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The impact of urban open space on residential property values in the Tucson basin

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THE IMPACT OF URBAN OPEN SPACE ON RESIDENTIAL PROPERTY VALUES IN THE TUCSON BASIN

by

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TABLE OF CONTENTS

	Page
LIST OF FIGURES	6
LIST OF TABLES	7
ABSTRACT	8
1. INTRODUCTION	9
Open Space Benefits	9
Open Space in Tucson	12
Urban Open Space Management	13
Open Space Preservation	19
The Problem	20
Objectives	21
2. THE CONCEPTUAL FRAMEWORK	22
The Amenity Concept	22
The Hedonic Model and Theory	24
Urban Amenity Applications	27
Specification	29
Functional form	30
3. METHODS	32
Data Collection	32
Variables	32
Sample	44
Measurement of Distances	46

TABLE OF CONTENTS--Continued

		Page
	Analysis	46
4.	RESULTS	47
	Residential Property Characteristics	47
	Regression Analysis	53
	Specification and Functional Form	53
	Specification	53
	Functional Form	56
	Stratification/Segmentation	56
	Hedonic Price Equations	60
	Structural/Neighborhood Variables	62
	Open Space Variables	63
	Designated/Developed	63
	Designated/Natural	64
	Undesignated/Natural	64
	Discussion	65
	Result Summary	69
5.	PLANNING IMPLICATIONS AND CONCLUSIONS	71
	Specific Applications	71
	Conclusions	73
	APPENDIX 1. AGGREGATE MODEL	77
	APPENDIX 2. ANALYSIS OF COVARIANCE	79
	LITERATURE CITED	80

LIST OF FIGURES

		Page
Figure 1.	Map of study area	38
Figure 2.	Location of neighborhood parks	40
Figure 3.	Location of district parks	41
Figure 4.	Location of regional parks	42
Figure 5.	Location of golf courses	43

LIST OF TABLES

		Page
Table 1.	Multiuse planning steps for managing open space systems in urban areas	14
Table 2.	List of independent variables	33
Table 3.	Variable means and standard deviations..	48
Table 4.	Open space characteristics	49
Table 5.	Correlation coefficients for TMP, SAGE and COR by Strata	55
Table 6.	Coefficients of multiple determination for Double-log and Box-Cox functions...	57
Table 7.	House Sales Price Per Square Foot by strata	59
Table 8.	Estimated hedonic equations by strata ...	61
Table 9.	Implicit prices of significant open space variables	72

ABSTRACT

The objective of this study was to estimate the effects of various types of urban open space on single-family residential property values in the Tucson basin in 1986.

The statistical results were mixed. Urban parks which emphasize recreational facilities decreased housing prices whereas private golf courses and natural open space areas increased property values. The negative impact on housing price appears to be the result of disamenities caused by recreational consumption (noise, traffic, congestion), and recreational facilities (blocked views). The positive impact on price seems to be a function of the benefits derived from such amenities as urban wildlife and scenic mountain and city views.

Public decision-makers need values of urban natural amenities to make informed policy and management decisions. The implicit prices generated here are useful in assessing whether the market prices of homes are expressing the benefits of urban open space.

CHAPTER ONE

INTRODUCTION

Economic research has provided useful estimates of the value people place on urban amenities. Most of this research has addressed the damages caused by urban disamentites such as air and water pollution. The urban growth and development contributing to the increase in these disamenities has also altered the quality and quantity of urban open space. Yet little research has focused on the value of such amentities. In this research we are attempting to assess the economic value of urban open spaces, as expressed through their influence on the prices of single-family residential properties.

Open Space Benefits

People benefit from the use of recreational services and activities supplied by urban open space and parks. Non-user benefits, such as the aesthetic value of a scenic view, existence value, are also afforded by open space amenities in terms of the intrinsic value of the flora and fauna preserved within open space, or in the security of knowing that valuable natural areas will be available for future generations (bequest value). Uncertain users also derive benefits by retaining the option to use the areas, or in valuing the amenities for their role in sustaining genetic diversity or stability in ecosystems.

The benefits generated from urban open space and parks are non-market goods; not exchanged in markets. Non-market goods may exhibit pure and quasi-public good characteristics. Pure public good aspects include scenic beauty or views, places of quiet or areas for the enjoyment of resident wildlife and vegetation. Characteristics of a quasi-public good include partial exclusion from certain benefits (a particular view) due to distance, or denial of access to private lands for example, or exclusion from recreational facilities because of user fees.

Pure public goods may be consumed collectively without exclusion or rivalry between consumers. This is true in the case of urban open spaces and parks because the majority of them are supplied by local governments at a nominal charge or no charge. Non-excludability relates to the difficulty of excluding non-contributors to the good's provision and thereby prohibiting the supply and allocation of the good through market prices. Non-rivalness means that the use of the good should be free since no additional cost is incurred by additional consumption (assuming no congestion).

Unfortunately, because open space services are not marketed, their benefits are not readily quantified in dollar terms. Quantification of the benefits attributable to open space amenities in monetary terms would be useful to planners making decisions regarding the optimal quantities of open space to be provided, in determining who benefits directly and if those affected would be willing to pay to maintain the resource.

Several methods have been used to measure the benefits provided by urban parks and open space. As Sinden and Worrell (1979) observe (page 121), "the appropriate method depends on the nature of the decision and the value (benefit) information required." In all cases the economic value of an urban open space is the difference between the willingness to pay (a measure of satisfaction), and the cost of using it. The cost to the consumer includes both the out-of-pocket expense and the cost of other foregone opportunities. Three methods have been used to measure non-market benefits: the hedonic method used here, the travel cost method and the contingent valuation method. The travel cost method only captures user benefits and the contingent valuation method relies on responses to hypothetical situations. Only the hedonic method captures user and non-user benefits by inferring values from real market transactions (Peterson & Sorg, 1987).

Open Space in Tucson

Pima County's Open Space Committee views the preservation of existing and future open space amenities as essential for maintaining Tucson's quality of life and economic vitality. The proposed goal is the protection and preservation of the important natural features of the Tucson area including: the major washes, mountain ranges, foothills, the National Monuments and public forest lands. To achieve this goal they recommend a total system of open space linked together through the establishment of natural open space corridors connecting the washes to the nearby mountain ranges.

Protection from higher density developments or incompatible land uses could be achieved by designating natural buffers or desert belts adjacent to the specified natural area. Buffers could function as transition areas providing for a gradual decrease in development density up to the amenity, or as barriers separating urban lands from natural; the buffer itself could be a designated natural open space. The open space corridors linked to the mountain ranges would prevent further fragmentation of the existing wash flow patterns, serve as recreational areas and provide access to mountain trailways.

The Open Space Committee revealed values implicit in urban open space. The riparian vegetation, wildlife habitat and recreational opportunities supported by the system of natural washes are all deemed valuable. The natural terraces adjacent to the washes contain prehistoric sites; an invaluable archaeological tie to the past. The streambeds function as recharge areas and support resident wildlife and vegetation. The scenic vistas available from nearly any point in the basin exemplify the unique beauty of the sonoran desert.

Urban Open Space Management

Urban open space serves three primary functions (Open Space Committee, 1987),

1. Maintenance of natural processes (water, gaseous, nutrient cycles and support of flora and fauna),
2. Enhancement of the aesthetic and physical conditions of the urban environment, and
3. Provision of space for recreational activity.

The Pima County Open Space Committee felt that Tucson open space should be managed to enhance all of these functions for the benefit of urban residents and workers. However, this may not be possible when conflict among functions exist. It is then necessary to make allocative decisions that maximize the net benefits from the natural resource. Key steps in multiple use planning that guide this allocative process are presented in Table 1.

Table 1. Multiuse planning steps for managing open space systems in urban areas.

1. Determine the desired mix of human benefits obtainable through urban space management.
2. Determine the urban environmental conditions necessary to achieve human benefits.
3. Identify the management and vegetative manipulation techniques for affecting the urban environment.
4. Understand the market and political forces which are competing for employment of urban land and which may constrain management options.
5. Estimate the amount, diversity and availability of open space resources for public and private lands.
6. Develop plan for achieving needed amount, diversity and spatial arrangement of open space and estimate cost of plan implementation.
7. Devise and implement strategies for gaining political and public endorsement and funding for plan.
8. Set realistic objectives and goals.

Source: Cordell, 1979.

Economic value measures are needed to accomplish steps 1 and 4. Determining the desired mix of human benefits requires economic benefit estimation. Given the spatial distribution of public and private open space located near residential developments in the Tucson basin, value estimations from the hedonic method could be a powerful planning tool. Hedonic benefit measures could supply information regarding an approximate value for an open space area, help determine the optimal quantities of open space to be provided, and determine whether those who are directly affected by the amenity would be willing to pay some of the cost in maintaining the resource.

The willingness to pay schedule obtained from the second stage of the hedonic technique can be interpreted as the demand for the open space amenity (Rowe & Chestnut 1982). Given this demand, land use managers could hypothetically increase the cost of using the resource to estimate the reaction of users. Planners could then estimate the loss or gain in net benefits to consumers from a change in price or cost policy. Decisions regarding alternative land uses could also be simulated and analyzed. In this way, the total net benefits to the community from a particular land use versus another could be assessed.

Economic analysis can also play a crucial role in understanding the market forces in planning step 4. Specifically, the question of the demand relationship between publicly and privately supplied open space can be modelled within the hedonic framework (Cordell 1976). Whether or not open spaces are complements or substitutes, is vital to the evaluation applied in existing procedures for open space planning. At present, these procedures implicitly assume that public and private supply activities are unrelated. This issue is particularly relevant to Tucson where a substantial amount of open space is held by private parties (Stenberg 1988). Decisions involving a change in the supply of public open space, as a rule have not taken into account the existing supply of private open space. If we knew how public and private open spaces were related, there would be a basis for evaluating and, if necessary, adjusting the current planning and decision-making criteria.

In the study by Cordell (1976), public and private lands were found to be substituted. Decisions concerning planning for the growth of an area, urban renewal programs, expansion of public parks and open space systems, zoning decisions, housing policies and many other urban issues would be made more realistic if these relationships between public and private open spaces were taken into account.

Urban residents are faced with a large number of choices in their selection of residential location. Actualizing these choices is subject to income and various social constraints. Among the characteristics which make choice among alternative locations important, are the mix and total amounts of publicly and privately owned or managed open space. Households may be willing to substitute between public and private open space, but they are not perfect substitutes. Private open space is usually more widely dispersed among and closer to urban residences than public space. Public space is more highly developed for recreation and normally occurs as larger, more separated tracts. Public space is also usually free to the user. Public and private open space serve different roles as resources for recreation and aesthetic enhancement.

Public and private open space should be considered as interrelated components of a singular open space supply system. In land use zoning, the reality of open space substitution should be considered a part of necessary public-private coordination. Most zoning effectively sets minimum residential lot sizes, and thus directly effects the amount of private open space supplied. This indicated that decisions concerning zoning and public open space supply should be coordinated. Restrictions on lot sizes could be based on existing amounts of public open space available to the neighborhood or community. Logically, neighborhoods zoned for low density would require less public space than higher density neighborhoods.

One of the most important contributions of economics is the effect that urban land prices have on the demand for private open space, which in turn, effect the demand for public open space. If the continuing trend of rapidly increasing prices for urban land is not offset by real income increases, the quantity of privately open space demanded will decrease and possibly increase the demand for public open space. This indicates that growth of public open space supply should be tied to the quantity of private space demanded. The implications from rising urban land prices is clear and points to the need to monitor the effects these price rises are likely to have on private space demanded and thus the demand for public space. Changes in real property taxes will have the same effects as market-induced changes in land prices.

For recreation and park agencies and other city government officials, another implication of substitution behavior is that any increase in price to urban residents for the use of public space, or for its availability, will affect not only the demand for public open space, but will also effect the urban real estate market. Increases could include higher taxes for open space financing, starting a user fee system, or greater centralization of public recreational acreage. The likely result would be an increase in demand for private open space which will at the same time increase its price. This may be a burden to middle and lower income groups. Increased public space costs may reduce the ability of these groups to substitute private open space for less available public space.

Economic benefit measures will also be useful in gaining public and private support (step 7), and in setting realistic goals (step 8). Approximations of resource values can be used to justify the preservation of natural resources versus conventional development enabling the sponsors to demonstrate the value of open space in quantifiable terms. Demand analysis can be used to estimate the number of future recreation participants. This allows more realistic management strategies and the projection of maintenance costs.

Open Space Preservation

The findings of the Open Space committee (1987), and other studies (Burgarsky 1986, Ruther 1987), suggest that there is widespread support for open space preservation in the Tucson metropolitan area.

Burgarsky (1986 p. 56), found that 60 percent of the Tucson households surveyed supported management spending for the preservation of Pusch Ridge for bighorn sheep habitat. Ruther concluded (1987 p. 62), that the Tucson public would be willing to pay for urban wildlife conservation programs. The willingness of Tucson households to pay for the preservation of urban open space amenities is the subject of research designed as a follow up to this study.

Without good data and statistically derived estimates concerning residential choice and urban open space amenities, there is a large deficiency in multiple use urban open space planning. Management choices should be made on the basis of the gains in human benefits which management techniques and strategies can produce if properly implemented.

The Problem

Economic analysis has not focused on the benefits generated from urban open space and parks in the Tucson urban area. Hence valid value estimates of these benefits are not available. The research problem, then, is to provide information about the benefits of various types of open space in the Tucson metropolitan area.

<u>Objectives</u>

1. Estimate the effects of various types of open space on single-family residential property values in the Tucson.
2. Explicate the usefulness of the open space value estimates in the local planning process.

CHAPTER TWO

THE CONCEPTUAL FRAMEWORK

The Amenity Concept

Urban and regional economics examine a host of market and social phenomena whose activities are effected by a spatial dimension. Following the lead of Diamond and Tolley (1982, p. 3), amenity is defined in this study as a location specific good. Conversely, a disamentity is a location specific bad. People receive benefits from an amenity but suffer costs from a disamentity. There are many reasons why the location of an amenity will matter to producers and consumers.

Amenities, like other goods, impact the profits and satisfactions of suppliers and consumers, but gains in amenities can be obtained only through a change in location. There are exceptions, however. For instance, the aesthetic and/or productive value of a tree may be obtained through planting without moving one's location. But, in general, amenities can be distinguished from other products whose price is independent of location (Polansky & Shavell, 1976). Even for a tree, the benefits attributable to its existence can only be captured by a change in location once the tree is planted.

At a given time, amenities such as air quality, or disamenities such as air pollution, can be varied only by movement into another market or location. They are elements of the social, physical and legal environment. Amenities are goods that are not transferable across space. This location specificity indicates that the quantity of an amenity is beyond the control of an individual. Yet amenity levels can be a function of the number and type of individuals at a location. Households collectively create a social environment. But individual households can only determine their own consumption of amenities through movement in geographic space (Diamond, 1980).

Although beyond the control of any individual, the supply of an amenity can be directly or indirectly altered by human agents. For example, when local governments construct transportation systems, some households benefit from better access to work, others may encounter disamenities such as noise or visual obstruction from the same project. The benefits (costs) from an amenity (disamenity) may vary in magnitude across locations; those closest to the freeway suffer more noise pollution than those farther away. Amenities also reveal public good characteristics in the sense that once access to a location is obtained, additional consumption does not reduce consumption by other individuals (Abelson, 1979).

The Hedonic Model and Theory

The hedonic model suggests that consumers select the particular bundle of attributes that they desire when purchasing a differentiated market good, such as housing, and that it is from these attributes that consumers derive utility. The hedonic approach is related to the work of Becker (1965), Muth (1966) and Lancaster (1966), who postulated that housing characteristics yield utility, or are combined with other inputs including household time according to a production function to produce service that yield utility (Smith, Rosen & Fallis, 1988). Rosen (1974) formally rendered the hedonic approach by setting out a model of demand, supply and competitive equilibrium.

The hedonic price technique infers the value of a non-market resource from the prices of associated goods and services that are traded on the market. If all the characteristics of a residential property can be defined and quantified, then by observing the price of homes with different levels of attributes, the effect of each attribute on price can be determined. This relationship between the price of a market good and its characteristics is called the hedonic or implicit price function. Statistical estimation of the hedonic price function allows us to to see how changes in the level of one characteristic affect the price of the market good.

For urban open space and parks, the hedonic technique is applied by looking at property values in relation to open space amentities. Parks and urban open space produce benefits/costs which make a neighborhood a nice/bad place to live; the benefits/costs are reflected in the prices of nearby residences. All else being equal, a house close to a park should sell for a different price than a comparable house farther away, a concept termed location rent (Moore & Stevens 1982; Barlowe, 1986).

A given unit of housing may be characterized as consisting of a bundle of attributes which describe the structure itself, the land upon which it is built, and the relevant locational characteristics (Griliches 1971; Rosen 1974). We view proximity to various types of urban open space as part of the locational attributes of the housing bundle. We assume a fixed supply of housing attributes because the housing stock is altered only slowly over time and some neighborhood attributes are supplied perfectly inelastically, for example, a neighborhood school (Brown & Pollakowski 1977; Freeman 1979).

On the demand side, assuming a given spatial distribution of employment and a given distribution of preferences and income over households, we may envision a distribution over space of demands for these attributes. The housing market is thus viewed as consisting of implicit markets for each of the attributes of housing, and that at any given point in time a vector of implicit short-run prices exist (Rosen 1974).

Estimating the demand for a characteristic involves a two step procedure in which first the implicit price of the characteristic is estimated using the hedonic technique, and then the implicit price is regressed against observed quantities and other variables such as income to estimate the demand function itself. In this study, only the implicit prices of various types of open space are estimated.

As stated above, the hedonic model views the price of a heterogeneous commodity as a function of its characteristics. In this case: if H represents single-family detached residential properties, then the price of the property, P_{hi}, is considered to be a function of structural, neighborhood and environmental characteristics. This relationship is expressed as the hedonic or implicit price function:

$$P_{hi} = P_h (S_{i1},\ldots,S_{ij}, N_{i1},\ldots,N_{ik}, O_{i1},\ldots,O_{im}$$

Where : S_{ij} = structural variables
N_{ik} = neighborhood variables
O_{im} = environmental variables

The marginal implicit price of a characteristic is found by differentiating the hedonic price function with respect to that characteristic. The marginal implicit price of an open space characteristic is:

$$P_h/ \ O_m = P_{om} (O_m)$$

This derivative gives the change in expenditures on H, P_{hi}, required to obtain a house with one more unit of O_m, *ceteris paribus*.

Urban Amenity Applications

Ridker and Henning (1967) were the first to use the hedonic technique to relate the degree of environmental amenity to property value. The analysis determined an implicit price for pollution free air but revealed nothing about the demand for clean air. More recent studies based explicitly on the theoretical model of Rosen (1974) have used property value data to determine benefits from controlling environmental disamenities like air, water and noise pollution (Harrison & Rubenfeld 1978; Willis & Foster 1983 and Nelson 1978). Other studies have estimated the impacts of urban housing amenities (Witte, Sumka & Erekson 1979; Li & Brown and Cao 1980).

Hammer, Coughlin and Horn (1974) estimated the effects of a 1,294 acre park in Philadelphia on nearby residences. Location rent was found to range from about $11,500 per acre 40 feet from the park to $1,000 at 2,500 feet. Each acre of parkland generated a value of $2,600 in location rent. Weicher and Zerbst (1973) found homes near five Ohio parks valued seven percent higher than like homes one block away. Correll, Lillydahl and Singell (1978) found an increase of $4.20 for every foot closer to a 1,383 acre greenbelt in Boulder. Coughlin and Kawashima (1973) found that the total value of properties located within a 0-1,000 foot ring from a one acre park was $171,400, $803,000 for a five acre park, and $3,485,000 for a twenty-five acre park.

Brown and Pollakowski (1977) found that a dwelling close to a 200 wide setback of shoreline would sell for about $850 more than a comparable unit near a 100 foot setback. The same dwelling would sell for $1,350 more if located near a 300 foot setback. Schroeder (1982) analyzed the relationship between property values in Illinois and expenditures on recreational services and parkland per 1000 population. A positive relationship was found between expenditures and housing price but could not be cross validated with a control sample. Allen, Stevens, Yocker and Moore (1986) did not find a significant relationship between eight urban parks in Massachusetts and property value. They concluded that the effect of parks on property value may be too small to be detected among the data.

Specification

The independent variables of the hedonic price function should describe all the property characteristics that influence its price. In practice, the choice of these variables has depended on data availability and convenience and has varied widely across studies. In this study three categories of variables were defined, structural, neighborhood and environmental amenity. The structural variables describe the physical characteristics of the house and property.

Neighborhood variables are intended to be measures of a neighborhood's quality. For example, a neighborhood's level of public services might be measured by that area's tax rate (Kain & Quigley 1975; King 1975). Different measures of neighborhood quality could include variables such as school district, rate of crime or percentage of minorities living in the area (King 1975; Goodman 1977). Neighborhood quality also usually includes some measure of accessibility to various activity centers. These might include distance to the nearest employment or shopping center or distance to the nearest major freeway (Nelson 1978). The neighborhood variables used in this study are: zoned density, high school, distance to the nearest shopping center and employment center.

Amenity (disamenity) characteristics were first studied by Vaughn (1974), Pollard (1977), Diamond (1980) and Bloomquist and Worley (1980). In this study, the amenity characteristics are open space variables which are described below.

Functional Form

The functional form of the estimated hedonic equation must be chosen on the basis of *a priori* expectations and theory since the form chosen must match the economic model and its implications. For example, if the hedonic price function is specified as linear in characteristics, then the implicit prices of these characteristics are constants. That is, their prices do not depend on quantity. But if, as seems more reasonable, the implicit price of an additional unit of a characteristic depends upon its quantity, then a curvilinear form is called for. Implicit prices may also depend on the quantities of the other characteristics as well (Freeman 1979). Only the double-log and Box-Cox transformations allow the implicit price of a characteristic to depend on its own level and on the levels of the other characteristics (Freeman 1979, p. 1,140). These two functional forms were examined in this study.

CHAPTER THREE

METHODS

Data Collection

Variables

The structural and neighborhood variables listed in Table 2 have been shown to be statistically related to housing prices in other studies (Brown & Pollakowski 1977; Abelson 1977; Harrison & Rubenfeld 1977 and Li & Brown 1980).

Among the neighborhood variables, an employment center is defined by the locations of the five top employers in the city: the central business district, the University of Arizona, the University's Medical Center, Davis Monthan Air Force Base, and the Tucson International Airport (The Star 200, 1987).

Open space is defined as units of land of at least five acres in area, free of man-made structures and impervious surfaces except for those serving recreational needs. The open space variables were further organized into three classes: designated/developed, designated/natural and undesignated/natural.

Table 2. List of independent variables

NAME	DEFINITION	UNITS
Structural Variables		
HAREA	area under roof	sq. ft.
LAREA	area of lot	sq. ft.
BED	number bedrooms	
BATH	number bathrooms	
FP	fireplace	0, 1
POOL	none, private, community	0, 1, 2
COOL	evaporative, refrigeration	0, 1
PATIO	patio	0, 1
LANDSCAP	desert, nondesert	0, 1
GAR	garage	0, 1
CONSTRUC	type construction	7 classes
AGE	age of house	years
GH	guesthouse	0, 1
Neighborhood Variables		
D	zoned density	0
	low = one house per	
	180,000-36,000 sq. ft.	
	high = one house per	1
	36,000-6,000	

Table 2. CONTINUED

NAME	DEFINITION	UNITS
HS	high school	17
SHOP	distance to nearest regional mall	one-half mile
EMP	distance to nearest employment center	one-half mile
Open Space Variables		
Designated/Developed		
NBRPK neighborhood park	distance to nearest neighborhood park	one-half mile
DIST	distance to nearest district park	one-half
REG	distance to nearest regional park	mile
GOLF	distance to nearest public/private course	mile
CEM	distance to nearest cemetery	mile
Designated/Natural		
SAGE	distance to the Saguaro National Monument	mile
TMP	distance to Tucson Mountain Park	mile
COR	distance to Coronado National Forest	mile
BIG	distance to nearest of SAGE, TMP, COR	mile

Table 2. CONTINUED

NAME	DEFINITION	UNITS
Undesignated/Natural		
HAB I	distance to critical wildlife habitat	one-tenth mile
HAB II	distance to wildlife habitat	one-tenth mile
NAT	distance to nearest of HAB I, HAB II	one-tenth mile
OTH	distance to other natural open space	one-tenth mile

Designated/developed urban open spaces included parks that are spatially distributed in relation to the spatial distribution of population are operated by a public entity, contain recreational facilities, offer organized recreational activities, and have a designed landscape. Cemeteries and golf courses were also included in this category even though they do not meet all of the conditions listed for the category.

Neighborhood parks emphasize playground activities, are 5-10 acres in area, are intended to serve a population of 3,000-6,000 people within a service area with a radius of one mile. Neighborhood parks emphasize playground activities. District parks are approximately 40 acres in size, are intended to serve a population of 15,000-30,000 people within a service radius of one and one-half miles. District parks contain such facilities as: swimming pools, tennis courts, picnic areas and recreation centers. Regional parks are characterized by large natural picnic areas, lakes, and specialized recreation services (gymnasiums, golf courses). They are intended to serve an area of population of 60,000-85,000 people within a service radius of four miles and range in size from 40 to 640 acres. Public golf courses are generally 160 acres for 18 holes intended to serve a population of 60,000 people living within a thirty minute drive (Parks & Recreation Master Plan, 1988). Cemeteries are also included in this class as they are designated landscaped open spaces.

The airline distance from the block of the property to the nearest neighborhood (NBRPK) and district park (DIST) were measured to the nearest one-half mile. Similarly, airline distance from a property's block to the nearest regional park (REG), golf course (GOLF), and cemetery (CEM) were measured to the nearest mile.

The designated/natural open spaces consist of Saguaro National Monument East, Tucson Mountain Park and Saguaro National Monument West, and the Santa Catalina District of the Coronado National Forest. They are large natural reserves forming a half moon around the northern section of the city (see Figure 1). Saguaro National Monument East, administer by the National Park Service (NPS), is located southeast of Tucson and is characterized by a designated wilderness area, a visitor center, and a picnic area. Saguaro National Monument West, also administered by the NPS, also has a visitor center, picnic facilities and hiking trails, and is adjacent to Tucson Mountain Park. The Pima County Parks and Recreation Department administers Tucson Mountain Park which houses an amusement park (Old West), the Arizona Sonora Desert Museum, picnic and camping areas and hiking trails.

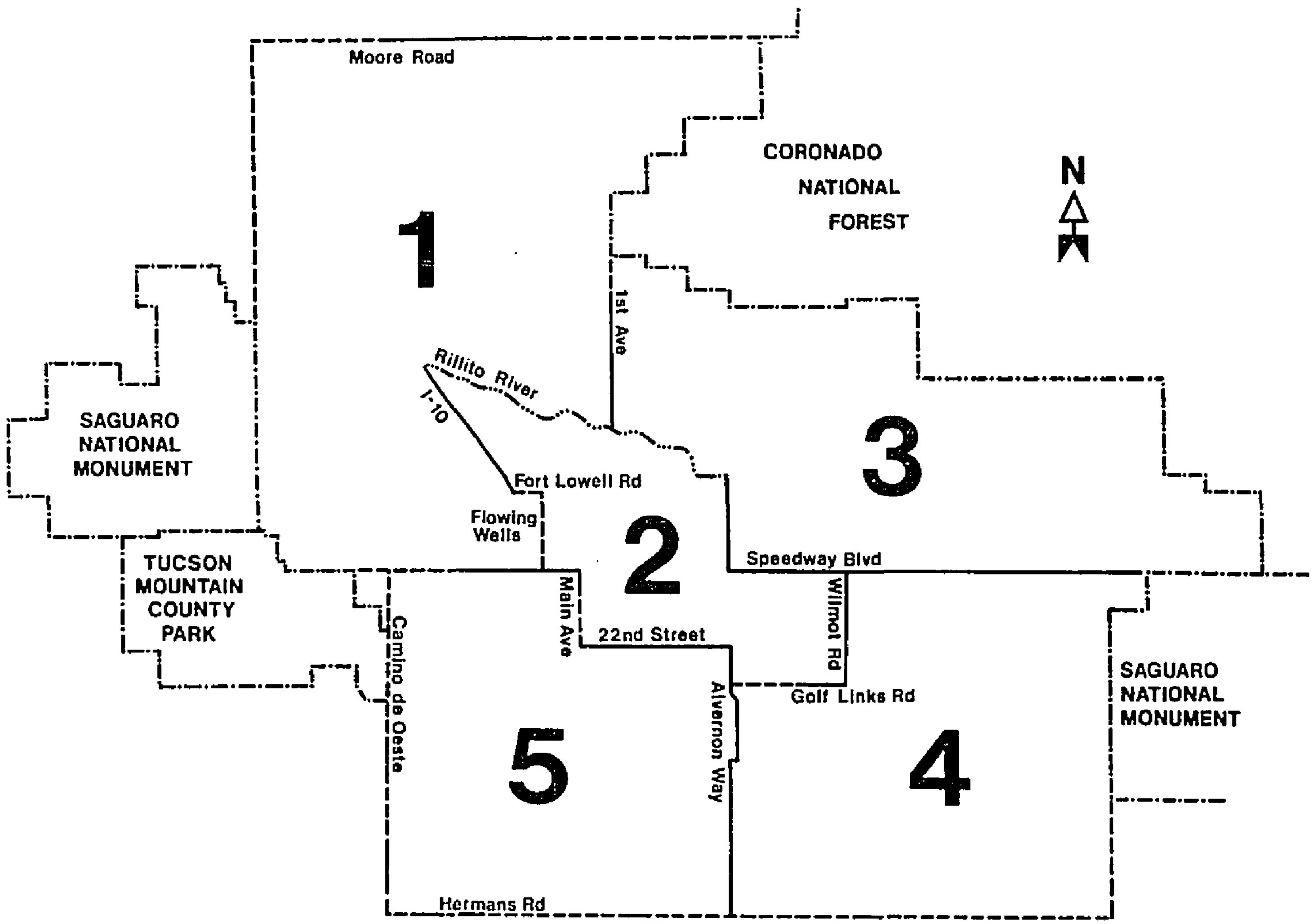

Figure 1. Map of study area.

The Santa Catalina District of the Coronado National Forest, is located northeast of Tucson and is administered by the Forest Service. It is characterized by designated natural areas (Butterfly Peak & Santa Catalina), significant archaeological and ecological areas, a ski resort on Mt. Lemmon and lakes and creeks (Rose Canyon & Sabino Canyon).

The airline distances from a property's block to Saguaro Monument East (SAGE), Tucson Mountain Park/Saguaro Monument West (TMP), and the Coronado Forest were also measured to the nearest mile (see Figures 2 - 5).

Wildlife Habitat I, Habitat II and other natural open space make up the undesignated/natural open space class. Both publicly and privately owned lands are included. Wildlife habitats I and II were defined as critical and sensitive wildlife habitat (Wildlife Habitats in Tucson, 1986).

The Habitat I class is defined as including "habitats that are exceptionally important for wildlife and which are scarce and declining in supply," (Wildlife Habitats in Tucson, p. 3). Specifically, these habitats may include:

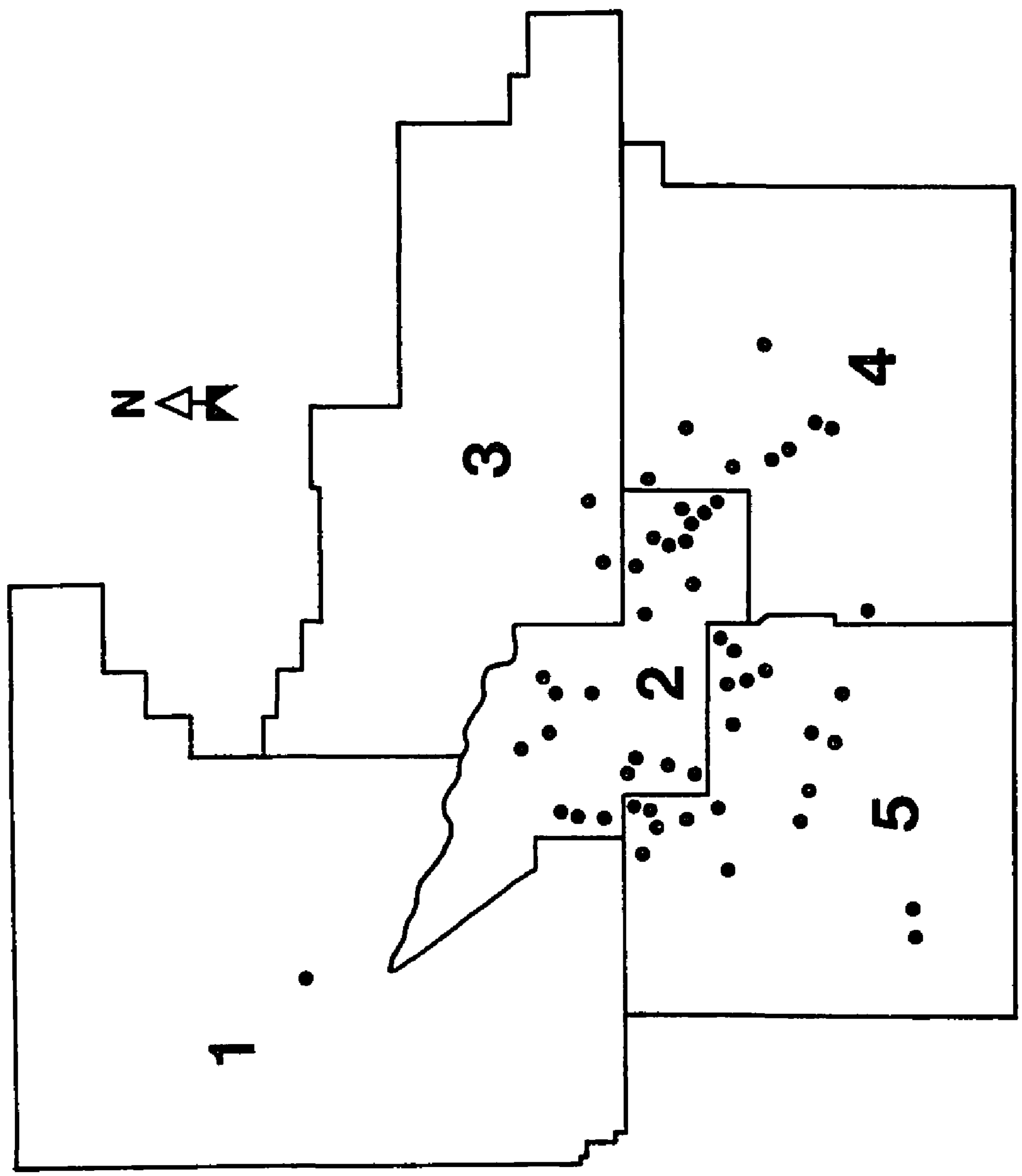

Figure 2. Location of neighborhood parks.

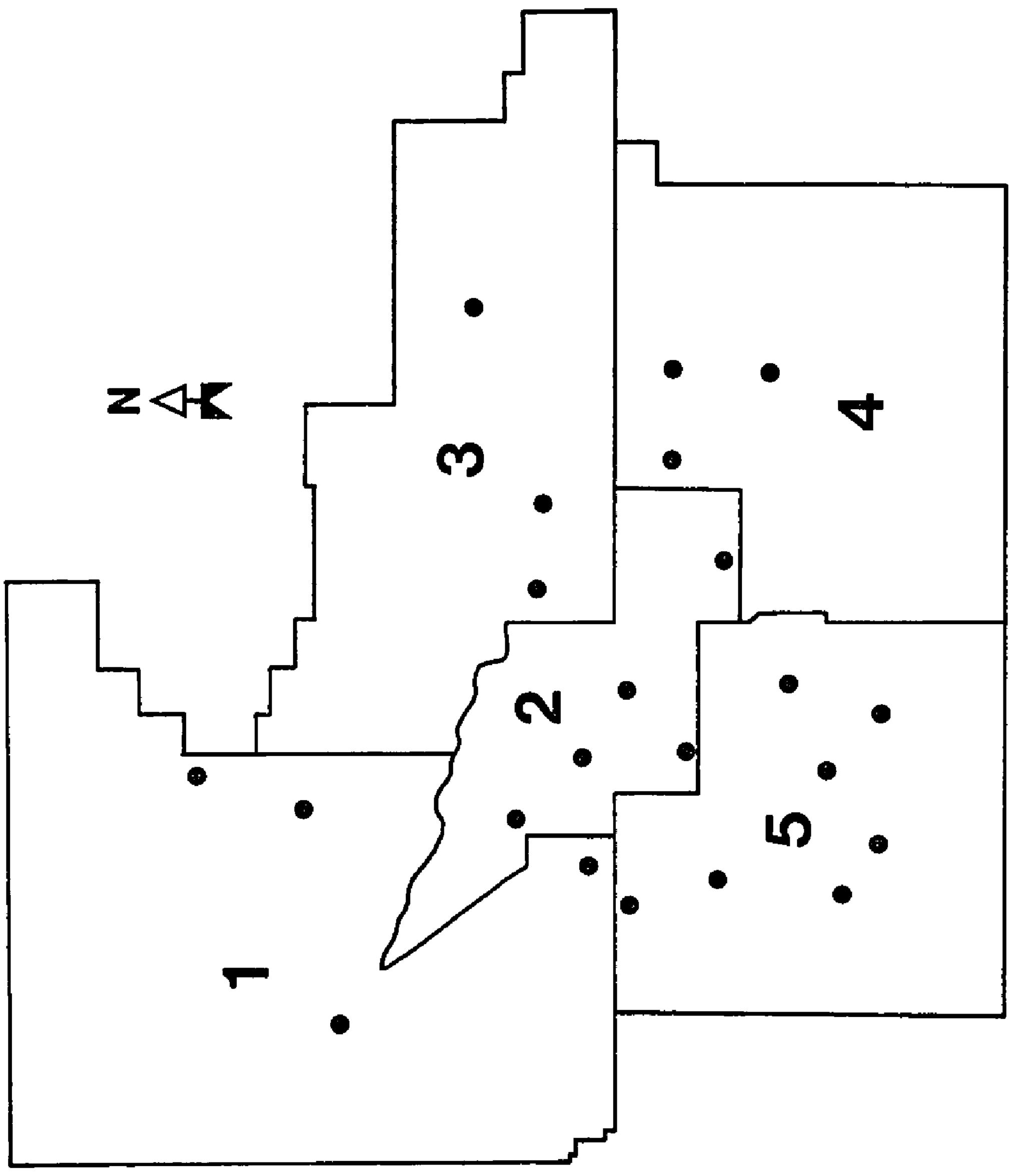

Figure 3. Location of district parks.

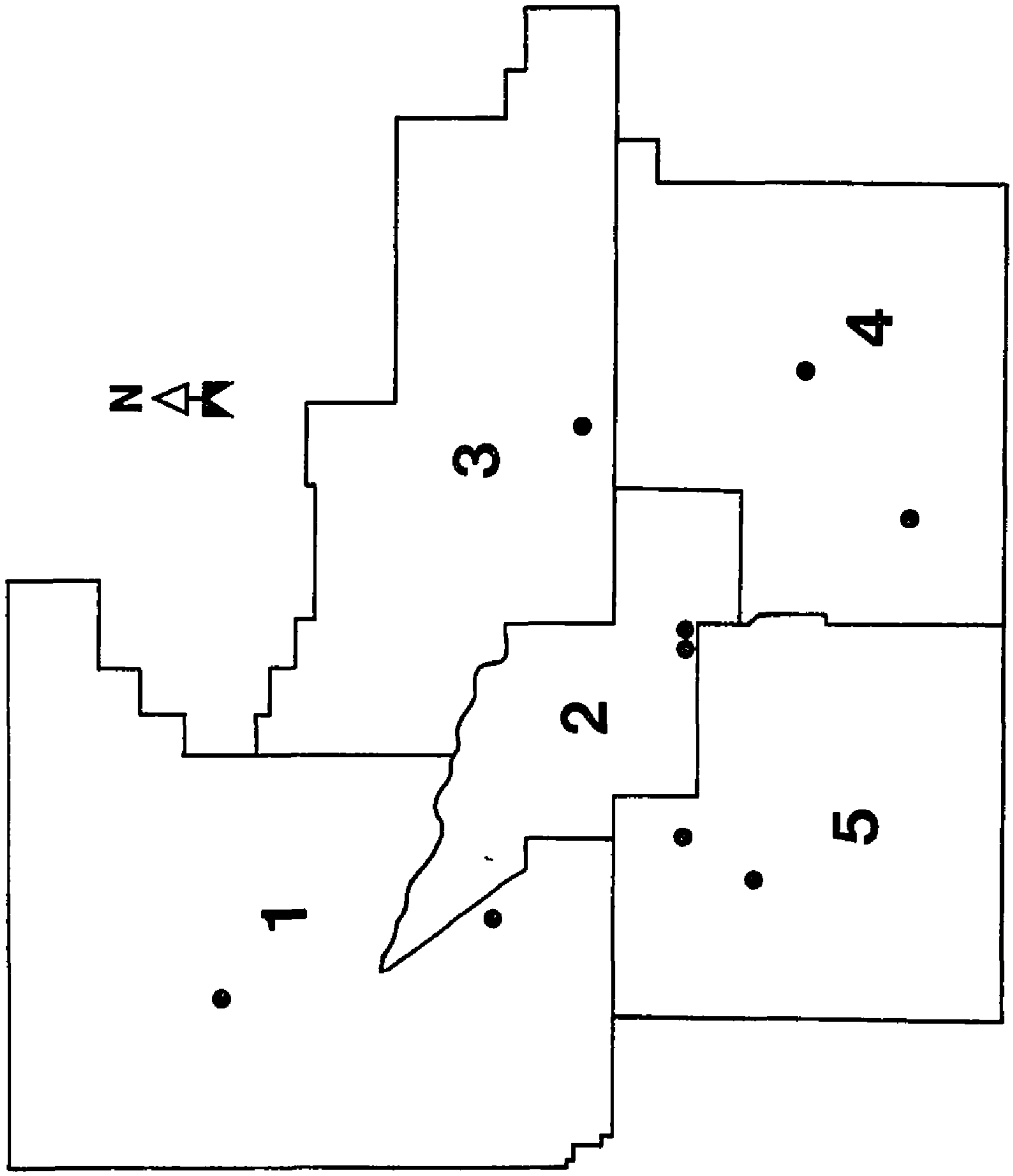

Figure 4. Location of regional parks

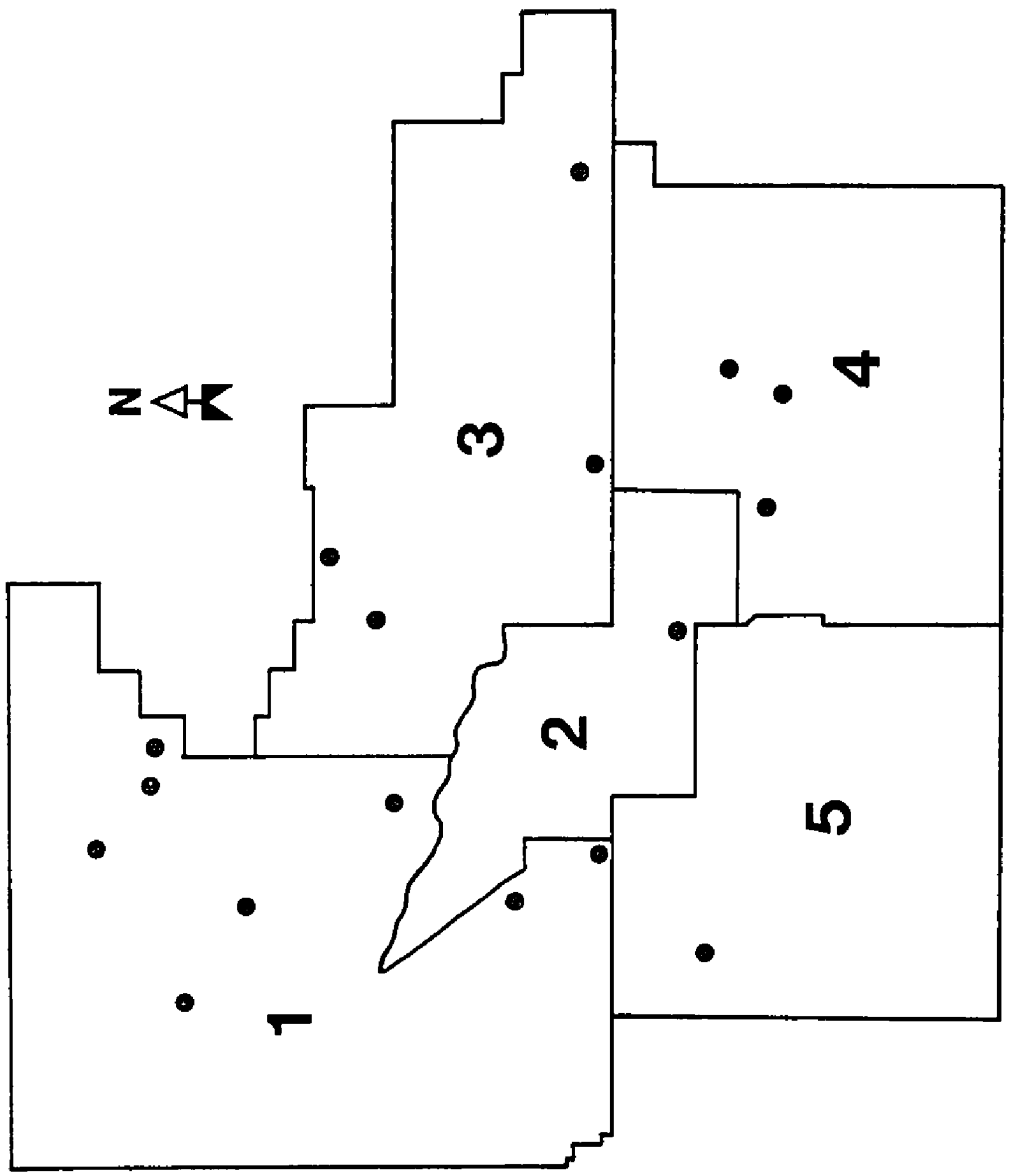

Figure 5. Location of golf courses.

1. Deciduous riparian woodlands,
2. Mesquite bosques,
3. Lakes, ponds and wetlands, and
4. Major extensions of desert riparian habitat from the large reserves of public lands surrounding Tucson.

Habitat II is defined as including "areas important to wildlife because they support a diversity of species and large numbers of individuals," (Wildlife Habitats in Tucson, p. 7). These areas include:

1. Paloverde-saguaro community,
2. Ironwood plant community, and
3. Major segments of riparian habitats not linked with protected areas.

Other natural open space areas include undesignated, private or public units of land which is not adjacent to either Habitat I or Habitat II. Airline distances to Habitat I, Habitat II (HAB I, HAB II), other natural open space (OTH) were measured to the nearest one-tenth mile.

Sample

The sample frame was the Multiple Listing Service report of residential property sales in the Tucson Metropolitan area for 1986. Five geographic strata were defined on the basis of socioeconomic characteristics, land use patterns and personal knowledge of the area (Tucson Trends, 1986).

A ten percent systematic sample with a simple random start was drawn from each stratum. The number of observations by strata is:

STRATA	OBSERVATIONS
1	110
2	123
3	188
4	109
5	72
TOTAL	602

Townhouses were excluded from the analysis to achieve greater homogeneity. They constituted only about 17 percent of the original sample. The final sample distribution is:

STRATA	OBSERVATIONS
1	96
2	111
3	143
4	97
5	56
TOTAL	503

Measurement of Distances

The city blocks of each property, designated/developed and natural open space, employment centers, high schools and shopping malls were located on a map of Tucson (Compass Maps, 1987). Five acre plots of Habitat I, Habitat II and the other natural open spaces were located on the aerial maps on which they had been mapped (Critical and Sensitive Biological Communities, Division of Wildlife and Fisheries, 1987). Airline distances were measured for all distance variables.

Analysis

Multiple regression and correlation analysis were used to estimate the hedonic equation. Various specifications and functional forms were tested and will be discussed in the following chapter.

CHAPTER FOUR

RESULTS

Residential Property Characteristics

The residential property characteristics for the five geographical areas are shown in Tables 3 and 4. Some general observations concerning the characteristics of each stratum follow below.

Strata 1 and 3 are both located in the foothills of the Santa Catalina Mountains; stratum 1 is located in the northwest portion of the Tucson metropolitan area; stratum 3 in the northeast section. They both have the highest mean house prices, largest houses and lots in the sample. The homes in these two areas are younger on average and are located in less densely developed neighborhoods than the homes in the other three strata (see Table 3).

These two foothill areas fall mainly outside the city limits of Tucson with basic urban services supplied by Pima County Government (streets and sewers), City of Tucson (bus and water), and private firms (garbage and fire). Thus, the kind and quality of services offered differ from those provided by the city. For example, there are no bus routes in stratum 3 and only one route in stratum 1 (see

Table 3. Variable means and standard deviations.

	Strata 1	Strata 2	Strata 3	Strata 4	Strata 5
PRICE	$89,429 (29,726)*	$60,682 (22,652)	$130,743 (68,696)	$66,500 (14,761)	$48,438 (12,963)
HAREA	1,747 (558)	1,341 (785)	2,082 (653)	1,471 (347)	1,181 (335)
LAREA	36,155 (39,105)	11,163 (785)	35,684 (37,684)	10,935 (23,571)	9,771 (10,919)
AGE	10 (6)	34 (12)	12 (8)	18 (7)	19 (12)
EMP	10 (2.3)	3 (1.5)	8 (2)	3.5 (1.5)	4.5 (2)
NBRPK	3.8 (1.7)	2.2 (1.1)	5.3 (1.9)	1.9 (0.8)	4 (2.2)
DIST	2.5 (1.1)	2.7 (1.0)	3.2 (1.2)	2.2 (1.0)	2.3 (1.3)
REG	3.4 (1.3)	3 (1.4)	4.5 (2.1)	2.7 (1.1)	3.3 (1.6)
GOLF	2.1 (0.7)	2.7 (1.3)	3 (1.4)	2 (0.8)	5.7 (2.5)
BIG	4.5 (1.5)	7.9 (1.2)	4.3 (2.1)	6.2 (1.6)	4.7 (1.8)
NAT	0.56 (0.4)	1.7 (1.0)	0.39 (0.3)	0.95 (0.6)	0.61 (0.4)
OTH	0.40 (0.8)	3.40 (1.3)	0.60 (0.6)	1.0 (0.5)	0.61 (0.5)

* Numbers in parentheses are standard deviations.

Table 4. Open space characteristics

	S1	S2	S3	S4	S5
NUMBER OF PROPERTIES SOLD	960	1,110	1,430	970	560
AREA OF STRATA (sq. mi.)	97	40	82	54	90
NUMBER OF NEIGHBORHOOD PARKS	1	11	0	5	7
Parks per property	0.010	0.10	0	0.050	0.125
Parks per sq. mi.	0.010	2.75	0	0.093	0.078
NUMBER OF DISTRICT PARKS	4	5	3	3	7
Parks per property	0.420	0.040	0.021	0.031	0.125
Parks per sq. mi.	0.042	0.125	0.035	0.050	0.077
NUMBER OF REGIONAL PARKS	1	1	1	2	2
Parks per property	0.009	0.009	0.006	0.021	0.036
Parks per sq. mi.	0.099	0.025	0.011	0.036	0.021
NUMBER OF PUBLIC GOLF COURSES	0	1	0	1	2
Golf per property	0	0.009	0	0.009	0.036
Golf per sq. mi.	0	0.025	0	0.018	0.022
PRIVATE	5	0	4	2	1
Golf per property	0.051	0	0.028	0.021	0.018
Golf per sq. mi.	0.051	0	0.049	0.036	0.011

Table 4. CONTINUED

NUMBER OF OTHER NATURAL OPEN SPACES 5 acre plots	57	17	63	30	25
Plots per property	0.60	0.15	0.44	0.31	0.45
Plots per sq. mi.	0.60	0.43	0.76	0.55	0.27
SAMPLE PROPERTIES	96	110	143	97	56

Sun Transit map). The density of bus routes and the frequency of service are much higher in strata 2, 4 and 5 than in 1 and 3.

Properties in strata 1 and 3 have the shortest mean distances to golf courses (Table 3). Only private golf courses are located in these two strata; five in stratum 1 and four in stratum 3. It must be noted, however, that distances were measured to the nearest golf course whether it was in or out of the strata boundaries.

The longest mean distances to the designated/developed open spaces, NBRPK, DIST and REG appears in stratum 3. This is partially explained by the fact that stratum 3 has no neighborhood parks, and stratum 1 has just one. Since publicly designated open space is developed according to population standards, we would expect their distribution to be less frequent in less densely populated (zoned) areas than in more densely populated areas.

Stratum 3 also has the shortest mean distances to Habitat I or Habitat II (NAT), and the largest number of other natural open spaces (OTH) per square mile (see Tables 3 and 4). Stratum 1 has the shortest mean distance to other natural open space (OTH), and also the highest number of natural open spaces per square mile.

The other three strata are located in the basin flatlands; stratum 2 is in the central portion of the metropolitan area, stratum 4 is in the southeastern portion and stratum 5, in the southwestern area. Houses and lots in these strata are smaller than in strata 1 and 3 (see Table 3). In general, the homes in these areas are older and in more densely developed neighborhoods. These areas all have public golf courses, which are associated with a regional park (see Figures 4 & 5). Homes in stratum 5 are furthest from golf courses (Table 3).

Sales properties in stratum 2 had the longest mean distance to the designated and undesignated classes of open space (BIG, NAT, OTH), with other natural open space making up the smallest percentage per total observations and area in the sample. But this area has the highest percentage of neighborhood and district parks per total observations and area (Table 4). In general, Strata 2, 4 and 5 have the shortest mean distance to district parks and to employment centers, but average the highest distance to other natural open space.

Regression Analysis

Specification and Functional Form

Specification

Specification was complicated by high multicollinearity among both the structural and neighborhood independent variables. The problem was resolved by selecting one variable to represent each of the two categories.

To make this selection, regressions were run, within each category, between each variable taken in turn as the dependent variable and the remaining variables (Keleljian & Oates 1981, p. 132). Based on the largest R^2 value, the results led to the selection of house area (HAREA) to represent the structural variables and distance to the nearest employment center (EMP) to represent the neighborhood variables. Another neighborhood variable, zoned density (D), was included in the specification as a reflection of the amount of private open space associated with a property in strata 1 and 3. In strata 2, 4 and 5, there was so little variation in zoned densities that it was not included in these regressions.

Underspecifying the structural or neighborhood variables (omitting variables) is problematic only if the omitted characteristics are correlated with open space characteristics. For example, house floor area and number of bedrooms may be slightly different measures of the capacity of a house, and therefore only one need be specified in the equation. Which of the two makes no difference because the primary purpose of the study is to determine the influence of open space (its implicit price), and if both variables are correlated with open space characteristics.

SAGE, TMP and COR were also highly correlated (Table 5). Originally, it was hypothesized that these open spaces would have a differential impact (implicit price) on sales price. However, because of the high multicollinearity, it is not possible to separate out their individual influences. Therefore, distance to the nearest of Saguaro National Monument East, Tucson Mountain Park and Saguaro Monument West and the Coronado National Forest was measured. This new variable is called BIG (see Table 2). It seemed that the differences between Habitat I and Habitat II would not be perceived by the average home buyer. For this reason, distance to the nearest unit of these two types of open space was defined as a variable called NAT (see Table 2).

Table 5. Correlation coefficients for TMP, SAGE and COR by strata.

	STRATA				
	S1	S2	S3	S4	S5
VARIABLES					
LNTMP with LNSAGE	-0.3755*	-0.7600	-0.6495	-0.5749	-0.6766
LNTMP with LNCOR	-0.8364	-0.3572	-0.3637	-0.0484	-0.2396
LNCOR with LNSAGE	-0.8364	-0.0268	-0.1347	-0.0318	0.3808

* Significance levels for a 1-tailed t-test:

Statistically different from zero at 1% level > .2800
5% level > .2600
10% level > .2400

Functional Form

As noted above, it seems logical that the effect of an open space characteristic on sales price depends upon the levels of the property's other characteristics and on its own level. Because the double-log and Box-Cox transformation allow for these expectations, these two functional forms were investigated (Freeman 1979, p. 142). The general functional form of the Box-Cox transformation is shown below (Freeman p. 140).

$$\frac{R^c - 1}{c} = a + bP$$

Where c is an unknown parameter.

A very limited Box-Cox search was performed using power transformations (c), ranging from -0.05 to 0.2. The double log function, a special case of the Box-Cox transformation, (c = 0), was chosen because differences between the R^2 of the double-log form and the best (highest R^2), Box-Cox transformation were very small (see Table 6).

Stratification/Segmentation

We assumed that the Tucson housing market was segmented, and so the sample was prestratified. Freeman (1979) argues that one of two conditions must hold for market segmentation to exist. The first condition concerns barriers to mobility, such as income and/or race, which

Table 6. Coefficients of multiple determination (R^2) for Double-log and Box-Cox functions.

Functional form	Strata 1	Strata 2	Strata 3	Strata 5	Strata 5
DOUBLE-LOG	0.787	0.458	0.786	0.67	0.469
BOX-COX	0.772	0.467	0.777	0.688	0.451

prevent some buyers from entering a particular housing market. The second condition is that the structure of supply or demand vary from one segment to another. This second condition means that, holding all else constant, the housing packages being supplied and demanded differ among strata.

To test whether segmentation existed, we tested for significant differences in the slopes and intercepts among strata regression equations (Kelejian & Oates, 1981, see APPENDIX 1). The F-tests showed that both intercepts and slopes were significantly different (see APPENDIX 2). This result indicates that the Tucson housing market is segmented and that one or both of the above two conditions exist in the Tucson housing market.

That income might be a barrier to a particular housing market is shown by the mean prices shown in Table 3. Strata 2, 4 and 5 are well below the overall average of $85,607. Differences in the mean sales price per square foot of house area among strata also imply that different housing packages are being supplied and demanded (Table 7).

Further, these results mean we cannot combine strata and estimate a single hedonic equation for the Tucson urban area.

Table 7. House sales price per square foot by strata.

Strata	Price per sq. ft.
1	$51.19
2	$45.25
3	$62.80
4	$45.21
5	$41.01

Hedonic Price Equations

All distance variables were transformed by taking their natural logarithms (Ln). Table 8 reports the regression results for the hedonic equations using the final specification and double-log functional form for the five strata. Both strata 2 and 5 have the lowest R^2's of the regressions, 0.458 nd 0.469 respectively. Stratum 4 had an R^2 of 0.671 in between those in strata 1 and 3, and 2 and 5. The low R^2's in strata 2 and 5 indicate that the variables specified in these equations are explaining less of the variation in the dependent variable than in the other strata. Only the variable LnHAREA was found to be statistically different from zero in all strata. The simple correlation coefficients and the presence of many insignificant variables (only half of the coefficients have t-values with P's < 0.10), indicates a high degree of imperfect multicollinearity (Kelejian & Oates 1981, p. 197). This, along with the large R2's, means that at least one independent variable is systematically influencing the dependent variable but we cannot tell which one.

High multicollinearity causes the estimates of the regression coefficients to be unreliable. That is not a problem, however, if we wish to predict property prices. It is a problem if we wish to estimate the implicit prices of characteristics.

Table 8. Estimated hedonic equations by strata.

Variables	Strata 1	Strata 2	Strata 3	Strata 4	Strata 5
Constant	5.6 (9.219)**	5.825 (8.919)**	4.82 (6.039)**	6.525 (14.587)**	6.14 (7.676)**
Ln(HAREA)	0.73 (10.626)**	0.602 (8.700)**	0.887 (12.440)**	0.595 (10.350)**	0.672 (6.547)**
D	0.023 (.431)		0.237 (4.109)**		
Ln(EMP)	0.021 (0.307)	-0.043 (-0.520)	-0.094 (-0.489)	-0.041 (-0.541)	0.021 (0.160)
Ln(NBRPK)	0.163 (2.257)**	0.117 (1.337)	0.103 (0.673)	0.073 (1.441)	0.021 (0.377)
Ln(DIST)	0.007 (0.112)	0.075 (0.776)	-0.034 (-0.449)	0.148 (2.795)**	-0.031 (-0.022)
Ln(REG)	0.133 (1.819)*	0.03 (0.189)	0.131 (1.729)*	0.096 (1.485)	0.45 (1.304)
Ln(GOLF)	-0.122 (-1.841)*	0.1 (0.576)	-0.225 (-3.417)**	-0.09 (-1.419)	-0.139 (-1.071)
Ln(BIG)	-0.028 (-0.396	0.291 (1.192)	0.149 (1.317)	-0.089 (-0.332)	-0.037 (-0.390)
Ln(NAT)	0.077 (0.827)	0.031 (0.352)	-0.032 (-0.253)	-0.216 (-2.888)**	-0.071 (-0.342)
Ln(OTH)	-0.201 (-1.643)*	-0.112 (-0.755)	-0.243 (-2.212)**	0.113 (1.467)	-0.213 (-1.294)
R^1	0.788	0.4579	0.7866	0.6712	0.4688
F	36.71**	7.13*	53.51**	23.01**	6.423*
N	96	111	143	97	56

1 = Tailed t-test
** = P < 0.01
* = P < 0.05

Structural/Neighborhood Variables

The regression coefficient of the log of house area (LnHAREA) was significantly greater than zero in each of the strata regressions. This means that as house area increases, the price of the residence also increases.

The coefficient on the density variable (D) was statistically greater than zero at the 1% probability level in stratum 3, but was not in stratum 1. This difference may be because of the low proportion of properties in stratum 3 in the high density class, 36 percent, as compared to 51 percent in stratum 1.

The coefficient on distance to the nearest employment center (LnEMP) was not found to be statistically significant from zero any of the regressions. Some studies have found this variable to influence housing price (Li & Brown 1980; Nelson 1978; Witt et al., 1979, and Tolley & Diamond 1982).

However, this conclusion has not been reached in studies of urban areas, such as Tucson, that do not have a single major employment center, or central business district (Harrison & MacDonald 1974). For example, more people are employed at the University of Arizona and the Tucson International Airport then in the central business district (The Star 200, 1987). In addition, employment centers are fairly evenly distributed throughout the Tucson metropolitan area. Thus, lack of variation in the employment location variable which may be the reason for its insignificant regression coefficient. It has been suggested that, when a single employment center does not exist, a better measurement of this attribute is accessibility to freeways (Harrison & MacDonald 1974). However, Tucson does not have serious traffic congestion, so accessibility to major freeways or roads may not be an appropriate substitute measure for Tucson. The general lack of a serious traffic problem may also explain why this variable seems to have little impact on house prices in Tucson.

Open Space Variables

Designated/Developed

The designated/developed open space regression coefficients were either not statistically different from zero, or they were significantly greater than zero. The coefficient on LnNBRPK was statistically greater than zero at the 1% probability level in stratum 1. The regression coefficients on LnREG also have positive signs ($P < 0.05$) in strata 1 and 3. The coefficient on LnDIST was statistically greater than zero at the 1% level in stratum 4 (see Table 8). This means that as distance to a neighborhood, district and regional park decreases, house price also decreases in these strata.

The other kind of designated/developed open space is golf courses. Ln(GOLf) had a negative coefficient on sales price in stratum 1 and in stratum 3. Ln(GOLF) also had negative coefficients in the other strata but they were not statistically less than zero. In strata 1 and 3, the closer a property is to a golf course the higher is its price.

Designated/Natural

The coefficient on distance to the nearest designated/natural open space, Ln(BIG), was not statistically significant in any of the strata.

Undesignated/Natural

The coefficient on distance to the nearest Habitat I and Habitat II (NAT) is statistically less than zero in stratum 4 ($P < .05$), but did not enter any of the other regressions. The coefficient on distance to other natural open spaces Ln(OTH) is statistically less than zero ($P < .05$) in stratum 1 and in stratum 3 ($P < .05$). Both these strata have the lowest mean distance to these natural areas indicating that they are less scarce in these strata than in the others. Generally, other natural open space (OTH) consists of "upland" areas which occur more frequently in the foothills region. As one approaches natural upland areas, house price increases.

<u>Discussion</u>

Urban parks that emphasize developed recreational facilities have been shown to depress housing values in other studies. Weicher and Zerbst (1973) found that for properties whose view was obstructed by playground equipment, housing values were eight percent lower than properties that faced or backed onto park grounds. Moore and Stevens (1982) also found parks that offered sports and recreational facilities and activities have a negative impact on housing.

We can generally conclude from our results and the literature, that the existence of developed recreational facilities tends to decrease housing values because of their disamenities such as: the obstruction of views by recreational equipment; the noise, traffic and overcrowding caused by such activities and the perceived fear of safety from night activities and social gatherings taking place on park grounds.

What physical and geographical features might explain the differing statistical results between strata concerning the designated/developed urban parks? One hypothesis is that if a type of open space is relatively more scarce in one stratum as compared to others, we might expect a larger, positive impact on housing price. The measure of scarcity in this study is the mean distance between properties and the nearest units of open space. Since the mean distance to a neighborhood park is highest in stratum 1 (see Table 3), we expect that as distance decreases to the neighborhood park, the value of a property would increase. However, in stratum 1, house price decreases as distance to a neighborhood park decreases. So this logic does not seem appropriate here.

Another hypothesis concerns the spatial distribution of zoned densities within strata. Because designated/developed open space development is normally driven by population, it could be that as one approaches these urban parks, density of development increases, and so, house area decreases. These relationships tend to decrease house price. The simple correlation coefficients between density and these parks shoe this relationship : D and LnNBRPK = 0.737, D and LnREG = 0.567 (stratum 1); D and LnDIST = 0.255 (stratum 4); and D and LnREG = 0.623 (stratum 3).

Proximity to private golf courses increased property values in strata 1 and 3. This might be explained by the fact that private courses usually precede and complement high priced residential developments. The nonsignificance of Ln(GOLF) in the other strata may be due to the fact that all of the golf courses are public and associated with a regional park.

The lack of statistically significant regression coefficients on distance to the nearest designated/natural open space Ln(BIG), may be due to their distribution around the perimeter of the Tucson basin. This distribution results in a lack of variation in the variable, and indeed, LnBIG has the lowest coefficient of variation (39.9%) of all the independent variables. The open spaces embodied in BIG are also ever present features in the Tucson horizon. This ubiquitousness may cause them to be taken for granted within the aggregate housing market.

One explanation for the generally insignificant results of distance to the nearest Habitat I and Habitat II Ln(NAT), may be the fact that these "wash" areas are not readily visible from individual residences. What factors might explain the significant influence of Ln(NAT) in stratum 4? One factor may be that these riparian areas are highly visible in this stratum as it lies at a lower elevation than do strata 1 or 3. Strata 2 and 5 are also lower in elevation but the river corridor is most prominent in stratum 4 (see figure 1).

The positive impact from Ln(NAT) in stratum 4 may be the result of benefits associated with viewing and enjoying urban wildlife. Riparian areas support about 85 percent of Arizona's wildlife (Nature Conservancy, 1988). Ruther (1987, p. 44) found that 90 percent of Tucson households surveyed enjoyed seeing wildlife within a one mile radius of their homes. Forty-two percent said that the washes and undeveloped urban open spaces provided the most wildlife enjoyment.

Urban open spaces that emphasize non-recreational natural areas Ln(OTH) have been shown to have a greater positive impact on housing value than those which emphasize developed recreational activities. Coughlin and Kawashima (1973); Correll, Lillydahl and Singell (1978); Pollakowski and Brown (1977); Hammer, Coughlin and Horn (1974); Moore and Stevens (1986); Allen, Stevens, Yocker and Moore (1986); Hagerty, Stevens and Moore (1982) and Cordell (1980), all found that urban parks that emphasized natural open space increased housing value. Coughlin and Kawashima concluded that developers try to capture the benefits of open space amentities since larger, more expensive homes are typically located adjacent to private open space. One of the most important selling features in Tucson is scenic mountain and city views. The upland areas in strata 1 and 3 allow such views, and therefore have a positive impact on housing price. The value of scenic or aesthetic amentities is well documented (Brookshire, Thayer et al., 1982 and Pollard 1982).

The insignificance of Ln(OTH) in strata 2, 4 and 5 may be a function of homeowners preferences. Homeowners who choose to live in more densely populated areas may value such amenities as proximity to work or cultural events, more than natural open space. However, this result may also be caused by income barriers to the more expensive housing markets located in strata 1 and 3.

Result Summary

In general, we found that when urban open space was shown to have an impact on residential property price, proximity to developed open space decreased housing value, whereas proximity to natural open space increased the value of homes. The negative impact on price from developed open space may be due to disamenities from recreational activities, or density patterns. The positive impact on price from natural open space may be capturing the benefits from urban wildlife and scenic views.

The lack of statistically significant variables may have been caused by the presence of multicollinearity, the low correlations between the independent variables and the dependent variable (strata 2, 5), the lack of variation in a variable (BIG), poor visual contact with an amenity (NAT) and different preferences of homeowners.

It was concluded that the Tucson basin contained separate housing markets as represented by the five strata. Each strata contained a different housing package. The fact that no open space variables had any influence on price in strata 2 and 5 may be a result of different preferences. The representative homeowner in these strata may not demand urban open space amenities as part of a housing package. A different supply and demand equilibrium for housing may exist among the strata.

CHAPTER FIVE

PLANNING IMPLICATIONS AND CONCLUSIONS

Specific Applications

In this study, only the implicit prices of various types of urban open spaces were estimated. Nothing was directly revealed about consumer demand for these open spaces. However, these prices are useful information in managing an open space system in Tucson.

One application of the estimated implicit prices (see Table 9), is tax increment financing. A land-value-increment tax is similar to a realized-capital-gains tax, with the tax liability imposed at the time of a land sale (Property Tax and Local Finance 1983 p. 325). The basic logic for the land increment tax is the existence of unearned increments--rising land values as a social rather than an individual product. Essentially, it is a supplementary capital gains tax on lands which which could provide at best limited revenues (Netzer 1982 p. 212). Traditionally, incremental tax financing has been used as a substitute means of financing certain kinds of capital improvements frequently handled through special assessments, or as a means of recouping part of such costs (Netzer 1982).

Table 9. Implicit prices of significant open space variables.

Variables	Stratum 1	Stratum 3	Stratum 4
HAREA (sq. ft.)	$ 70.42	$ 2.01	$ 0.24
NBRPK (per mile)	$ 94.81		
DIST (per mile)			$ 39.40
REG (per mile)	$ 83.87	$ 114.72	
GOLF (per mile)	-$ 120.50	-$ 265.25	
NAT (per mile)			-$ 141.10
OTH (per mile)	-$1,198.34	-$ 709.89	

It has been suggested (Correll et al., 1978), that incremental tax financing be used to maintain existing open space by public acquisition. An alternative approach would be the subsidization of private development on the basis that the subsidy would be repaid by the higher taxes resulting from the higher property values.

The information gained from this study is useful knowledge. The fact that existing developed recreational parks may decrease residential property values in some areas should motivate planners to rethink the design and placement of recreational facilities with respect to nearby homes. That natural open space increases the value of certain properties should prompt developers to be more sensitive when planning a new housing development. Cluster housing, where homes are grouped at a higher density within a development in order to create a continuous area of natural open space, is evidence that some developers do consider natural open space valuable to potential home buyers.

Conclusions

The results of this study were mixed. We found that urban parks which emphasize developed recreational facilities decreased housing price, whereas private golf courses and natural open space areas seemed to increase property values in some parts of the urban area, and had no influence in other areas. The negative impacts on price appear to be the result of disamenities caused by recreational consumption (noise, traffic, congestion), and recreational facilities (blocked views). The positive impact on price seems to be a function of the benefits derived from urban amenities such as wildlife and scenic views. These findings are consistent with the findings in other studies.

The lack of influence of urban open space amenities on residential property values in strata 2 and 5 may be a result of different preferences of homeowners. The fact that homeowners may have different preferences, or demand different housing packages, is supported by the finding that the Tucson housing market is segmented.

The mixed results demonstrate the complexity of the residential property market and point to the need for research designed to improve our understanding of home buyers' perceptions of urban natural amenities. In light of the results found here and in the literature, research study design and variable specification warrant discussion.

In those studies that found a statistically significant influence of amenities on housing price (Hammer et al., 1974; Weicher & Zerbst 1973; Correll et al., 1978; Coughlin & Kawashima 1973; Brown & Pollakowski

1978 and Allen et al., 1986), distance to an open space area was measured to the nearest foot, not to the nearest tenth of a mile, half mile, or mile as was done in this study. These units may not be precise enough to reveal the benefits of an urban amenity. Li and Brown (1980) and Allen et al (1986), found that beyond a half-mile the effects of the open space area were lost in the "noise" of other neighborhood characteristics and competing open space areas.

In addition, this study included eight different types of open space areas, whereas most other studies only examined the impacts from one or two. This may have effected our results as well. In those studies that included four or more urban parks, a statistically significant relationship on price was not found (Cordell 1976; Schroeder 1982; and Stevens & Moore 1986).

Variable specification also may have an impact on statistical results. In general, studies have found that slight modifications in how a variable is specified, and which variables are included in the hedonic equation, change the statistical results (Freeman 1979). In the studies that did show a significant relationship, (see above), distance to an open space, and distance to an employment center, were measured to the nearest park entrance or by freeway access rather than by the airline distance to the nearest boundary.

Other studies have also included different proxies for neighborhood quality such as crime rate, percentage of minority residents and so on. Defining neighborhood quality in different ways may impact statistical results.

Regardless of the shortcomings we now see in hindsight, we have shown that the information generated from this study is useful knowledge in open space management and planning. Open space preservation and management will become more important as development pressures continue. In order for decision-makers to make informed policy and management decisions that maximize the benefits to the Tucson community, they need information on the values of urban natural amenities. This study was an attempt to reveal some of the values and importance households place on these natural amenities.

APPENDIX 1. AGGREGATE MODEL.

Variables		Variables	
Constant	6.45 ***	LnGOLF	-0.18
	(8.54)		(-1.57)
LnHAREA	0.64 ***	S1GOLF	0.05
	(6.33)		(0.46)
S1HAREA	0.09	S2GOLF	0.24 **
	(0.66)		(1.75)
S2HAREA	-0.04	S3GOLF	0.01
	(-0.36)		(0.05)
S3HAREA	0.24 **	S4GOLF	0.85
	(1.99)		(0.85)
S4HAREA	-0.36	LnBIG	-0.04
	(-0.26)		(-0.43)
D	0.16 ***	S1BIG	-0.01
	(4.52)		(0.01)
LnEMP	-0.31	S2BIG	0.3 **
	(-0.28)		(1.75)
S1EMP	-0.62	S3BIG	0.13
	(-0.41)		(1.57)
S2EMP	-0.03	S4BIG	0.03
	(-0.31)		(0.26)
S3EMP	0.04	LnNAT	0.05
	(0.24)		(0.37)
S4EMP	-0.01	S1NAT	0.01
	(-0.06)		(0.10)
LnNBRPK	0.03	N2NAT	-0.03
	(0.40)		(-0.62)
S1NBPRK	0.01	S3NAT	-0.04
	(0.70)		(-0.81)
S2NBPRK	0.01	S4NAT	-0.82
	(0.08)		(-1.34)

APPENDIX 1. CONTINUED

S3NBPRK	0.06	LnOTH	-0.23 **
	(0.57)		(-1.91)
S4NBPRK	0.01	S1OTH	-0.01
	(0.16)		(-0.05)
LnDIST	-0.06	S2OTH	0.13
	(-0.60)		(1.13)
S1DIST	0.04	S3OTH	-0.04
	(0.50)		(-0.76)
S2DIST	0.05	S4OTH	0.12 **
	(0.66)		(1.83)
S3DIST	0.01	S1	-0.62
	(0.10)		(-0.60)
S4DIST	0.09	S2	-0.35
	(1.31)		(-0.42)
LnREG	0.08	S3	-1.65 **
	(0.74)		(1.89)
S1REG	0.05	S4	0.29
	(0.43)		(0.29)
S2REG	-0.11		
	(-0.86)		
S3REG	0.01		
	(0.06)		
S4REG	0.08		
	(0.19)		
R2	0.826		
F	49.34		
N	505		

P < 0.01 ***
P < 0.05 **
P < 0.10 *

APPENDIX 2. ANALYSIS OF COVARIANCE

Sources of variation	Sums of squares	Degrees of freedom	F
Interaction/ additive	0.907	49	116
Additive	0.896	12	433
Interaction	0.896	36	2.22

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