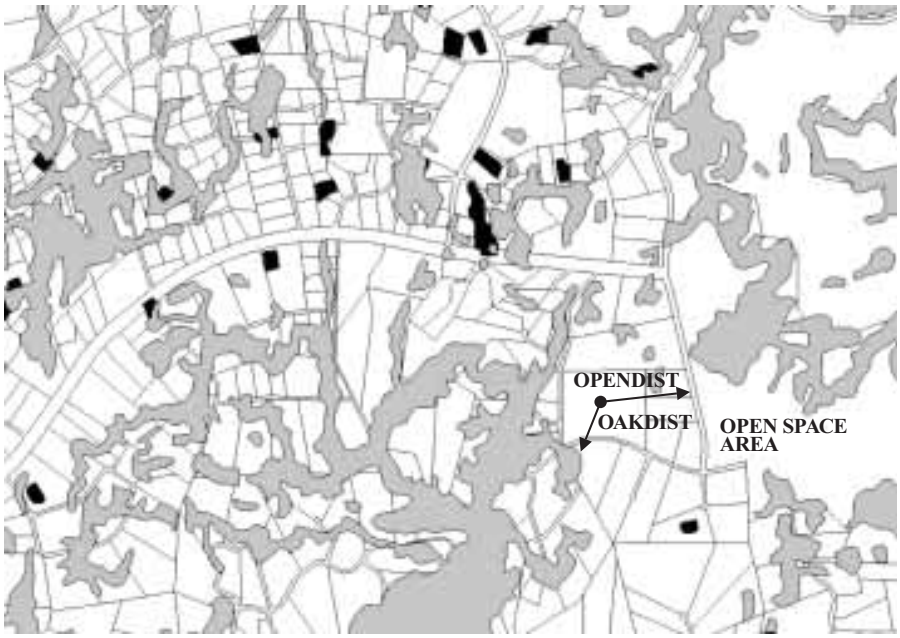

Fig. 5.–Example parcel, with distance to nearest oak stand (OAKDIST) and distance to the permanent open space land (OPENDIST) shown. Gray shaded areas are native oak woodland stands. Black shaded areas are developed areas

1974). This involves a procedure whereby the dependent and independent variables are transformed using the lambda transformation, shown in equations 1 through 3 below.

$$y^{(\ )} \quad \frac{y \quad 1}{\quad} \text{ for: } \quad 0 \qquad [1]$$

$$y^{(\ )} = \ln (y) \text{ for: } \quad = 0$$

$$y^{(\ )} \quad a_0 \quad a_1 x_1^{(\ )} \ \ldots \ a_n x_n^{(\ )} \qquad [2]$$

$$\frac{y \quad 1}{\quad} \quad a_0 \quad a_1 \frac{x_1 \quad 1}{\quad} \quad a_2 \frac{x_2 \quad 1}{\quad} \ \ldots \ a_n \frac{x_n \quad 1}{\quad} \qquad [3]$$

The Box-Cox procedure solves for the coefficients, a_i, as well as for using a maximum likelihood process. If equals zero, the relationship is a Cobb-Douglas production model, while a of one is a linear relationship.

Commercial property, agricultural land, and multiple family units were excluded from the analysis. Table 1 shows descriptive statistics for single family homes and unde-

veloped land for several of the variables evaluated in this study. This shows the three open space variables calculated for each parcel to date (distance to the permanently deeded open space land, distance to hiking trailhead, and distance to nearest native oak woodland habitat). This also shows that the parcels in the study area contain both developed and undeveloped parcels. The average lot size was 9.4 acres, and average home size was 3,328 square feet. Approximately one-third of all parcels changed hands in the last three years.

Table 1

Descriptive statistics of parcels surrounding the TNC Santa Rosa Preserve in southern Riverside County

Variable Analyzed	Mean	Standard Error	Min./ Max. Value	Notes
Lot size (acres)	9.4 acres	0.2	(0.04 to 64)	80% of all lots were less than 16 acres in size
% lot improved	22%	0.63	(0.0 to 96)	57% of lots had no improvements at time of study
House size (sq. ft.)	3,328 sq. ft.	53.6	(510 to 12,780)	67% of all houses were between 2,400 and 4,300 square feet.
# Bedrooms	3.6	0.05	(1 to 10)	
Land tenure (yrs. since last transaction)	7 years	0.1	(0 to 21)	30% of lots have changed hands in last 3 years, 48% of lots changed hands 4 to 9 years ago; 22% have been owned over 9 years
Land value ($/ac.)	$15,327	230.7	(426 to 93,749)	Land values increasing at average of 4% annually
House value ($/sq. ft.)	$86.40	1.0	(1.0 to 185)	Average of houses that have been built
Distance to nearest oak stand (ft.)	886 ft.	19.3	(0.0 to 7,410)	Nearest oak stand on either private or open space land.
Distance to TNC open space (ft.)	10,452 ft.	113.3	(92 to 26,365)	Linear distance from individual parcels to closest TNC boundary.
Distance to TNC trailheads (ft.)	18,720 ft.	172.3	(541 to 43,363)	Distance along travel corridors to public trailhead access to reserve.

The house value model was evaluated on a dollar per square foot basis in 1997 dollars. The contribution of various components of the developed homes in the study area were evaluated, including the number of bedrooms, the presence of a swimming pool, the number of bathrooms, the number of stories in the house, and the total square feet in the house. The relative importance of the three open space values on house value, namely the distance to native oak stands, the distance to the edge of the permanent open space area, and the distance to trailheads in the open space area were evaluated. Other data included in the hedonic regression included the lot size in which the house was located and the percent of the building lot classified as improved. Hedonic regression was also carried out to determine the components that contribute to the assessed land value on a per acre basis. The same basic variables described above to assess the house value model were evaluated for the value of the land.

With the advent of California's Proposition 13 in 1978 reforming land and home appraisal and property taxation (Fulton, 1999), the assessed value of property is adjusted when the land or home are sold. In the interim, the assessment can be adjusted upward a maximum of 1 % annually. Since actual real estate prices have increased at a much higher rate during the past several decades in the Southern California study area, a term for the date of the last sales transaction was included in the analysis to show trend in the value data.

RESULTS

Equation (4) shows the results of hedonic regression of the house value model. Table 2 shows the coefficients of the model and their statistical significance.

$$HOUSE_i^{(\ )} \quad a_0 \quad a_1 BED_i^{(\ )} \quad a_2 LOTAC_i^{(\ )} \quad a_3 PCTIMP_i^{(\ )} \quad a_4 LASTTRAN_i^{(\ )} \quad a_5 POOL_i^{(\ )} \quad a_6 OAKDIST_i^{(\ )} \qquad [4]$$

Table 2

Results of Box-Cox regression to determine hedonic prices of single family homes in the Santa Rosa Plateau Area (Riverside County, California)

Variable	Coefficient (significance)
$HOUSE_i$ = Assessed value of house i in dollars per square feet (1997)	(dependent variable)
a_0 = constant	–79.636 ***
BED_i = Number of bedrooms in house i	–0.15107 **
$LOTAC_i$ = Lot size where house i located in acres	0.14371 ***
$PCTIMP_i$ = percent of lot where house i located that is improved	0.73312 ***
$LASTTRAN_i$ = Date of last sales transaction for house i	8.1075 ***
$POOL_i$ = Presence (1) or absence (0) of a pool at house i	0.12069 **
$OAKDIST_i$ = Distance in feet from house i to nearest stand of native oak habitat	–0.017232 **
= Box-Cox transformation coefficient	0.0700
Equation significance	***

Note: * = significant at 0.10 level; ** = significant at 0.05 level; *** = significant at 0.01 level.

Equation [5] shows the results of the hedonic regression for land value in the Santa Rosa Plateau area. Table 3 shows the coefficients and their significance.

$$LAND_i^{(\ )} \quad a_0 \quad a_1 OPENDIST_i^{(\ )} \quad a_2 PCTIMP_i^{(\ )} \quad a_3 LASTTRAN_i^{(\ )} \qquad [5]$$

Table 3

Results of Box-Cox regression to determine hedonic per acre land prices of in the Santa Rosa Plateau Area (Riverside County, California)

Variable	Coefficient (significance)
$LAND_i$ = Assessed value of land parcel i in dollars per acre (1997)	(dependent variable)
a_0 = constant	–2793.9 ***
OPENDIST = Distance in feet from lot i to deeded open space preserve	–0.18568 **
PCTIMP = percent of lot i that is improved	0.73312 ***
LASTTRAN = Date of last sales transaction for lot i	8.1075 ***
= Box-Cox transformation coefficient	0.3300
Equation significance	***

Note: * = significant at 0.10 level; ** = significant at 0.05 level; *** = significant at 0.01 level.

The results of the hedonic regression shows that different open space elements are important in determining the value for houses and for land. The distance to native oak habitats was the most important open space variable for house prices, and the distance to the dedicated open space land was the most important variable for land value. This does show that both of these variables can be evaluated for their contribution to the overall economic value of the area.

The positive sign for the date of the last sales transaction shows the generally increasing value of homes and land in the study area. Future work will focus on the time series of these prices over time.

DISCUSSION

The results of the hedonic price model can be used to determine a general economic value of the oak habitat and dedicated open space on a surrounding community. These general relationships can be used to evaluate the economic benefits of open space land conservation strategies and oak woodland restoration programs.

The effect of oak woodland stands on overall community value was calculated using the results of the house price hedonic regression from Table 2. The Box-Cox relationship was transformed to provide home price directly (see equation 6).

$$\text{HOUSE} \quad a_0 \; a_1 \frac{BED_i^{(\;)} \; 1}{1} \; a_2 \frac{LOTAC_i^{(\;)} \; 1}{1} \; a_3 \frac{PCTIMP_i^{(\;)} \; 1}{1} \; a_4 \frac{LASTTRAN_i^{(\;)} \; 1}{1} \; a_5 \; 1 \; POOL_i \; a_6 \frac{OAKDIST_i^{(\;)} \; 1}{1}^{\frac{1}{}} \quad [6]$$

This equation was applied to each of the 544 single family houses in the Santa Rosa Plateau study area. The effect of the distance to the nearest oak stand was modeled by varying the distance for each unit from a 50 % reduction in the distance (oak stands in closer proximity), to a 50 % increase in the distance to the nearest oak stand (oak stands further away). Figure 6 shows the results of this analysis. The total 1997 value of the 544 houses in the study area was $157 million. If there were to be an effort on oak restoration, and the increase in oak woodland acreage resulted in decreasing the distance to the nearest oak stand by 10 percent, then the overall value of the houses in the community would increase by $4 million.

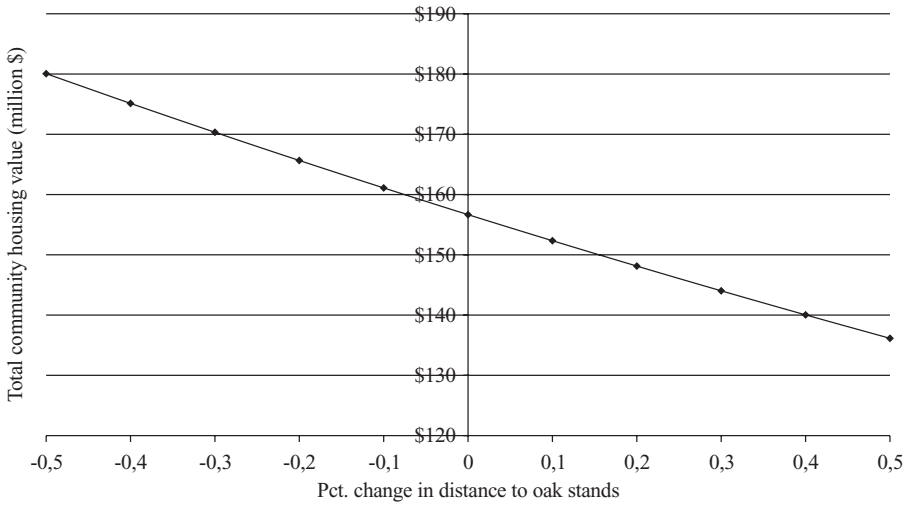

Fig. 6.–Change in overall community assessed value with changes in distance to native oak stands

An important implication of these results is that the native oak stands in a geographic area are a valuable community asset. The overall assessed value of this particular community would be expected to increase because of the value added by these oak stands to indi-

vidual home prices. Given the local property tax rate of 1 %, the annual property tax increase accruing to the local government from the increased home value would be $40,000 annually. The present value of the infinite stream of increased tax revenue at a 5 percent real discount factor would be $280,000 ($40,000/0.05) This can be used to justify the public financing of local oak restoration efforts.

The effect of oak stands in a community on an individual homeowner was evaluated. The mean conditions for the area (3,328 square foot home, 6.7 acre lot, 70 % of lot improved, 4 bedrooms, no pool) were kept constant in the hedonic model, and the distance to the nearest oak stand varied. Figure 7 shows the results of this approach. The average home in the study area was 886 feet away from a native oak stand, for an average 1997 home value of $87 a square foot. For the same general housing characteristics, if native oak stands were immediately adjacent to an owner's house, then the average 1997 home price in the study area would be over $97 a square foot, an increase of almost 12 percent. This shows that individual homeonwers are willing to pay a premium for having native oak stands near to their residences.

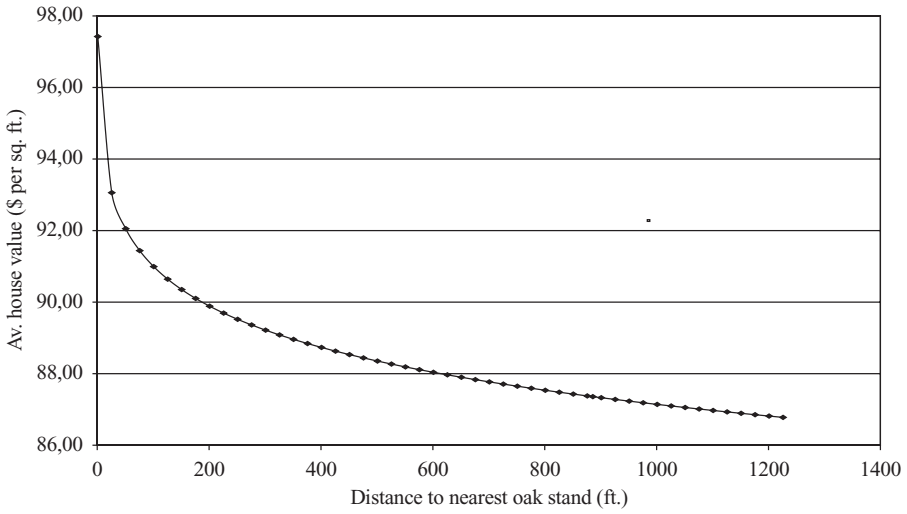

Fig. 7.–Effect of distance to nearest oak stand on average house value (3328 sq. ft., 6.7 acre lot, 70% of lot improved, 4 bedrooms)

The same evaluation can be made on the contribution of the dedicated Santa Rosa Plateau open space land on the overall land value of the community. The hedonic model of land prices (from Table 3) was applied to the 2,465 parcels of land (both developed and undeveloped) in the study area. Figure 8 shows the net effect of changing the distance to open space land on the total assessed value of the land. The total 1997 assessed value of the private land parcels in the study area was $262 million. If it were possible to increase

the amount of open space land in the community, thereby decreasing the average distance to open space land by 10 percent for each parcel, the total value of the private land parcels in the area would increase by $16 million. The open space land has the effect of increasing the overall value of the entire community. In addition to providing important conservation values for an area, the overall value of all the land in the area increases. This 10 percent decrease in the distance to open space land would result in additional annual tax revenue of $160,000 annually, with a present value of $3.2 million (at a 5 percent real discount factor).

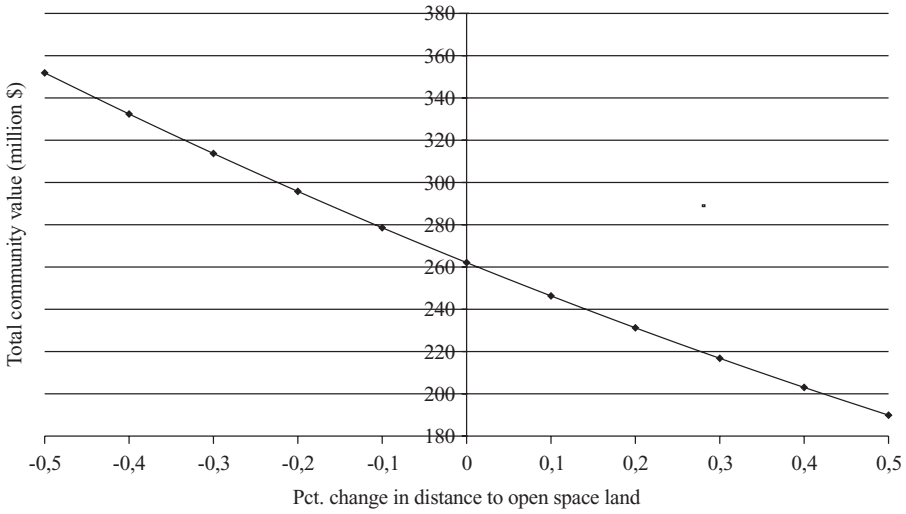

Fig. 8.–Change in assessed community land value with changes in distance to open space

The effect of increasing the amount of open space land (decreasing the distance to the open space area) on an individual's land value can also be investigated by applying the results of the hedonic regression. Figure 9 shows the results of this sensitivity analysis for an individual parcel. Undeveloped land immediately adjacent to the open space area is projected to be valued at over $22,000 an acre. The same land characterisitics, set 1,000 feet from the edge of an open space area, would be valued at only $18,500, a decrease of almost 17 percent. Private owners receive a premium by being located adjacent to land that will remain as dedicated open space.

The results of this study can be compared with other studies of the economic value of open space. Weicher and Zerbst (1973) demonstrated that a wide variety of open space types have a positive effect on adjacent property values, although open space with highly developed recreational facilities resulted in a negative effect on adjacent property value. They demosntrated that property values adjacent to open space were up to 23 percent higher than houses that were one block away. Correll *et al.* (1978) estimated that home

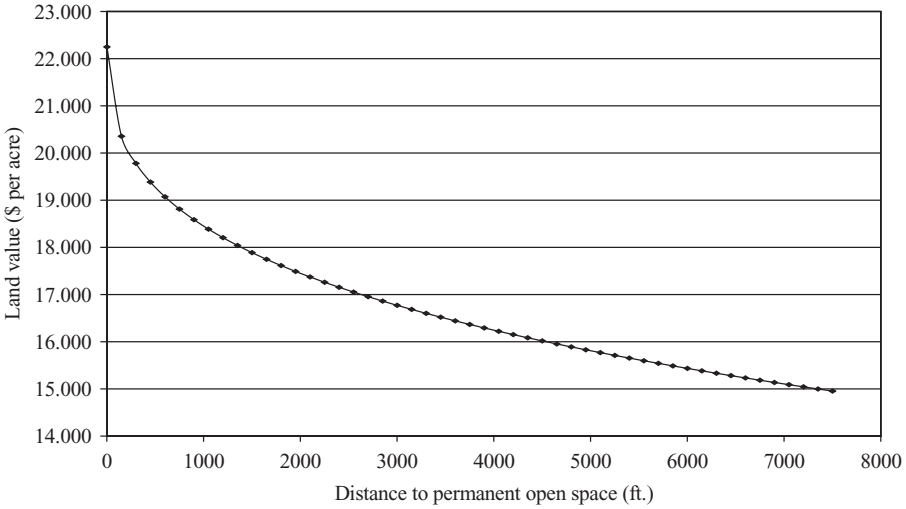

Fig. 9.–Effect of distance to permanent deeded open space on average undeveloped land value

prices adjacent to protected open space were 32 % higher than houses just 3,200 feet away. Nelson (1985) showed that urban land increased in value by $1,200 an acre if it was wtihin 1,000 feet to open space. Correll *et al.* (1978) also point out that if all the increased property tax revenue were to go to the city or agency which financed the open space purchase, it would take only three years to recoup intial investment costs.

CONCLUSIONS

As urbanization increases in California, open space areas are becoming increasingly rare, and valued more highly for their ecological and amenity values. This study shows how hedonic prices can be used to evaluate the relative value of open space on individual house and land prices, as well as on an overall community's value. It is clear from this study that natural resources in a broad geographic area contribute to the economic value of real property. This increased value provides an economic incentive for investing in conservation values.

These results of this work will be used in the future to model different open space conservation and oak restoration strategies. Optimal economic patterns of open space design and restoration will be compared to conservation biology principles of optimal reserve design.

The increasing scarcity of natural resources in rapidly urbanizing areas is resulting in economic values that are reflected in both individual and community economic values. This study shows promising results that can be used to evaluate how public and private investments in conservation and restoration can be justified in economic terms.

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RESUMEN

El valor del bosque de quercíneas y pastizales en régimen de propiedad privada al sur de California

Este artículo analiza hasta que punto el mantenimiento de los bosque de quercíneas y pastizales en una zona de rápida urbanización en el sur de California tiene influencia en los precios de mercado del bosque nativo y de las viviendas. Este estudio de caso ha sido realizado en la meseta de Santa Rosa en la provincia de Riverside. Las informaciones de los precios de las viviendas y de la tierra se refieren a 4.800 parcelas urbanizadas para viviendas y 8.300 acres de monte abierto de quercíneas pertenecientes a propietarios privados. Estos datos se superpusieron con datos espaciales de mapas de vegetación utilizando sistemas de información geográfica (SIG). Se calcularon las distancias entre las parcelas y los límites lejanos del monte abierto, los senderos forestales y las superficies de quercíneas más cercanos. Una regresión hedónica muestra que tanto el valor del bosque de quercíneas como de las viviendas decrecen, al incrementarse las distancias del monte abierto de quercíneas con referencia a las viviendas. Los resultados del modelo se extrapolaron a todas las viviendas y parcelas de tierras en el área de estudio. Una reducción del 10 por ciento en la distancia de las viviendas a las superficies de quercíneas más cercanas, resulta en un incremento de 4 millones de dólares en el valor total de las viviendas y de 16 millones de dólares en el valor total de la tierra en toda la comunidad. Esto demuestra que los beneficios externos de los pastizales y bosques abiertos de quercíneas californianas incrementan simultáneamente los valores de las tierras forestales y viviendas de la comunidad. Existe un valor económico de conservación de los hábitats del bosque mediterráneo californiano. Este prometedor método de análisis facilitará en un futuro la caracterización de la influencia de diferentes configuraciones de espacios forestales abiertos en los valores de mercados de la tierra y de la vivienda.

PALABRAS CLAVE: Bosques de quercíneas
Regresión hedónica
Monte abierto
Valor ambiental
Externalidades

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